Technical Plastic recycling in Europe : a focus on plastics from ELV and WEEE

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About PRE

+ 150 Member Companies & Organizations

25 Years of Experience

6 Plastic Waste Streams Focused Working Groups

Voice of Plastic Recyclers In Europe

Technical Plastics Recyclers and their role in cleaning up POPs

The input

- The input of a technical plastics recycler is the “shredder light fraction” (SLF) from WEEE and ELV treatment centers. The composition of this material varies depending on the source, but typically includes: Plastics, Rubber, residual metal, minerals, foams, wood, cables; **with plastics being dominant**.
- The plastics fraction contains a large number of polymers such as: PE, PP, PS, ABS, PC, PC-ABS, PVC (rigid and soft), PMMA, PU, and more
- In Electrical and Electronic Equipment and Automotive Vehicles certain parts need to be flame retardant and others need not be flame retardant.
- Consequently, certain shredded pieces of individual polymers will contain (brominated) flame retardants and others will not contain such (B)FRs
- Certain BFRs have been: identified as POP, are banned in virgin material, and may not be recovered but need to be destroyed. (The POP PBDEs)

☐ Mixed E&E/ELV Shred	
☐ Mixed E&E Shred	☐ Mixed ELV Shred
☐ Temperature Exchange Equipment	☐ ELV Bumpers
☐ CRT Displays	☐ ELV Dashboards
☐ Flat Panel Display	☐ ELV Headlights
☐ Large Equipment	
☐ Small Equipment	
☐ Small IT	
☐ Other, Please Specify	

Technical Plastics Recyclers and their role in cleaning up POPs

The Process

- Typical technical plastics recyclers utilize density sorting to obtain a fraction of polyolefins (<1.0 g/cm³; PP/PE) and a fraction of styrenics (1.0 – 1.1 g/cm³; PS/ABS).
- When added to functional levels (~6 – 15%), brominated flame retardants increase the density of plastics material to such an extend that the density increases to beyond 1.1 g/cm³.
- The polyolefin and styrenics fractions are almost free of BFRs, including the POP BFRs. The BFRs are concentrated in the heavy fraction which is to be send for incineration.

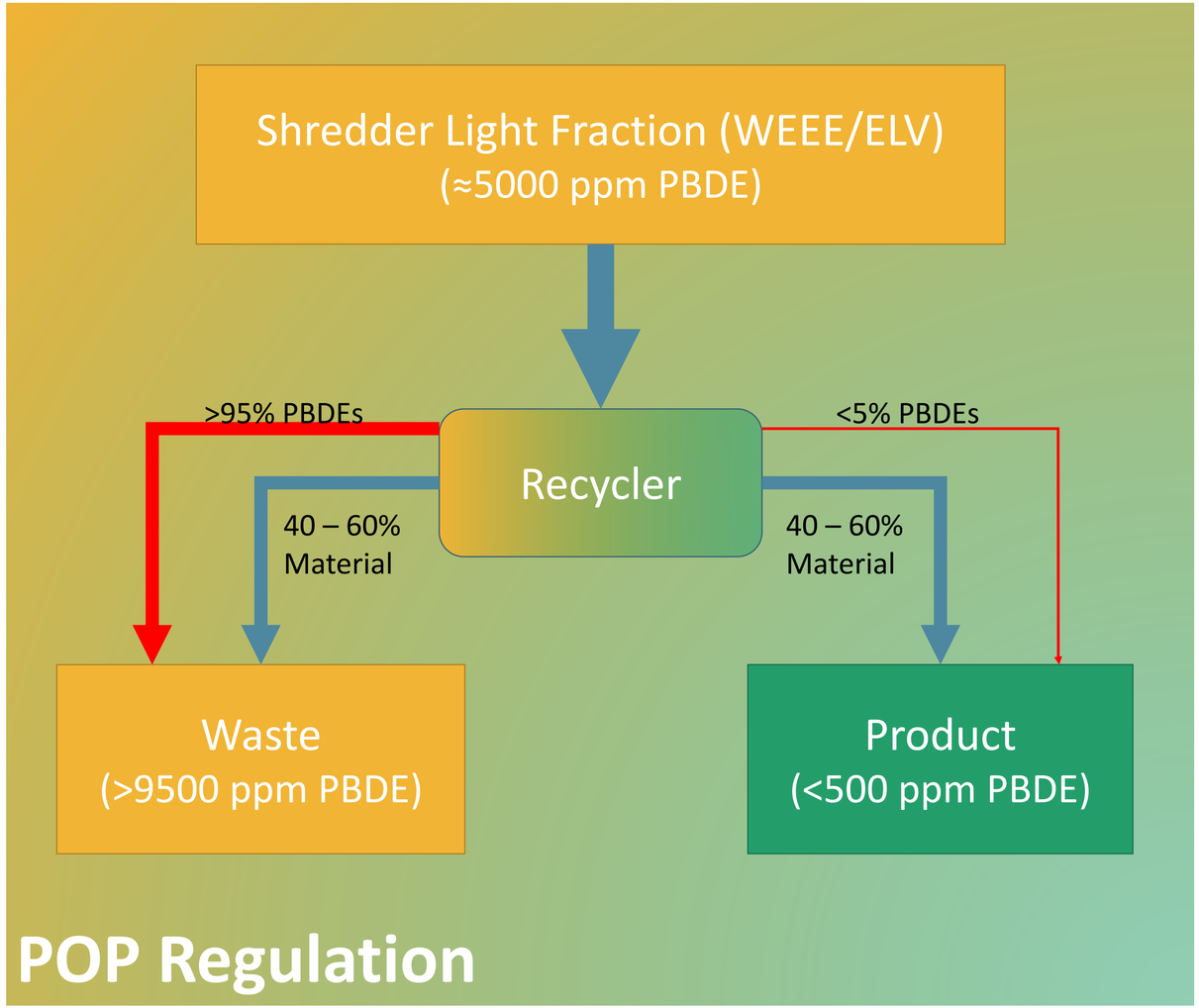


Figure of PBDEs in input is exemplary for many SLF subtypes, though not a uniform rule for all. It can be higher or lower depending on the stream.

Technical Plastics Recyclers and their role in cleaning up POPs

The Process

- This first step in the process is not perfect but PO and Styrenics fractions can meet the Unintentional Trace Contaminant (UTC) level specified in the POP regulation of 500 ppm sum total of PBDEs.
- In the example in the figure more than 95% of PBDEs are send for destruction.
- The process is wasteful however, as the heavy fraction (>1.1 g/cm³) comprises 40 – 60% of the input and contains pieces of other polymers with higher densities that do not contain POP PBDEs.

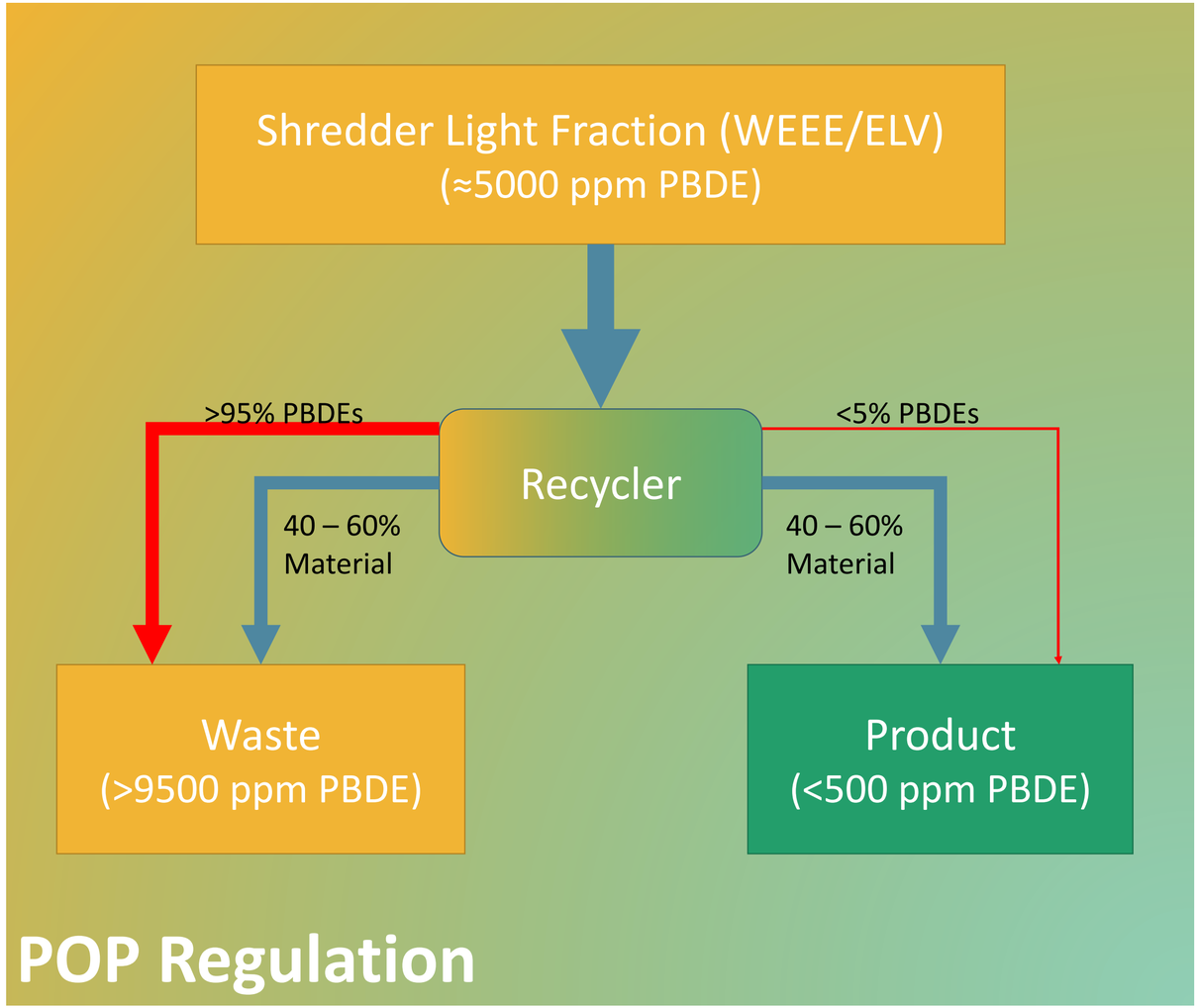
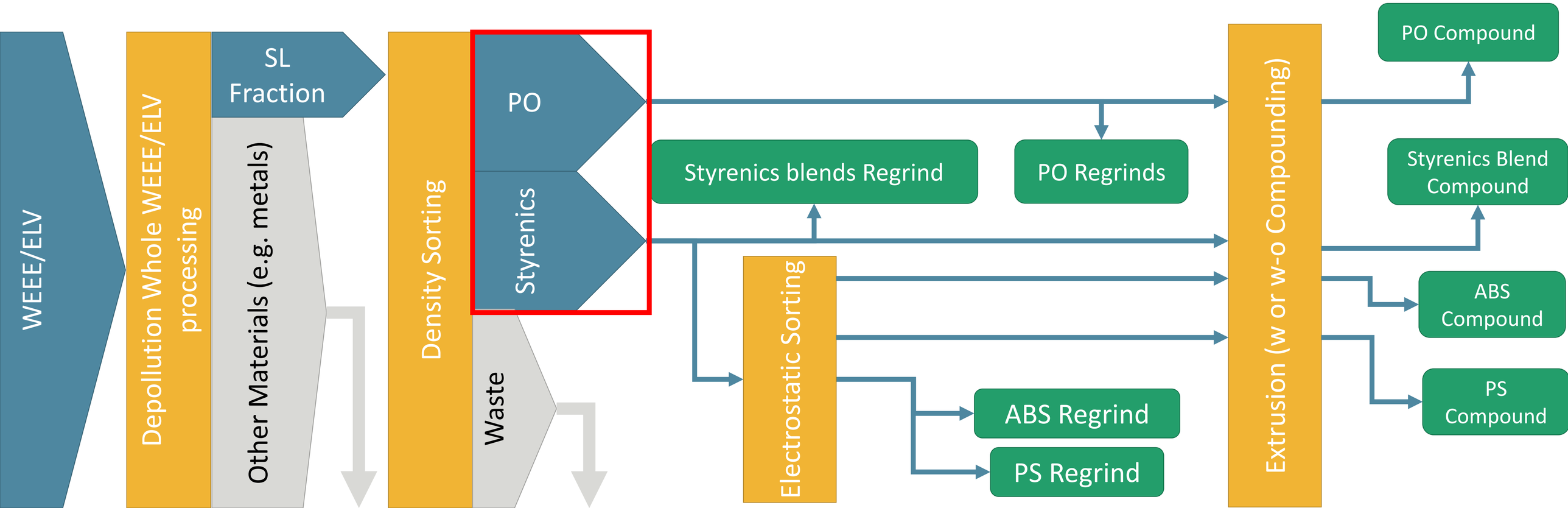


Figure of PBDEs in input is exemplary for many SLF subtypes, though not a uniform rule for all. It can be higher or lower depending on the stream.

Recycling Value Chain Structure and Market Research

Structure of the Recycling Value Chain

- After the first step, there are many possibilities for further processing. Each process step is associated with a cost, an increase in quality and an increased economic value of the material.
- Each recycler will make decisions on how far he takes the material depending on the delta between the cost of processing and the increased valuation of the material.



Recycling Value Chain Structure and Market Research

Market Research Results

- PRE collects data on the capacity of plants treating SLF to produce PO and Styrenics.
- Based on interviews additional qualitative information was obtained:
  - →Not all WEEE and particularly ELV SLF is send to recycling facilities a lot is going directly to energy recovery
  - →Export of certain qualities of WEEE/ELV plastics to non-EU countries occurs, with possible poor recycling practices (e.g. TV back casings being processed without density separation to remove POPs)
  - →Several WEEE/ELV treatment centres have started operating pre-float facilities, to create a fraction of a fraction <1.1 g/cm³ and a fraction >1.1 g/cm³, following difficulties with shipments of the uncut SLF.

2020	Plants	Capacity (Kt)	Input (waste) (Kt)	Output (waste) (Kt)	Output (product) (Kt)	Styrenics Output (Kt)	Polyolefin Output (Kt)
Total	17	442	361	169	192	100	92
Austria and Germany	6	129	113	53	60	36	24
Portugal and Spain	3	18	16	8	8	4	4
United Kingdom	3	80	72	36	36	18	18
Other Europe	5	215	160	72	88	42	46

Indicative data, collected by PRE. Likely underestimation of the total volume.

Future Challenges and Opportunities

The obvious

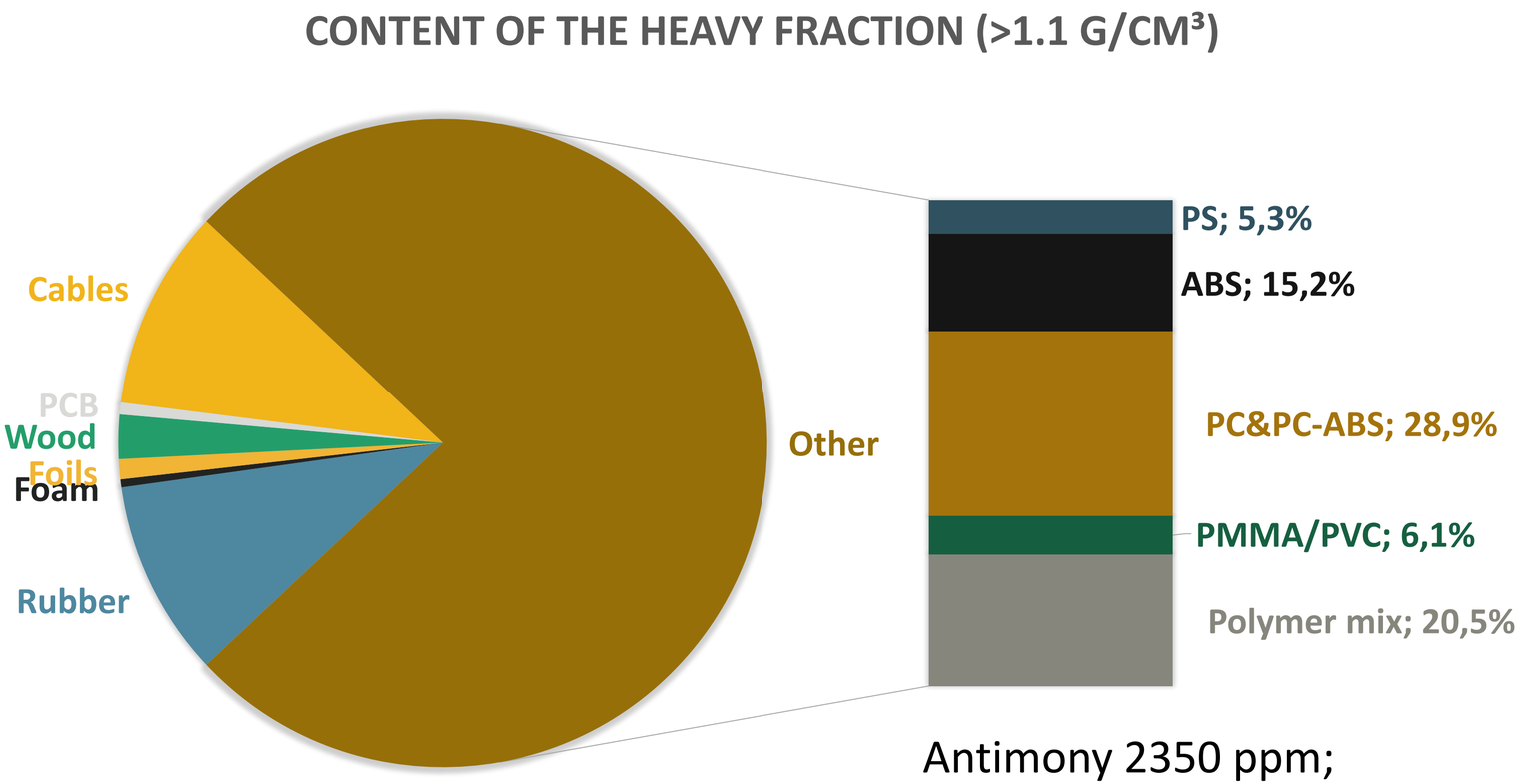
- Any shredder light fraction that is not send to a proper recycler is resulting in wastage of material from the circular economy. With the revision of the ELV Directive and the WEEE directive this problem should be corrected.

- Export of WEEE/ELV plastics to non-EU countries should be limited to those facilities that treat this particular stream in an environmentally sound manner and perform the necessary steps to separate POP PBDEs. The Waste Shipment Regulation proposal from the European Commission is including provisions on third party certification of non-EU facilities receiving waste.

Future Challenges and Opportunities

The current waste fraction

- The heavy fraction is currently to be send for destruction.
- Particularly the PC and PC-ABS contained in this fraction has a high market value if separation from this waste stream becomes possible.
- Several companies have already started working on developing technology to:
  - →first separate PC and PC-ABS from the heavy fraction and
  - →subsequently separate the BFR containing PC/PC-ABS from the PC/PC-ABS fraction.
- Separation of more non BFR containing material from the heavy fraction should increase the antimony level in the residual waste.



From WEEE (SDA/ICT Equipment)

Antimony 2350 ppm;
Calorific value 20 – 22 MJ/kg

Future Challenges and Opportunities

On pre-floating WEEE/ELV treatment centers

Benefits

- In the short term, provision of only SLF cut at <1.1 g/cm³ will facilitate the waste shipments (at least in the EU due to potential compliance with EU3011).
- Furthermore, recyclers will only have to deal with a substantially less amount of residual waste. (that problem is transferred to the

Risks

- In the longer run, not having the substantial residual waste stream at the few dedicated WEEE/ELV plastics recyclers, in a smaller form distributed over many WEEE/ELV treatment centers will not stimulate the developments of technology to recover other polymers from the heavy fraction.

In general, the WEEE/ELV plastics recycling industry believes that there is little benefit from simple pre-float technology being used by WEEE/ELV treatment centers to produce a shippable plastics waste fraction.

Future Challenges and Opportunities

Solvent Dissolution Technology

- Another technology that is interesting to liberate more material from the heavy fraction would be solvent dissolution technology.

- Solvent dissolution has been demonstrated to be effective in separating HBCDD from polystyrene foam from demolition waste by PSLoop.

- The technology would essentially work by a combination of selective dissolution (e.g. all polymers from non-polymers) and selective precipitation (e.g. certain additives in one step, certain polymers in other steps).

Future Challenges and Opportunities

Bromine and Antimony Recovery

- Antimony trioxide and bromine, while a minor component of SLR have very high price levels (e.g. >8000 EUR/ton*)

- HBCDD from PSLoop is already being send for destruction with bromine recovery.

- Further concentration either by advances in mechanical recycling removing non-flame retardant material from the heavy fraction or solvent dissolution separating this separately from the bulk polymer, should facilitate technology to recover these valuable molecules.

* Publicly available information from: http://www.sunsirs.com/uk/prodetail-643.html and https://www.metalbulletin.com/Article/2604892/Antimony-trioxide-price-slides.html. Better proprietary sources should exist with more reliable information. Included here as indicative.