H2020-SC5-2018-2: PLASTICS TO BE CLEANED BY SORTING AND SEPARATION OF PLASTICS AND SUBSEQUENT RECYCLING OF POLYMERS, BROMINE FLAME RETARDANTS AND ANTIMONY TRIOXIDE

D6.17: POLICY BRIEF

A SUSTAINABLE AND EQUAL LEVEL PLAYING FIELD FOR COMPLEX RECYCLING OF BROMINATED EEE WASTE IN THE EU

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Executive summary

This is a policy brief based upon the lessons learned during the research executed within the EU Horizon 2020 project PLAST2bCLEANED. It provides context and policy recommendations to further develop, implement and utilize the results reached in this project with respect to the recycling of complex Electrical and Electronic Equipment (EEE) waste.

The challenge with EEE plastics is:

1. To recycle the high-density fraction containing different types of plastics including BFRs and Phosphorous Flame Retardants PFRs which are complicated to separate. This fraction of 31% of the plastics is currently incinerated (391 kton for the EU, resulting in 649 kton of CO_2 emissions).
2. This stream is expected to double due to intended increased collection rates. At the same time, uncertainty is large due to contradictory developments with respect to debromination regulation and expected high growth of EEE put on market.
3. Legislation is not expected to solve the issue of toxic flame retardants; rather there will be a shift to other, less but possibly still toxic, substances while there is always the risk of imported non-compliant plastic products.
4. These high uncertainties make decision making very difficult, from both a business and a policy perspective.

For these challenges, PLAST2bCLEANED provides a solution:

5. With the PLAST2bCLEANED innovative sorting and superheated dissolution process, it is technically feasible, demonstrated at Technology Readiness Level (TRL) 5, to separate Brominated Flame Retardants (BFRs) and Antimony Trioxide (ATO) from Acrylonitrile Butadiene Styrene (ABS) and recycle the ABS with mechanical properties comparable to virgin ABS.
6. Challenges are still however the further reduction of remaining BFRs and ATO content in the recovered polymer to comply with current regulations, to improve ATO and bromine recovery and to upscale the process.
7. In the EU, the PLAST2bCLEANED process can potentially treat 391 kton of heavy plastics and recover 69 kton rABS/HIPS per year. This saves, including PC and metal recovery, approximately 1450 kton CO_2/year.
8. The PLAST2bCLEANED superheated dissolution process is economically feasible from a societal point of view, factoring in avoided waste incineration and avoided CO_2 emissions. Without these, it is not (yet) commercially attractive.
9. The PLAST2bCLEANED innovative sorting process can also be commercially attractive on its own since it improves the yield of clean, mechanically recycled plastics (PC and PC blends) and cables (metals).

The present bottlenecks for WEEE recycling, in particular of BFR containing plastics, are as follows:

10. The plastic recycling market is a highly global and very volatile market where scenarios for the future can vary enormously, making investments decisions and policy making a challenge.
11. To establish a stable EU market for recycled plastics, in particular more advanced plastic recovery from brominated WEEE, export of plastic waste and imports of polluted plastic products must be avoided, as well as the too-fast strengthening of chemical limit values for restricted substances (Unintentional Trace Contaminant UTC limit values) in recyclate.
12. Rapid scale up and uptake of PLAST2bCLEANED technology highly depends on policy (stimulating measures, legislation and regulations) and market conditions.
13. For the solid fraction containing BFRs and ATO, additional developments are needed before further scaling up.

To perform further research and development plus investing in scaling up plants in the coming 10 years, there is a strong need for a stable investment climate which can only be created by a consistent set of policy measures to arrange a sustainable and equal level playing field for complex recycling of brominated EEE waste in the EU, addressing:

14. Equal EU transboundary requirements for all products, half-products, raw materials and wastes (containing plastics).
15. A stable regulatory environment for substances of concern with clear and realistic limit value projections.
16. Creating an internal market for circular plastics, decoupled from the virgin plastics market (with recyclate pricing decoupled from the oil price).
17. Creating sufficient plastic waste supply by increasing separate collection of recyclable waste streams (e.g. WEEE) and by banning export of plastic waste.
18. Internalise CO_2 externalities, i.e. include CO_2 price in the cost price in the plastics value chain including recycling.

There is strong need for a consistent set of policy measures to arrange a sustainable and equal level playing field for complex recycling of brominated EEE waste in the EU to be able to do further research and development plus investing in full scale plants the coming 10 years.

To support this, further research is needed on:

19. Further separation and optimisation of the ATO and BFRs from the polymer down to the expected Unintentional Trace Contaminant (UTC) limit value for Persistent Organic Pollutants (POP) Polybrominated Diphenyl Ethers (PBDEs) and HexaBromoCycloDodecane (HBCD), plus cleaning up the solid fractions of solid BFRs and ATO.

20. Validated standardised sampling and analytical methods to assess POP PBDEs and HBCD in the final recyclate below the current UTC level to prove compliance.
21. System analysis for EEE products and waste development per application type, including future scenarios on put on market forecasts, imports and exports, BFR limit values, alternative flame retardants, sorting and recycling options etc.
22. Standards and technologies promoting high quality recycling of WEEE plastics rather than downcycling.
23. Consistent methodologies and data for making meaningful comparisons across projects.

Care must be taken in any policy decision to prevent unwanted substitution of substances used in EEE. Substances of concern may be replaced by new substances which introduce new risks, while available technology or technology under development may not be able to remove them anymore. Or perfectly recyclable plastic products may be replaced by difficult to recycle materials such as the example of paper-plastic laminates. Therefore, impact analyses supporting policy should always consider the ‘what if substitution happens’ question.

LIST OF ABBREVIATIONS

Acronym	Definition
ABS	Acrylonitrile Butadiene Styrene Copolymer
ABS + BFRs	Acrylonitrile Butadiene Styrene Copolymer containing Brominated flame retardants
ATO	Antimony Trioxide
BFR	Brominated Flame Retardant
Br	Bromine
BRU	Bromine Recovery Unit
CO_2-eq	CO_2 equivalent emission
CTU	Chemical Treatment Unit (hazardous waste incinerator)
DBDPE	Decabromodiphenyl Ethane
DecaBDE	Decabromodiphenyl Ether or oxide
EEE	Electrical and Electronic Equipment
HDPE	High Density Polyethylene
HIPS	High Impact Polystyrene
HIPS + BFRs	High Impact Polystyrene containing Bromine Flame Retardants
ICT	Information and Communication Technology
LCA	Life Cycle Assessment
LCC	Life Cycle Costing
LDPE	Low Density Polyethylene
PBB	Poly Brominated Biphenyls
PC	Polycarbonate
PMMA	Poly (Methyl Methacrylate)
POP	Persistent Organic Pollutants
PBDE	PolyBrominated DiphenylEthers
PVC	Polyvinylchloride
rABS	Recycled Acrylonitrile Butadiene Styrene Copolymer
REACH	Regulation EC 1907/2006 on Registration, evaluation, authorisation and restriction of chemicals
rHIPS	Recycled High Impact Polystyrene
ROHS	Directive 2011/65/EY on Restriction of hazardous substances

Acronym	Definition
Sb	Antimony
SDA	Small Domestic Appliances
SoC	Substances of Concern
TRL	Technology Readiness Level
WEEE	Waste Electrical and Electronic Equipment

1. INTRODUCTION TO THIS POLICY BRIEF

This is a policy brief based upon the research executed within the EU Horizon 2020 project PLAST2bCLEANED. It provides context and policy recommendations to further develop, implement and utilize the results reached in the project with respect to the recycling of complex Electrical and Electronic Equipment (EEE) waste.

PLAST2bCLEANED's aim was to develop a recycling process for WEEE plastics in a technically feasible, environmentally sound and economically viable manner, by addressing the recycling of the most common WEEE plastics acrylonitrile butadiene styrene (ABS) and high-impact polystyrene (HIPS) that contain up to 20wt% brominated flame retardants (BFR) and up to 5wt% of the synergist antimony trioxide (ATO).

2. The challenge of BFR containing EEE waste

Currently, more than 13 Mton of Electrical and Electronic Equipment (EEE) is put on the market in the EU. The plastic part of this is estimated to be 26%, viz. 3.25 Mton. Only 43% of this waste is being collected. The WEEE plastic is sorted and treated by wet separation and sensor-based sorting, resulting in mechanical recycling of the non-brominated part of 42%. The main remaining challenge to increase the recycling rate is to recycle parts of the high-density fraction containing different types of plastics including BFRs and Phosphorous Flame Retardants (PFRs) where the last one is complicated to separate. This fraction of 31% of the plastics is currently incinerated (391 kton for the EU, resulting in 649 kton of CO_2 emissions). It contains PVC, PC, cables, and a 22% fraction of plastics (ABS, HIPS) which are containing BFRs as a result of the use of flame retardants in the EEE. These are a potential health hazard when used in the wrong material application. For that reason, BFR containing plastics are currently being incinerated instead of recycled.

Also, within Europe major regulations are in place relating to the governance of persistent organic pollutants (POPs), Directive 2011/65/EY on Restriction of hazardous substances, “ROHS” for short (“Directive - 2011/65 - EN - rohs 2 - EUR-Lex,” n.d.), and Regulation EC 1907/2006 on Registration, evaluation, authorisation and restriction of chemicals (“REACH” for short). All regulations are concerned with the concentration levels of hazardous materials such as different types of legacy additives including brominated flame retardants. According to those regulations, the concentration of Poly Brominated Biphenyls (PBBs), PolyBrominated DiphenylEthers (PBDEs) including Deca Bromo Diphenyl Ether (DecaBDE) in the product has to be below limit values (Unintentional Trace Contaminant (UTC) limit for HBCD <75 ppm and for POP PBDEs below 500 ppm today and moving down to 350 ppm after 2025). However, this leads to substitution by alternative flame retardants which may be less toxic but are still not wanted in recycled plastics. Furthermore, imports of BFR containing plastic products are difficult to avoid.

In the next decade, it is expected that the collection rate will increase (policy objective to increase from 43% to 65% in 2030 and expected to be topping at approximately 80%), also as a result of the plastic waste export ban, and could easily lead to doubling of the amount of collected BFR containing plastics. In addition, two uncertain and opposite developments will take place, viz. the effect of before mentioned flame retardant regulations (leading to less BFRs in WEEE and an expected growth of EEE waste (which was the last decade 7.3% per year).

Summarizing, the challenge with EEE plastics is:

1. To recycle the high-density fraction containing different types of plastics including BFRs and Phosphorous Flame Retardants PFRs which are complicated

to separate. This fraction of 31% of the plastics is currently incinerated (391 kton for the EU, resulting in 649 kton of CO_2 emissions)

2. This stream is expected to double due to intended increased collection rates. At the same time, uncertainty is large due to contradictory developments with respect to debromination regulation and expected high growth of EEE put on market.
3. Legislation is not expected to solve the issue of toxic flame retardants; rather there will be a shift to other, less but possibly still toxic, substances while there is always the risk of imported non-compliant plastic products.
4. These high uncertainties make decision making very difficult, from both a business and a policy perspective.

3. THE PLAST2bCLEANED SOLUTION

In the PLAST2bCLEANED project, a WEEE plastics recycling process was successfully developed and demonstrated at Technology Readiness level 5 (TRL5). The method focuses on the recycling of the most common WEEE polymers, bromine flame retardants and antimony trioxide using innovative technologies, and separates hazardous additives from plastics. The main results are an innovative pre-sorting prototype and realization of a TRL5 recycling pilot plant based on dissolution under superheated conditions. And this plant was used for production of 9 kg of recycled ABS (rABS) from sorted post-consumer waste with mechanical properties comparable to virgin ABS and used to manufacture a new product.

Still, some open technical challenges remain to be addressed before the technology can be further scaled up and adopted by the industry. Namely, the reduction of Br and Sb content in the recovered polymer needs to be further optimised to comply with current regulations. It should be noted that the regulations on SoC & POP (Substances of Concern & Persistent Organic Pollutants) tend to change, and the separation technology developed with current targets in mind might not comply in years to come. In that case, even more effort needs to be invested in the technology adaptation. Furthermore, the ATO and bromine recovery (insoluble fraction) is still at a TRL <4 with respect to the yield, robustness and purity. Currently, this side stream cannot be handled. For the soluble BFRs, a process has reached TRL8-9 with a direct feed to Chemical Treatment Unit/Bromine Recovery Unit.

From the industry perspective, a direct scale-up of this process including ATO and Bromine recovery is not feasible yet. To be able to show, reliably, a potential business case for commercialisation, the process needs to be further scaled up into a demo plant with a higher throughput (30 kg/h opposed to current 1 kg/h at TRL5). Processing a complete WEEE waste stream (including all impurities present in the sorted stream going to the dissolution process due to limitations in sorting) needs to be tested together with evaluation of several other factors such as reusability of solvents, build-up of impurities, and continuous drying/extrusion.

Furthermore, although the pre-sorting prototype showed good results on selected input streams, more research is needed to improve the technology in order to be able to work with real sorted ABS waste with 5-10% other plastics. Since this stream is the largest potential input, this is needed before the technology can be scaled up. If effectively in operation, the improved pre-sorting results in recovery of PC (and PC blends) and metals (cables), herewith increasing recycling rates further and additionally saving CO_2 by avoided incineration and virgin production.

The process is more environmentally friendly compared to incineration, on average reversing CO_2 impact from 1.7 kg to -2.0 kg CO_2 emissions per kg of heavy plastic waste by avoiding emissions of incineration and virgin plastic production. A major part of this impact is caused by improved sorting, the superheated dissolution is contributing a smaller part (since it is a more energy intense process).

In the current situation, in the EU this means a potential treatment of 391 kton heavy plastics containing 22% ABS / HIPS, which theoretically lead to 69 kton rABS/HIPS. This leads to a potential CO_2 reduction by the PLAST2bCLEANED route including PC and metal recovery for the total heavy fraction 1450 kton CO_2.

Life Cycle Costing screening indicates that in terms of waste treatment, it is cost-effective to apply the PLAST2bCLEANED route since a large share of incineration is avoided and valuable products are being generated. The PLAST2bCLEANED innovative sorting process can also be commercially attractive on its own since it improves the yield of clean, mechanically recycled plastics (PC) and cables (metals). However, when a product perspective is being applied (and avoided waste incineration is not factored in), the costs of producing rABS are slightly above the current price of virgin ABS. Sensitivity analysis shows that costs can rise as a result of uncertainties on the process parameters (e.g. energy consumption, solvent recovery / use, labour needed).

If one takes a societal perspective on recycling and avoided CO_2 costs (e.g. at a level of 100 euro/ton CO_2) would be taken into account, this could lead to a relative price difference with virgin fossil plastic in the order of 400 euro / ton rABS, which could make a difference in the profitability of dissolution.

The full market adoption of the PLAST2bCLEANED recycling technology is further dependent on external factors such as commodity pricing (raw materials, energy), supply and availability of the suitable pre-treated feedstock, and political climate.

Summarizing the PLAST2bCLEANED solution and factors for its implementation:

1. With the PLAST2bCLEANED innovative sorting and superheated dissolution process it is technically feasible, demonstrated at TRL 5, to separate BFRs and ATO from ABS and recycle ABS with mechanical properties comparable to virgin ABS;
2. Challenge is the further reduction of remaining BFRs and ATO content in the recovered polymer to comply with future regulations, to improve ATO and bromine recovery and to upscale the process.
3. In the EU, the PLAST2bCLEANED process can potentially treat 391 kton of heavy plastics and recover 69 kton rABS/HIPS per year. Including PC and metal recovery, this saves approximately 1450 kton CO_2/year.
4. The PLAST2bCLEANED superheated dissolution process is economically feasible from a societal point of view, factoring in avoided waste incineration and avoided CO_2 emissions. Without these, it is not (yet) commercially attractive.
5. The PLAST2bCLEANED innovative sorting process can also be commercially attractive on its own since it improves the yield of clean, mechanically recycled plastics (PC and PC blends) and cables (metals).

4. THE PRESENT BOTTLENECKS FOR ADVANCED RECYCLING

The plastic recycling market is a highly global market, going beyond the reach of European policy. The past decade has shown that it is also a very volatile market. Compared to the global plastics demand, the supply of recycled plastics is relatively small. Combined with the fact that there is no separate market for recycled plastics (yet), this makes that the recycled plastics market is still completely linked to the virgin plastics market. Therefore, all the factors that influence the demand and price for virgin plastics, also have at least the same impact on recycled plastics.

The virgin plastics market is a cost-plus business, driven by oil prices. The big impact of oil on plastics prices (virgin as well as recycled), but not having a significant impact on recycling costs, makes that the profitability of plastics recycling fluctuates hugely. At a low point, this can even lead to recycling plastics becoming more expensive than virgin.

The demand for plastics has an obvious impact on the market. But global production capacity for virgin plastics is equally important. In the past decade, China has invested in own production capacity in order to become less dependent of imports (mainly from Europe). In normal circumstances this would have led to overcapacity in the European market. However, the market conditions in 2023 – 2024 are all but normal. The drop in demand has led even to overcapacity on the Asian market. That overproduction is now dumped on the European market specifically since the US market has enough anti-dumping measures in place. [1]

Besides offtake of the recycled plastic, also availability of waste plastics is important. Today, large volumes of mixed WEEE plastics are being exported to Asia for recycling. Specifically, plastics that are difficult to recycle (such as BFR plastics) are being exported. The main driver of this export is of course profitability. But this profitability stems from differences in regulatory requirements. These Asian countries do not have REACH, do not have the same level of environmental protection measures. This unlevel playing field makes it difficult for the European WEEE plastics recyclers to compete. The upcoming export ban for waste plastics, which was agreed in the revision of the Waste Shipment Regulation (WSR), should improve this situation. However, the lack of enforcement in many member states might result in the current situation continuing through new backdoors.

The final major constraint for European recyclers lies mainly in chemicals legislation. With REACH and POP, the EU tends to go far in protection of environment and public health. And this is only commendable. However, continuously, substances are being added to the lists, and continuously the limit values are under discussion. The everlasting threat of moving goalposts is a risk that is considered in every investment in the plastics recycling

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[1] https://www.plasticsrecyclers.eu/news/low-demand-and-high-imports-endanger-the-european-plastics-recycling-industry/

business. Often it is a reason not to invest. The fact that discussions on limit values are heavily politicised and polarised, even that the actual facts are being ignored (e.g. the current discussion on the UTC limit for POP BDEs and HBCD and downwards on trend), is a clear warning signal for recyclers to hold their investments. With investments being long term decisions, there is a need for long term regulatory stability.

For the bromine recovery, an existing process does exist which is able to safely handle the soluble BFRs. For the insoluble BFR fraction plus ATO containing fraction, additional process development needs to be performed to obtain two clean fractions of BFRs and ATO which then safely can be handled into reusable bromine and antimony.

Summarizing, the present bottlenecks for recycling, in particular of BFR containing plastics, are as follows:

1. The plastic recycling market is a highly global and very volatile market, where scenarios for the future can vary enormously, making investments decisions and policy making a challenge.
2. To establish a stable EU market for recycled plastics, in particular more advanced plastic recovery from brominated WEEE, leakage of plastic waste and imports of polluted plastic products must be avoided, as well as the too-fast strengthening of chemical limit values for restricted substances (UTCs).
3. Rapid scale up and uptake of PLAST2bCLEANED technology highly depends on policy (stimulating measures, legislation and regulations) and market conditions.
4. For the solid fraction containing BFRs and ATO, additional developments are needed before further scaling up.

5. The need for policies

The EEE plastic product system is a very complex and highly dynamic environment. This makes decision making very difficult, from both a business and a policy perspective. If debromination regulation will be effective, BFR containing ABS and HIPS could be phased out in a few decades. In that case, the treatment by dissolution will be needed at least for 'cleaning up' historic BFR containing ABS. In addition, super-heated dissolution can be adapted to other polymers and future substances of concern. Furthermore, a risk remains that regulation turns out to be ineffective and the ABS and HIPS stream with BFRs will remain to be incinerated. Regulation can for instance be ineffective due to substitution to still toxic flame retardants or waste from products imported from outside EU. It is then possible that the WEEE waste will grow exponentially, like it has in the past. In that case, it seems unlikely that dissolution-based processing capacity can meet that growth. Even when the technology is scaled-up today already, it is possible that half the BFR containing ABS / HIPS potential has to be incinerated, hampering circularity and climate change abatement.

Hence, see here the uncertainty that hinders technological development, which leads to unpreparedness for certain foreseeable and realistic situations. To be clear, PLAST2bCLEANED improved sorting will be effective in any case.

Therefore, in order to reach EU targets with respect to a circular economy, one cannot rely on simple mechanical recycling only. The more challenging, polluted plastic waste streams need to be recycled as well, now and in the future. For these, more complex technologies such as advanced sorting and dissolution are needed, at least to process the waste heritage but also to maintain quality of recyclate in the future. To create an economic opportunity for recycling in the EU in general, but particularly more challenging types of recycling, there is a need for a clear and stable investment climate within the EU.

The long-term objectives of the EU do provide stability with respect to recycling and CO_2 targets, but do not define the way towards it. Because of the complexity of plastics production, application and collection and the variety of recycling technologies developing, clear conditions must be set without prescribing solutions. A political framework should be set in the way that recycled material not just has an environmental benefit, but the externalized costs of using virgin plastics is internalized. Also, volatility of virgin feedstock prices are a risk for recycling technologies since low virgin prices changing within a short timeframe can endanger the development of a long-term recycling technology.

Hence, policy has to create as much as possible clarity on the conditions that can be controlled, such as plastic product property requirements, plastic waste availability, limit value developments and internalising external effects in order to create a level playing field for plastics recyclers. Global competition should be made feasible by setting equal requirements for competitors from inside and outside EU. This means that allowances and limit values for additives should apply for both EU produced as well as imported plastic products, and they should be enforced equally. This also means that regulations that increase the cost for producers in the EU, must exclude unfair competition by producers outside the EU.

When it concerns waste, a ban on export of plastic waste (EUR-Lex - 52021SC0331 - EN - EUR-Lex) would be a first step to create clarity on responsibility for waste treatment and potential for a circular plastics system, herewith avoiding inferior treatment of plastic waste elsewhere and creating opportunities for development of a circular plastics economy. As a second step, this ban should be enforced by all member states.

With respect to health, drastic sharpening of limit values in a faster pace than technological development is counterproductive, especially in an open market like the EU where these values are not properly enforced on the millions of products that are being imported. Here, additional research should recommend a clear future projection of limit values based upon both health requirements as well as alternative chemicals and technically feasible solutions as documented within REACH.

Up to now, the most important environmental factor, CO_2, has not been priced into plastics and plastic recycling yet. It is planned to include waste incinerators in the Energy Trading Scheme, however, we observed that from a waste perspective indeed recycling is more cost-effective than incineration, but the recyclate market is too volatile to develop technology and make large investments. In other words, from a product or business perspective, these investments are too risky. Hence, it would be a stronger incentive if the CO_2 price is included in the plastic price, herewith creating a price disadvantage for virgin plastics and an advantage for recycled plastics.

Taking a broad societal scope, including avoided waste incineration and CO_2 damage costs in the economic equation, demonstrates that even complex recycling is socio-economically cost-effective. However, internalising these factors in the value chain will not be a guarantee that it will be profitable from a business perspective. The main reason is the high volatility of oil market prices. This could even be stronger in a future where oil is less demanded for transportation. Hence, we also call for research on the need for additional regulation with respect to high quality treatment of WEEE plastics.

Summarizing, to perform further research and development plus investing in scaling up plants in the coming 10 years, there is a strong need for a stable investment climate which can only be created by a consistent set of policy measures to arrange a sustainable and equal level playing field for complex recycling of brominated EEE waste in the EU, addressing:

1. Equal EU transboundary requirements for all products, half-products, raw materials and wastes (containing plastics).
2. A stable regulatory environment for substances of concern with clear and realistic limit value projections.

3. Creating an internal market for circular plastics, decoupled from the virgin plastics market (with recyclate pricing decoupled from the oil price).
4. Creating sufficient plastic waste supply by increasing separate collection of recyclable waste streams (e.g. WEEE) and by banning export of plastic waste.
5. Internalise CO_2 externalities, i.e. include CO_2 price in the cost price in the plastics value chain including recycling.

6. OUTLOOK

There is strong need for a consistent set of policy measures to arrange a sustainable and equal level playing field for complex recycling of brominated EEE waste in the EU to be able to do further research and development plus investing in full scale plants the coming 10 years.

Care must be taken in any policy decision to prevent unwanted substitution of substances used in EEE. Substances of concern may be replaced by new substances which introduce new risks, while available technology or technology under development may not be able to remove them anymore. Or perfectly recyclable plastic products may be replaced by difficult to recycle materials such as the example of paper-plastic laminates. Therefore, impact analyses supporting policy should always consider the 'what if substitution happens' question.

To support this, further research is needed on:

1. Further separation and optimisation of the ATO and BFRs from the polymer down to the expected UTC for POP PBDEs and HBCD, plus cleaning up the solid fractions of solid BFRs and ATO.
2. Validated standardised sampling and analytical methods to assess POP PBDEs and HBCD in the final recyclate below the current UTC level to prove compliance.
3. System analysis for EEE products and waste development per application type, including future scenarios market forecasts, imports and exports, BFR limit values, alternative flame retardants, sorting and recycling options etc.
4. Standards and technologies promoting high quality recycling of WEEE plastics rather than downcycling.
5. Consistent methodologies and data for making meaningful comparisons across projects.

Consistency in methodologies and data is pivotal for making meaningful comparisons across projects. Hence, the collaboration between LCA practitioners working on these projects is essential for understanding the relative environmental impacts of technologies developed in different projects and enabling accurate benchmarking. Establishing a community of LCA practitioners on the EU level that shares databases, models, and best practices allows efficient use of resources and avoidance of duplication of work. The reviewing process should also be aligned with the same mindset and consistency between all the similar projects.