EUROPEAN
COMMISSION

Brussels, 28.10.2021
SWD(2021) 300 final

PART 1/2

COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT REPORT

Accompanying the document

Proposal for a Regulation of the European Parliament and of the Council

amending Annexes IV and V to Regulation (EU) 2019/1021 of the European Parliament and of the Council on persistent organic pollutants

{COM(2021) 656 final} - {SEC(2021) 379 final} - {SWD(2021) 299 final} - {SWD(2021) 301 final}

Table of contents

Glossary

Term or acronym	Meaning or definition
C&D	Construction & Demolition
CoP	Conference of the Parties
DecaBDE	Decabromodiphenyl ether
dl-PCB	Dioxin-like polychlorinated biphenyl
ECHA	European Chemicals Agency
EEE	Electrical and Electronic Equipment
EGD	European Green Deal
ELV	End of Life Vehicles
EPS	Expanded polystyrene
EU	European Union
HBCDD	Hexabromocyclododecane
HCBD	Hexachlorobutadiene
HIPS	High-impact polystyrene
LPCL	Low POP concentration limits
MPCL	Maximum POP concentration limits
MSWI	Municipal Solid Waste Incineration
MS	Member States
NDL	Non-dioxin like (PCBs)
PBT	Persistent, Bioaccumulative & Toxic
PCBs	polychlorinated biphenyls
PCDD	Polychlorinated dibenzodioxins
PCDF	Polychlorinated dibenzofurans
PCP	Pentachlorophenol
PFHxS	Perfluorohexane sulfonic acid
PFOA	Perfluorooctamoic acid (Pentadecafluorooctanoic acid)
POP	Persistent Organic Pollutant
POPs Regulation	Regulation (EU) 2019/1021
SCCPs	Short-chain chlorinated paraffins
TEF	Toxic equivalency factor
TEQ	Total dioxin toxic equivalence
UNECE	United Nations Economic Commission for Europe
UTC	Unintentional Trace Contaminant level
vPvB	very Persistent and very Bioaccumulative
WEEE	Waste Electrical and Electronic Equipment
WHO	World Health Organisation

1. INTRODUCTION: POLITICAL AND LEGAL CONTEXT

Persistent Organic Pollutants (POPs) are chemicals that **persist in the environment, bio-accumulate and pose a risk of causing significant adverse effects** to **human health or the environment**. If released, these pollutants are transported across international boundaries far from their sources and even accumulate in regions where they have never been used or produced. POPs pose a threat to the environment and to human health all over the globe, with the Arctic, Baltic and the Alpine regions being examples of EU sinks of POPs.

At the EU level, significant progress has been made towards the elimination of POPs. **Manufacture and use of all POP chemicals is prohibited with some minor exemptions, limited in time**, after which they are phased-out. A main challenge for the EU is to eliminate POPs and remaining stockpiles from the waste cycle as these still represent a major emission source.

This impact assessment **deals with POPs in waste and with their potential presence as legacy substances.** More specifically it covers the threshold values set in Annexes IV and V of the POPs Regulation. These values determine how the waste is to be treated, including **whether it can be recycled**, or whether it should be destroyed or irreversibly transformed. This impact assessment does not cover any other aspects of the POPs Regulation nor specifically addresses contamination of environmental compartments (e.g soil, water, air) by POP substances.

As indicated in the EU Chemicals Strategy for Sustainability[1] certain chemicals, including some POPs, can cause cancer, affect the immune, respiratory, endocrine, reproductive and cardiovascular systems, weaken human resilience and capacity to respond to vaccines and increase vulnerability to disease. By way of example, findings in a recent report by the Nordic Council of Ministers[2] indicate that the **annual health-related costs** associated to certain perfluorinated substances known collectively as PFAS is estimated to be 52 – 84 billion EUR per year for all EEA countries. Another study[3] providing overall estimates of the cost of illness related to negative effects of exposure to **endocrine disruptors** on human male reproduction in the Nordic countries, concluded on costs estimates ranging from 59 – 1,200 million EUR per year, extrapolated to the EU28.

The European Green Deal[4] (EGD) puts forward the objective of achieving **climate neutrality** in Europe by the year 2050 and to implement a new Circular Economy Action Plan[5] (CEAP) to stimulate the development of lead markets for climate neutral and circular products in the EU and beyond. Focus is placed on resource-intensive sectors such as textiles, construction, electronics and plastics. As also announced in the EGD and subsequently laid out in its Communication on a **Zero Pollution Action Plan**[6], the EU has defined a zero pollution vision for the year 2050, whereby air, water and soil pollution is reduced to levels no longer considered harmful to health and natural

---

[1] COM(2020) 667 final https://eur-lex.europa.eu/resource.html?uri=cellar:f815479a-0f01-11eb-bc07-01aa75ed71a1.0003.02/DOC_1&format=PDF

[2] The cost of inaction. A socioeconomic analysis of environmental and health impacts linked to exposure to PFAS. G. Goldenman et al. Nordic Council of Ministers 2019. http://norden.diva-portal.org/smash/get/diva2:1295959/FULLTEXT01.pdf

[3] The Cost of Inaction - A Socioeconomic analysis of costs linked to effects of endocrine disrupting substances on male reproductive health. Ing-Marie Olsson. Nordic Council of Ministers. 2014.

[4] COM(2019) 640 final

[5] COM(2020) 98 final

[6] COM(2021) 400 final

ecosystems and that respect the boundaries our planet can cope with, thus creating a toxic-free environment.

Matters relevant to the management of POP-containing wastes should be analysed within the broader EU policy context set by the Green Deal objectives and the commitments made in the new CEAP. These include:

- the prioritisation of waste prevention and reuse;
- the recovery of economic value from waste that cannot be avoided, with minimal impact on climate change, the environment and human health;
- the strengthening of secondary raw material markets, in particular through the establishment of mandatory recycled content targets for secondary raw materials and green public procurement targets;
- the zero-pollution ambition and the objective of achieving "toxic-free" material cycles.

Consequently a key challenge in defining policy actions relative to waste that contains POP substances is that of achieving an **optimum balance** between the overarching objective of **eliminating POP substances from the environment and from new material cycles** while at the same time **increasing recycling and circularity and reducing greenhouse gas emissions**[7] associated to these actions.

1.1. Main elements of the impact assessment

Scope:

- This proposal aims to ensure the **environmentally sound management of waste** that contains POP substances, ensuring emissions to the environment are minimised, with a view to eliminating them as soon as possible. This IA relates to **nine specific POP substances** or families of substances.
- The limit values for POPs in waste determine **the way in which POP waste can be treated**, resulting in waste containing POP substances above certain limit values, following any necessary pre-treatment, generally having to be destroyed (and therefore making recycling impossible).
- As such **the limits discussed do not determine whether secondary materials recovered from waste can be placed on the market**. This is regulated by conditions and limits fixed for some POP substances in Annex I of the Regulation. These are out of the scope of the current proposal.

Relation to relevant international conventions:

- The Stockholm Convention addresses the **harmful effects of human health and the environment brought about by POP substances** and seeks their phase-out. The Basel convention addresses **trans-boundary shipment of hazardous waste and certain other wastes** and seeks to ensure their **environmentally sound**

[7] In general, increased circularity brought about by recycling has positive effects in terms of reduction of greenhouse gas emissions. This is because recycling avoids emissions associated to extraction and production of primary raw materials used to substitute the material that is not recycled. Stricter POP limits on waste will often lead to less material being recycled, at least in the short / medium term.

management. The EU is a party to both conventions, as are the large majority of its Member States[8].

- Any changes in the list of POP substances in Annexes A, B and C of the Stockholm Convention **have to be taken up**[9] under the EU POPs Regulation in its Annexes I, II or III as well as in its Annexes IV and V. **Only** changes to Annexes IV and V of the POPs Regulation, dealing with POP waste, are within the scope of this impact assessment.
- The need to review Annexes IV and V of the POPs Regulation, only two years after its recast, **arises from the listing of new POP substances** under the Stockholm Convention in 2019, as well as from specific review obligations for some flame retardant substances, imposed upon the Commission by the co-legislator.
- As further explained under section 3.1, the Commission has to propose the **listing of POP substances** identified under the Stockholm Convention **into Annex IV** (on waste) of the POPs Regulation. This is because such listing triggers the obligations defined in Article 7 of the Regulation which enables the Union to comply with its obligation, under the Stockholm and Basel Conventions, to manage POP waste in an environmentally sound way.
- Under the **Basel Convention**, limit values (or ranges of limit values), applicable to waste, for each POP substance listed in the Stockholm Convention, are agreed upon as a result of political negotiation and published in so-called **POP Waste General Technical Guidelines**, which are reviewed periodically and are **not binding** to the Parties of the Basel Convention.
- These values have been taken into consideration when defining the options considered in the impact assessment, but other considerations, resulting from a previous study by Ramboll (2019) are also relevant (e.g. information on analytical limits or existing limit values in the POPs Regulation).
- The maximum values defined under **Annex V** of the POPs Regulation do not have an equivalent under the Convention, but are part of the control system defined by the Regulation. Consequently the Commission also has to propose to list into this Annex V any substance identified as a POP under the Stockholm Convention.
- For POP substances listed in Annexes IV and V, the **Commission has discretion**, based on its assessment, on **proposing specific limits** values (for both new listings and for reviews of pre-existing values).

[8] With the exception of Italy that has not ratified the Stockholm Convention (but is bound by the EU POPs Regulation). The Stockholm convention has 184 Parties and has not been ratified, among others, by Israel, Italy, Malaysia and the United States of America. The Basel convention has 188 Parties and has not been ratified by Haiti and the USA.

[9] As determined by article 15(1) of Regulation (EU) 2019/1021. Furthermore, Article 2 of Council Decision 2006/507/EC concerning the conclusion, on behalf of the European Community, of the Stockholm Convention on Persistent Organic Pollutants, requires that: "*Whenever an amendment to Annexes A, B or C or additional Annexes to the Convention is not implemented in the Annexes to Regulation No 850/2004 or other relevant Community legislation, **within one year** from the date of communication by the depository of the adoption of the amendment, the Commission shall notify the depository in accordance with Article 22 of the Convention*".

Hierarchy of objectives:

- As described throughout the impact assessment report, the limit values defined for POPs in waste in Annex IV of the POPs Regulation **determine the proportion of POPs containing waste that has to be destroyed** versus the fraction that can be managed via non-destructive treatments (e.g. landfilled). To a greater or lesser extent, for all POP waste that is not destroyed, the risk remains that some of the POP substances they contain may be released to the environment (even if this risk, depending on the precise disposal option, may be very small).
- Subject to **also complying** with limit values in Annex I this waste can also potentially be recycled and the resulting material placed back on the market as a product.
- The **overarching objective** of the POPs Regulation is **protection of human health and the environment against POP substances** and, for waste, the objective is **elimination or at least the minimisation of emissions.** Consequently, this impact assessment attributes the **greatest weight to this consideration**, as compared to any others.
- As required by the POPs Regulation and described in the Communication from the Commission on the **precautionary principle**[10], this principle is taken into account in the methodology used to derive the values in Annex IV. It is applied to **lower the proposed values** as far as possible, down to the highest of the lower limitation criteria, even if lower than the values that could de determined to protect human / environmental health[11]. This has been the case for PBDEs, HBCDD, PCDD/Fs, SCCPs and dicofol.
- The POPs Regulation also requires consideration of **proportionality**[12] and, for example, economic impacts on the different operators (such as higher waste management costs, loss or revenue from recyclate sold, etc) could lead to higher Annex IV values being proposed.
- There are also environmental trade-offs in lowering POP limit values for waste. Doing so may reduce the release of POPs into the environment, but destructive treatment is associated with increased **greenhouse gas emissions**.
- As there are trade-offs between the different objectives, a **certain level of discretion and judgement is required from the assessor** (the Commission) in determining what represents, for instance, an acceptable trade-off between economic impacts for a group of stakeholders and health or environmental impacts. This is considered as part of an established methodology, which allows for a structured consideration.

---

[10] COM (2000) 1 final. https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2000:0001:FIN:EN:PDF

[11] It should be noted that toxicological reference values cannot be defined for all the substances in scope, or at least not for all their different adverse effects, given that for some substances **a no-effect threshold cannot be established** (e.g. for endocrine or neurodevelopmental effects, PBT substances, etc.). For such substances a standard risk characterisation cannot be performed and an approach ("PBT approach") based on minimising exposures and emissions to humans and the environment, throughout the lifecycle of the substance is used in other instruments regulating chemicals (see e.g. point 6.5. of Annex I of Regulation (EC) 1907/2006 (REACH).

[12] Article 7(1) of the POPs Regulation requires that producers and holders of waste **undertake reasonable efforts** to avoid contamination of waste with POP substances. Recital 34 of the Regulation also recalls the principle of proportionality and requires that the regulation does not go beyond what is necessary in order to achieve its objectives.

Methodology:

- The methodology used to determine the values proposed for Annex IV and Annex V values is **well established**. It was developed in the context of prior work commissioned by the European Commission to develop these limit values, following the adoption of the former POPs Regulation in the year 2004.
- It should be noted that this methodology is as such **unrelated** to the criteria and the process used to identify and list POP substances under the Stockholm Convention.
- The methodology determines for each substance a set of **lower and upper limitation criteria** based on technical, practical and economic criteria and which takes into account the application of the precautionary principle.
- The range is subsequently **narrowed down to a single specific value.** Consideration is given in particular to the precautionary principle, which by itself leads to as low a value as possible. However, other criteria can lead to higher values reflecting the trade-offs based on further assessment and (duly justified) policy choices. Further details are provided in section 5.2 and in Annex IV.
- The methodology also takes account of **existing limit values**, where the weighting of the different criteria have passed political scrutiny and often are the result of a negotiation (previously under comitology and currently under the ordinary legislative procedure). The values proposed by the Commission in this impact assessment **will be examined under the ordinary legislative procedure**, where the application of the criteria, the extent of application of the precautionary principle[13] and the assessment of proportionality **will be either validated or modified**.
- This methodology has since its development been included as reference in the General Technical Guidance on POP Waste as **non-binding guidance**, under the Basel Convention. Assessment reports supporting limits on waste, done by the EU using this methodology, are **largely appreciated internationally** and provide a very significant contribution to such discussions under the Convention. This same methodology has also been used, in this same context, in a study by commissioned by Germany[14].
- The report by consultants used by the Commission in support of this impact assessment (which makes use of this methodology), as well as previous related studies of 2005, 2011 and 2019, are not subject to peer review, but are considered to be robust as they are **based on hundreds of peer reviewed studies and publications** and are subsequently assessed by the Commission. As indicated, these studies are widely considered and appreciated in the international context, under the Basel Convention, and have been the basis of former reviews of the POP waste annexes.

[13] As stated in COM (2000) 1 final: "*it is for the decision-makers and ultimately the courts to flesh out the principle. In other words, the scope of the precautionary principle also depends on trends in case law, which to some degree are influenced by prevailing social and political values*"

[14] UBA (2015). Identification of potentially POP-containing Wastes and Recyclates – Derivation of Limit Values. https://www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/texte_35_2015_identification_of_potentially_pop-containing_wastes.pdf

1.2. Policy context

The primary purpose of this initiative is to implement, for the substances concerned, the EU's international obligations under the Stockholm and Basel Conventions and, more specifically, those derived from the POPs Regulation. Therefore protecting human health and the environment from the adverse effects caused by POP substances and **eliminating or minimising emissions of POPs from waste** are at the core of this impact assessment. This assessment builds upon and is linked to the European Green Deal, its objectives and the initiatives that stem from it.

The table below presents an overview of the substances for which threshold values are proposed in this impact assessment, plus a short description of the use of the substances and the materials in which they are found. Most of the uses described are historic uses[15], now banned or severely restricted, but they are relevant in terms of waste arising from these products when they are disposed of.

Substance	Uses	Where is it found? (in what types of waste, or articles upon becoming waste)
Polybrominated diphenyl ethers (PBDEs): Tetrabromodiphenyl ether, Pentabromodipheny lether, Hexabromodiphenyl ether, Heptabromodiphenyl ether Decabromodiphenyl ether	Flame retardants. Used often in conjunction with antomony trioxide to provide fire-resistance to plastics, textiles and other materials.	In certain plastics and textiles contained in electrical and electronic equipment (EEE) and in vehicles. Also in some plastics used in construction and in textiles such as those in upholstered furniture, tarpaulins, etc.
Hexabromocyclododecane (HBCDD)	Flame retardant. Used to provide fire resistance in expanded and extruded polystyrene insulation panels. Limited use in other plastics (high-impact polystyrene) and textiles.	Major use in thermal insulation panels used in construction. Also found in some EEE and in back-coated textiles.
Polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs)	These substances have no use as such and are not produced or added to materials intentionally. They are unintentionally produced in combustion processes.	Present as impurities in ashes from municipal waste incinerators and in other ashes. Also in other industrial waste.
Dioxin-like PCBs	Similar to dioxins, they are unintentionally produced in combustion processes. Also present in some PCB oils historically used as dielectric fluid or plasticiser.	Present as an impurity in some ashes. Potentially present in oils from some remaining electrical transformers and capacitors.
Short-chain chlorinated paraffins (SCCPs)	Flame retardant. Used in some rubber and plastic materials.	Used in industrial and mining rubber conveyor belts, hoses, cables, seals. Soft PVC plastic articles. In some construction sealants and paints.

[15] Having an understanding of the products in which POP substances were used helps to understand in what waste they will be present. Most uses have now been banned, but some exceptions remain, for example, the use of decaBDE is permitted in the manufacture of certain aircraft components and their spare parts and in the manufacture of certain spare parts motor vehicles.

Substance	Uses	Where is it found? (in what types of waste, or articles upon becoming waste)
Perfluorooctanoic acid (PFOA) its salts and PFOA-related compounds	Used to make fluorinated polymers such as PTFE[16]. Provides water and oil repellency: water-proofing and anti-stain protection. Protective and lubricating functions, modifier of surface tension.	Present in some fire-fighting foams, in water-proof textiles (eg outdoor jackets), upholstered furniture and carpets. Also found in electronics (semiconductors, coatings, seals, printed circuit boards).
Perfluorohexane sulfonic acid (PFHxS), its salts and PFHxS related compounds	Similar to PFOA, except not used in the manufacture of fluoropolymers.	Similar to PFOA
Pentachlorophenol (PCP), its salts and esters	Pesticide and biocide. Used as a treatment to prevent wood and textiles from rotting, especially outdoors. Production and import in the EU ceased in 2002.	Wood used in outdoor construction – poles, fences, awnings. Textiles – tents, tarpaulins.
Dicofol	Pesticide. Used in agriculture, mostly in Spain until 2010.	No evidence of stockpiles. Probably no or very limited presence in the EU.

Table 1: Substances in scope of the impact assessment, uses and relevant waste streams

The EGD states that creating a **toxic-free environment** requires more action to prevent pollution as well as measures to clean and remedy it. The Commission has also committed to consider legal requirements to **boost the market of secondary raw materials,** including setting targets for mandatory recycled content, and to ensure that all EGD initiatives achieve their objectives in the most effective and least burdensome way possible, living up to a **green oath to '*do no harm*'**. In this context, the Commission adopted in May 2021 an EU Action Plan "Towards Zero Pollution for Air, Water and Soil"[17].

The **2015 Communication on a Circular Economy Action Plan**[18] called for the promotion of **non-toxic material cycles** and better tracking of chemicals of concern in products as a way to facilitate recycling and improve the uptake of secondary raw materials.

Subsequently, the Communication of January 2018 on the **interface between chemical, product and waste legislation**[19] laid down a general ambition to achieve *materials that are safe, fit-for-purpose, designed for durability and recyclability and that have a low environmental impact*. For those materials not yet fulfilling this overarching vision, it invited to a reflection on the **appropriate balance** between the benefits from circular use of a material and the health and environmental concerns relating to substances present in those materials.

The **new Circular Economy Action Plan** includes numerous policy guidelines, relevant to waste streams and materials addressed by this initiative such as:

[16] Better known as one of its registered trademarks: Teflon®
[17] COM(2021) 400 final
[18] COM(2015) 614.
[19] COM(2018) 32.

- putting in place measures to **reduce waste** and ensure that the EU has a **well-functioning internal market for high quality secondary raw materials**;
- a **Sustainable Product Policy** legislative initiative, setting out sustainability principles to regulate product durability, reusability, upgradability and reparability, addressing the presence of hazardous chemicals in products (including POPs), and increasing their energy and resource efficiency;
- increasing **recycled content** in products, while ensuring their performance and safety;
- enabling remanufacturing and **high-quality recycling** and reducing carbon and environmental footprints;
- increasing the **uptake of recycled plastics** and contributing to the more sustainable use of plastics, including proposing mandatory requirements for recycled content and waste reduction measures for key products such as packaging, construction materials and vehicles
- boosting the sorting, re-use and recycling of textiles;
- revising the Construction Product Regulation, including the possible **introduction of recycled content requirements** for certain construction products, taking into account their safety and functionality;

The **Chemicals Strategy for Sustainability**, adopted in October 2020, states that in order to move towards toxic-free material cycles and clean recycling it is necessary to ensure that **substances of concern in products and recycled materials are minimised**. It also states that, as a principle, the same limit values for hazardous substances should apply to both virgin and recycled materials. However, it also recognises that there may be exceptional circumstances where **a derogation to this principle may be necessary**, subject to conditions such as that the use of the recycled material is limited to clearly defined applications where there is no negative impact on consumer health and the environment. The use of an exemption for a recycled material, as compared to virgin material, should be justified based on a **case by case** analysis.

The **European Parliament** has in its resolutions on resource efficiency, on the Interface between chemical, products and waste legislation and on the Green Deal, shown consistent and strong support for increasing resource efficiency and the creation of markets for secondary raw materials. This includes setting of **targets for recycling and mandatory recycled content**. It has also been strongly supportive of the climate neutrality objectives put forward by the Commission and, in terms of waste management policy, calls for a strong reduction in incineration and landfilling.

At the same time, throughout these communications it has **firmly advocated for non-toxic material cycles, where the presence of legacy substances should not be perpetuated**. Although the EP has stated that *resource efficiency must also consider and be coherent with broader sustainability concerns, including environmental, ethical, economic and social dimensions*, no particular directions are provided on how this balance should be struck. Recent resolutions[20], such as the objection to the Commission's proposed measure under REACH to regulate legacy lead content in recovered PVC, and

[20] P9_TA-PROV(2020)0030

that on the Chemicals Strategy for Sustainability[21] indicate a very clear position towards the prevalence of non-toxic cycles as a **leading policy objective**.

The **European Council** has issued a number of relevant Conclusions such as those on "Delivering on the EU Action Plan for the Circular Economy", which specifically look at the "Interface" Communication, on a "Sustainable Chemicals Policy Strategy" and on "More circularity - Transition to a sustainable society". In all of them there is clear support for the objectives of resource efficiency, circularity, greenhouse gas emissions reduction, promotion of markets for high-quality and safe secondary materials, tracking of substances of concern and non-toxic material cycles.

1.3. Legal context

1.3.1. International context – the Stockholm Convention

The Stockholm Convention on POPs was adopted in 2001 and entered into force in 2004. The overall objective of the Stockholm Convention is to **protect human health and the environment from POPs**. It promotes global action on these substances and requires Parties to take measures to eliminate or reduce the release of POPs into the environment. Specific reference is made to a **precautionary approach** as set forth in Principle 15 of the 1992 Rio Declaration on Environment and Development.

Identification of POP substances

POPs are identified based on characteristics and screening criteria listed in Annex D to the Convention. This requires providing evidence related to the persistence, bioaccumulation, long-range transport and adverse effects associated to any proposed substance. The **POP Review Committee** (POPRC), established under the Convention and composed by experts from all regions of the world, is responsible for assessing proposals for the listing of new substances. It examines proposals sent to the Secretariat of the Convention, develops risk profiles and risk management evaluations for substances under consideration and makes recommendations for listing the substance in Annexes A, B, and/or C of the Convention[22]. The decisions on the listing, including on any specific exemptions or acceptable purposes that may be granted are adopted by the **Conference of the Parties** (CoP) which **meets every two years**.

The text of the Convention envisages generic exemptions from the ban on production and use allowing laboratory-scale research, use as a reference standard and the presence as unintentional trace contaminants in products and articles. Articles containing POPs manufactured or already in use before the date of entry into force of the relevant prohibition or limitation are also subject to an exemption, provided that Parties submit information on the uses and a national plan for waste management for such articles to the Secretariat of the Stockholm Convention.

Stockpiles and waste

The Convention also envisages identification and **safe management of stockpiles** containing or consisting of POPs. Waste containing, consisting of or contaminated with

[21] P9_TA-PROV(2020)0201

[22] Annex A of the Convention lists substances whose production and use it to be eliminated. Annex B lists substances for which this production and use is to be restricted. Annex C lists POP substances formed and released unintentionally from anthropogenic sources to which measures to reduce the total releases apply, with the goal of their continuing minimization and, where feasible, ultimate elimination.

POPs shall be disposed of in such a way that the **POP content is destroyed or irreversibly transformed** so that it does not exhibit POP characteristics.

Where this does not represent the environmentally preferable option **or where the POP content is low**, waste shall be otherwise disposed of in an environmentally sound manner. Disposal operations that may lead to recovery or re-use of POP substances are explicitly forbidden. With regard to shipment of wastes, relevant international rules, standards and guidelines, such as the 1989 **Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal** have to be taken into account.

Effectiveness

Article 16 of the Convention requires that the effectiveness of the measures adopted by the Convention is evaluated at regular intervals[23]. The objective of such effectiveness evaluation is assessing whether the Stockholm Convention is an effective tool to protect human health and the environment from persistent organic pollutants. The main conclusion from the latest evaluation, published in 2017, is that the Convention provides an effective and dynamic framework to regulate POPs throughout their lifecycle, addressing the production, use, import, export, releases, and disposal of these chemicals worldwide. However, inadequate implementation[24] is the key issue identified in this evaluation[25].

1.3.2. International context – The Basel Convention

The Basel Convention entered into force on 5 May 1992 and has been ratified by all EU Member States. It aims to **protect human health and the environment** against the adverse effects resulting from the generation, management, **transboundary movements and disposal of hazardous and other wastes**. It does this via a set of provisions on the transboundary movement of wastes and their **environmentally sound management** (ESM). In particular, the Basel Convention stipulates that any transboundary movement (export, import or transit) of wastes is permissible only when the movement itself and the planned disposal of the hazardous or other wastes are environmentally sound.

Table 2 in Section III of the Basel "*General technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants***"** contains a list of "provisional definitions" for "low-POP content" which conceptually are equivalent to the limits in Annex IV of the POPs Regulation. For some substances such as PBDEs and dioxins the guidelines contain a range of values, rather than a single value (reflecting the lack of consensus on a single value).

These values are discussed, introduced and sometimes modified, in the context of the review of the referred technical guideline. The guidelines themselves, and the values therein, **are not legally binding** but have international policy relevance and are intended to assist Parties to achieve environmentally sound management of these wastes. Under

[23] At its sixth meeting in April-May 2013, the COP of the Stockholm Convention adopted the framework for the effectiveness evaluation of the Stockholm Convention. http://www.pops.int/Portals/0/download.aspx?d=UNEP-POPS-COP.6-27-Add.1-Rev.1.English.pdf. Following this the first six-year evaluation cycle took place between 2010 and 2017.

[24] In the EU the POP regulation was recast in 2019 without substantive changes in its core provisions as this was not considered necessary.

[25] http://chm.pops.int/Implementation/EffectivenessEvaluation/Outcomes/tabid/5559/Default.aspx

Article 15(2) of the POPs Regulation, the Commission must **where appropriate**, propose to adapt Annexes IV and V of the Regulation to technical progress, but **there is no obligation** to align to the values in the Basel guideline, or to do so in a defined timeframe.

It is to be noted that, as further explained in the following section, the **listing of newly identified POP substances** under the Stockholm Convention in Annex IV of the POPs Regulation is, in practice, considered mandatory in order to meet the commitments of the EU under the Basel Convention. As regards **Annex V values**, **neither the Basel nor the Stockholm convention have provisions on a "maximum POP content limit"**, in the sense used in the POPs Regulation. However, given that the options to manage POP waste under the EU POPs Regulation are determined by establishing limit values both in Annex IV and V, **establishing a limit value in both these annexes** for newly listed substances, is also **mandatory** for the Commission.

For substances newly listed in Annexes IV and V, the **actual value that is introduced** for the first time, or **its review**, for listed substances which already have a value, remains **at the discretion of the Commission** and is carried out "where appropriate", as indicated in Article 15(2), based on the assessment made.

1.3.3. Regulation (EU) 2019/1021 on Persistent Organic Pollutants

As signatory to both the Stockholm Convention and the UNECE Protocol on POPs[26], the European Union created Regulation (EC) No 850/2004 on persistent organic pollutants (**the "POPs Regulation"**) to uphold the aims of the Convention and the Protocol at EU level.

This Regulation entered into force on 20 May 2004 and was directly applicable in all Member States, **including those which are not yet Parties** to the Stockholm Convention or the UNECE POP Protocol[27]. That Regulation has been repealed and replaced by Regulation (EU) 2019/1021 on persistent organic pollutants on 15 July 2019[28]. The POPs Regulation **ensures a coherent approach in the transposition** of obligations under these international Conventions in the EU (as opposed to this being done by each Party at the national level).

The POPs Regulation contains provisions regarding manufacturing, placing on the market and use of chemicals, management of stockpiles and wastes and measures to reduce releases of unintentionally produced POPs. Exports of POPs are regulated under Regulation (EU) No 649/2012 concerning the export and import of hazardous chemicals. The exemptions to the prohibitions under the POPs Regulation are limited to a minimum. As indicated above, POPs are identified according to procedures defined under the Convention and are **introduced in its relevant annexes by decisions adopted by the Conference of the Parties**.

[26] The Executive Body to the UNECE Convention on Long-Range Transboundary Air Pollution (CLRTAP) adopted the UNECE Protocol on POPs on 24 June 1998 in Aarhus, Denmark. This Protocol focuses currently on a list of 26 substances comprising 13 pesticides, 10 industrial chemicals and three unintentional by-products. The ultimate objective is to eliminate any discharges, emissions and losses of these POP substances. https://www.unece.org/environmental-policy/conventions/envlrtapwelcome/guidance-documents/protocol-on-pops.html

[27] Italy is the only EU Member State that has not ratified the Convention. All Member States have ratified the UNECE Convention UNECE Convention on long-range transboundary air pollution and only Malta has not ratified the POPs Protocol.

[28] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R1021&from=EN

The POPs Regulation has the following **Annexes**, which are mentioned frequently throughout the text of this impact assessment:

- Annex I: lists substances for which their **manufacture, placing on the market and use** (on their own, in mixtures or in articles) is **prohibited**.
- Annex II: lists substances for which their manufacture, placing on the market and use is **restricted** (this annex is currently empty).
- Annex III: lists unintentionally produced POP substances subject to **release reduction provisions**.
- Annex IV: lists substances that are subject to the **waste management provisions defined in Article 7** of the Regulation.
- Annex V: provides a list of **disposal and recovery operations permitted for waste** which **meet or exceed the Annex IV** limit value (Part 1). It also defines a **list of waste types** which may be **exempted** from being treated according to Part 1, defines a **maximum** concentration of the POP in waste (**Annex V limits**) up to which the exception may apply, and defines the **allowable alternative waste disposal options** (Part 2).

The POPs Regulation contains provisions requiring the setting up of emission inventories for unintentionally produced POPs, national and EU implementation plans and monitoring and information exchange mechanisms. Notably the POPs Regulation includes the development of **thresholds for POPs in waste**, which are detailed in Annexes IV and V of the Regulation[29]. The main focus of this Impact Assessment is on the Annex IV thresholds: when these are exceeded, the waste cannot be recycled and should be treated in a way that the POP content is **irreversibly transformed or destroyed**. Annex V provides exceptions from Annex IV provisions for certain wastes, but is rarely used.

Producers and holders of waste are obliged to undertake measures to **avoid contamination of waste with POP substances**. Waste with a POPs content higher than the lower (stricter) POP limits (under Annex IV) must generally be disposed of or recovered in such a way that the **POP content is destroyed or irreversibly transformed**. Certain specified wastes containing POPs above the limit in Annex IV, but below the limit in Annex V, may be otherwise dealt with without destructive treatment, subject to conditions (resulting in these waste being permanently disposed in hazardous waste landfills or in underground storage facilities). Neither of these values, applicable to waste, should be confused with the "**unintentional trace contaminant limit**" values set in Annex I, which apply to products placed on the market.

The POPs Regulation has been amended several times to take into account changes in the annexes of the Convention and the Protocol as well as changes in other related EU legislation such as the REACH Regulation. The POPs Regulation underwent a recast in the year 2019 with the main purpose of **aligning the POPs Regulation with the Lisbon Treaty** and the general chemicals legislation. The scope and other substantive provisions were not changed as it was considered that the legislation operates in a satisfactory manner. Prior to this recast the Commission adopted amendments of the limit values in Annexes IV and V via implementing acts in accordance with the **regulatory procedure**

[29] These amendments of the Annexes of the POPs Regulation result from the provision in its Article 15(2) to "keep Annexes IV and V under constant review", and generally follow the cycles of the Stockholm, Basel and Rotterdam CoPs (which take place jointly). However, **no mandatory periodicity is established for this review**.

with scrutiny referred to in Article 17(3) of Regulation (EC) No 850/2004. Such amendments were supported by studies carried out by external consultants, but without an impact assessment.

Consequently, this impact assessment supports measures that **target only the introduction or revision of limit values in Annexes IV and V of the Regulation** and not any other aspect of the functioning of the Regulation.

As detailed further in section 3.1. of this report the international obligations of the Union under the Stockholm Convention, implemented by the POPs Regulation, require that when new POP substances are identified and listed in Annexes A, B and C of the Convention, the Commission has to amend annexes I, II and /or III of the Regulation, accordingly.

As regards Annex IV, on waste, listing of new POPs in this annex is the only way of ensuring the wastes containing these substances will be covered by the control and management regime defined in Article 7 of the Regulation. Therefore, listing in Annex IV, as well as in Annex V, becomes obligatory, in order to implement the control system defined in that article and thereby comply with the requirement under the Stockholm and Basel Conventions to ensure the environmentally sound management of POP waste.

1.3.4. Other relevant EU legislation

Information on other relevant EU legislation is contained in section 5.3. of Annex V of the present impact assessment.

1.3.5. Enforcement:

Enforcement of new of revised limit values for POP substances in waste requires that analytical methods are available, affordable and have sufficient sensitivity to check compliance. These conditions **are met for all the substances in scope** although the cost per analysis of some of the substances concerned (e.g. PCDD/Fs or PFOA) may exceed 400 €/ sample.

The tightening or introduction of new limit values for some wastes, resulting in an increased amount of material requiring destructive treatment, may induce an **increase** in the amount of **waste submitted to "informal" or outright illegal treatment or disposal** (as further discussed for WEEE).

Article 7(6) of the POPs Regulation imposes on Member States traceability and control obligations on all wastes containing POPs. The set-up of **electronic registers** for hazardous waste (and potentially other wastes), required under Article 35(4) of the Waste Framework Directive, is expected to play a relevant role in achieving this objective.

The risk of increased illegal management of waste, which occurs whenever additional requirements are imposed in waste legislation, can be addressed by Member States in the context of, for example, cooperation under the existing **IMPEL network**[30] and the control mechanisms in the Waste Shipment Regulation, currently under review.

[30] European Union Network for the Implementation and Enforcement of Environmental Law. https://www.impel.eu/

1.4. Economic context

Most POP substances listed in Annex I of the POPs Regulation are banned and not manufactured or used in the EU, sometimes already for many decades. Some of them are subject to **exceptions** which allow a restricted number of uses, in most cases for a limited period of time.

Article 7(3) of the POPs Regulation **prohibits recovery operations** that may lead to recycling, reclamation or re-use **on their own** of substances listed in Annex IV of the Regulation. According to Article 7(2) waste containing or contaminated with POP substances in concentrations equal or above the limits defined in Annex IV of the Regulation have to be treated in such a way as to ensure that the POP content is **destroyed or irreversibly transformed**.

However, prior to such destruction of the POPs in waste, such waste can be subjected to **pre-treatment operations** (described in Part 1 of Annex V to the Regulation) to separate them from the waste or to separate the parts of the waste that contain POPs from those that do not (or do so below the Annex IV concentration).

One of the issues at stake when defining the Annex IV concentration limits is **how this affects the amounts of waste that can be recycled**, rather than being disposed of using a treatment that will destroy it, together with the POPs it contains. The possible **trade-offs** in terms of emissions reduction and human and environmental health protection also need to be considered. Depending on the limit value chosen for a POP substance listed in Annex IV, and the specific waste streams concerned, **the amount of waste that can be recycled will vary** and a stricter limit **could result in the cessation of recycling altogether**.

Such a situation may have **important economic consequences** for operators engaging in recycling and waste disposal operations, for users of secondary materials recovered from waste that contains POPs and for other actors in the waste treatment and secondary material supply chain.

Lowering Annex IV values, thereby impeding that greater amounts of material containing legacy POPs are recycled and are re-introduced into the market also has potential **favourable economic effects** that can materialise in a **reduction in healthcare costs, environmental remediation costs and other indirect costs** associated to these impacts, for instance, on services provided by ecosystems (e.g. pollination, nutrient cycling, etc.). These impacts are substance and waste stream specific and are analysed in detail in other sections of this report.

Annex V limit values are of **very limited practical and economic relevance** given they only determine the maximum POP concentration, applicable to a restricted list of waste types, up to which derogations from being subjected to destructive treatment applies. Notwithstanding, exceeding the Annex V limit value generally will only imply that, subject to authorisation by the competent authorities, the waste may be disposed of in a **permanent underground storage facility for hazardous waste** (rather than in a hazardous waste landfill)[31].

[31] See box 3.1 in section 3.3.3 of RPA(2021). The reference price for disposal of waste in a hazardous waste landfill and an underground storage facility is, in both cases, on average, of 260 €/ton. Consequently, the requirement to use one disposal option over the other, potentially brought about by exceeding the Annex V value, is unlikely to have significant economic consequences.

1.5. Public context

According to a Eurobarometer survey[32] of the year 2016, approximately **two-thirds of EU citizens** are **concerned about being exposed to hazardous chemicals** in their daily life, and this includes a quarter who are 'very much' concerned. At least half the citizens in every Member State are concerned.

An extensive open public consultation on the core societal concern relative to the presence of **legacy chemicals in recycled materials**, relevant to this assessment, was carried-out in the context of the Commission Communication on the interface between chemical, product and waste legislation adopted in January 2018. This consultation ran from 23 July to 29 October 2018 and received 461 valid responses from a wide variety of stakeholders including individual citizens[33]. The outcome of this consultation has fed into this report.

2. PROBLEM DEFINITION

International concern regarding the global pressures caused by the manufacture, use and release of POP substances into the environment, with severe, long-lasting trans-boundary effects on human health and on that of ecosystems led to the creation of the Stockholm Convention. The Convention, with a strong focus on the precautionary principle, was brought into EU law by the first regulation on persistent organic pollutants, recast in 2019.

The purpose of this assessment is not to analyse the global problems associated with POPs or the overall effectiveness of existing policies. Rather it looks at these problems **in the context of addressing specific substances** and **setting possible limit values** for waste, all under the light of the current EU policy context.

2.1. What are the problems?

The problems caused by POP substances, including those subject to this assessment, are related to their **intrinsic physical and chemical properties**, to how and where they have been used and to the effects that their progressive release has on the health of human beings and of the ecosystems and the services these provide.

In one way or another all POP substances are recognised to have adverse, generally long-term, effects upon living organisms. They persist for a very long time in the environment and in our bodies and can be transported unchanged to almost any remote point of the globe, far away from where they were produced or used.

The figure below shows the "problem tree" which links problem drivers, problems and consequences associated to POPs subject to the measure under consideration.

[32] Special Eurobarometer 456. Chemical safety. European Union (2016).

[33] https://ec.europa.eu/info/consultations/public-consultation-addressing-interface-between-chemical-product-and-waste-legislation_en

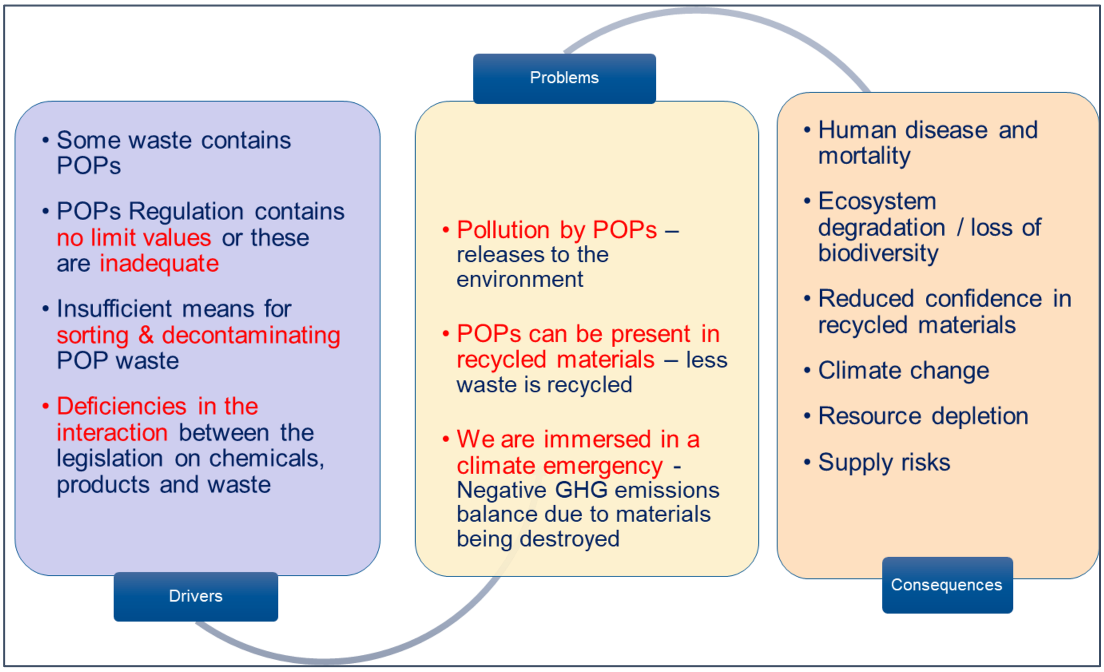

Figure 1: Problem tree

2.1.1. *Pollution by POPs*

Persistent organic pollutants, including those in scope of this measure are found in water, sediments and soil, **in waste** and **accumulating in the bodies of living organisms, including human beings**. These cause different and often substance-specific adverse effects on human health and on ecosystems including on **reproduction, sexual development, growth or on learning and neurological development**, to name just a few. Pollution by POPs thereby results in human disease and mortality and in the degradation of ecosystems and the services they provide.

In Europe, several past and on-going large-scale bio-monitoring programs have investigated the presence of POPs used as pesticides or flame retardants and of other hazardous chemicals in **human body fluids such as blood or urine**. Two of the most relevant EU projects are DEMOCOPHES[34] and the on-going HBM4EU[35] with the participation of 30 countries, the European Environment Agency and the European Commission. In 2004, a study by the WWF attracted high media attention when it revealed the presence of numerous hazardous chemicals, including POPs, in **the blood of EU citizens**[36]. More recently, a study[37] done in 2014 on the Flemish population has revealed that 77% of 50-65 year olds had PFOS and PFOA levels in their blood that exceeded reference values for absence of risk. Evidence from these and other sources points to significant environmental exposure to some POPs.

Pollution by these substances spreads throughout the globe, does not disappear naturally (or does so only very slowly) and **can exert its effects for decades to come**. It is **extremely difficult to clean-up** or to otherwise address pollution by these substances

[34] http://www.eu-hbm.info/democophes
[35] https://www.hbm4eu.eu/
[36] https://wwf.panda.org/wwf_news/press_releases/?12622/European-parliamentarians-contaminated-by-76-chemicals
[37] https://www.sciencedirect.com/science/article/pii/S0045653519324907?via%3Dihub

which makes **substitution and elimination** of POPs, together with **tight control on their emissions**, the only appropriate approach to their management.

2.1.2. POPs can be present in recycled materials

Having established that POPs are present in certain wastes it is easy to conceive that some of these POP substances **will be recycled together with the materials in which they are contained** (e.g. plastic, wood, paper) and be introduced back into the economy as products containing recycled materials. This is particularly relevant when contaminated materials are used to produce **products for consumers**, including for **children and other vulnerable populations,** with the resulting risk of exposure. According to EEB[38] and as further mentioned on the “interface” Communication[39], POPs have appeared in consumer products containing recycled materials such as toys, food containers and kitchen utensils.

The staff working document[40] to the referred Communication provided an overarching vision regarding the presence of substances of concern (including POPs) in recycled materials:

Materials should be safe, fit-for-purpose and designed for durability, recyclability and low environmental impact. These materials and the articles made from them ***should, to the extent possible, be designed, manufactured, traded and recycled free from substances of concern****. The reason being that they may be reused and eventually disposed of in a way that maximises the materials' economic benefits and utility to society while maintaining a high level of human health and environmental protection. For materials not fulfilling this overarching vision, the policy options in this document aim to* ***launch a reflection on the appropriate balance between the overall long term benefits from circular use of a material and the overall long term health and environmental concerns relating to substances present in that material****.*

This vision has been further developed under the Chemicals Strategy for Sustainability and clearly reflects the challenges faced to deal with, and ideally remove, all POP substances from recycled materials, ensuring they are safe, while at the same time striving to preserve the value of materials in the economy for as long as possible.

The presence of POPs in recycled materials represents a potential risk to the users of these materials[41], **reduces the confidence** of supply chain operators (e.g. plastic converters) and of consumers in recycled materials. Consequently, a successful circular economy with well-functioning markets for secondary materials **can ideally only be based on safe, toxic-free materials**. All POP substances have been phased out or are heavily restricted. For other substances of concern whose use continues and are essential for society, appropriate risk management measures have to be in place.

Keeping this very clearly in mind, the challenge addressed in this report lies is determining **maximum levels of POP contamination** that can be tolerated in waste that

---

[38] http://eeb.org/publications/81/circular-economy/33789/pops-in-the-circular-economy.pdf
[39] COM(2018) 32 final
[40] SWD(2018) 20 final
[41] The presence of POPs also poses risks during the previous waste management phase, both to workers handling the waste and to the environment (due to potential emissions).

will not be subjected to destructive treatment, including, potentially, **being recycled**[42] (Annex IV limits). Waste that exceeds such limits, set under the POPs Regulation, will be subjected to **destructive treatment**, generally incineration, or to another environmentally sound disposal option, such as landfilling in a hazardous waste landfill or underground storage facility. This will inevitably lead to the elimination, not only of the POP substance, but also to the **loss of all the material associated to it** and, very often, to an **increase in CO_2 emissions.**

This happens because once a material becomes contaminated with a POP substance **it is usually very difficult to remove it** or to separate clean from contaminated material. This loss of potentially recyclable material could in some cases **have an effect on the supply** of relevant materials, for instance secondary technical plastics obtained from waste electrical and electronic equipment (which would be relevant, for instance, if mandatory recycled content targets were to be introduced).

2.1.3. We are immersed in a climate emergency

The world is in the midst of a climate crisis as repeatedly confirmed by reports by the UN Intergovernmental Panel on Climate Change (IPCC) and fully backed and recognised as a key political priority by the EU. **Putting in place a more circular economy is a fundamental step towards achieving climate targets**[43].

As stated in the referred report by the Ellen McArthur Foundation, the greenhouse gas emissions causing climate change are a product of our 'take-make-waste' extractive economy, which relies on fossil fuels and does not manage resources for the long-term. The circular economy can contribute to emissions reduction by transforming the way we make and use products. The referred publication states that applying circular economy strategies in just five key areas (cement, aluminium, steel, plastics, and food) can eliminate almost half of the emissions from the production of goods – 9.3 billion tonnes of CO_2eq in 2050 – equivalent to cutting current emissions from all transport to zero.

In industry, this transformation can be partly brought about by **recycling the materials used to make goods and assets**. This reduces the demand for virgin materials such as steel, aluminium, cement, and plastics, and the **emissions associated with their production**.

To a greater or lesser extent, recycling of the materials containing POPs addressed in this report can contribute to this effort by reducing the emissions resulting from the production of their substitute primary materials and, potentially, by avoiding net emissions from their incineration (even if these can be at least partially off-set by emissions avoided by not burning fossil-fuel).

[42] Waste that is recycled will generally result in the POPs therein being re-introduced into the economy. If this happens via consumer products it can lead to exposure of consumers and, ultimately of the environment due to emissions during service life and upon disposal.

[43] Ellen MacArthur Foundation, Completing the Picture: How the Circular Economy Tackles Climate Change (2019). www.ellenmacarthurfoundation.org/publications

2.2. What are the problem drivers?

2.2.1. Some waste contains POPs

POP substances in scope of this initiative have been used in industry **for many decades** to manufacture products. In many cases the functionalities sought are associated to the chemical nature of these substances and is what actually makes them "POP substances". Examples of these are **perfluorinated substances** used to provide water repellence to clothes, to make anti-stick polymers for cookware or to provide better extinguishing properties to fire-fighting foams. A similar situation exists with members of a family of large bromine-containing organic molecules, known as PBDEs, used to make materials such as plastics and textiles **fire-resistant.**

Therefore, **waste sometimes contains POP substances**. This is the consequence of our industrial history and, even though these substances may today be banned or restricted, some still appear in waste, and will do so for many years to come. This is particularly true for waste from products that have **long life-cycles**, such as materials used in **construction**, in vehicles and certain types of **electrical and electronic equipment**.

2.2.2. The POPs Regulation contains no limit values or these are inadequate

For substances that have been **recently listed under the Stockholm Convention**, such as the pesticide **dicofol** or the perfluorinated substance known as **perfluorooctanoic acid** (PFOA), its salts and related compounds, there are currently no limit values in Annexes IV and V of the POPs Regulation. For other substances limit values exist but may have become **outdated due to scientific and technical progress** or some actors find them **not protective enough** and consider they should be modified (reduced). The purpose of the initiative supported by this impact assessment is to amend Annexes IV and V of the POPs Regulation to list substances that have been recently listed by the Convention and to, as appropriate, introduce new or revise existing limit values for POP substances, applicable to waste. Section 6.2 of Annex VI of this impact assessment contains further information about the substances in scope.

In practical terms, concerns about the value of the limits in Annex IV of the POPs Regulation translates into concerns about the **environmentally sound management** of POP waste. In general, wastes containing listed POP substances at concentrations equal to or above the limit have to be subjected to destructive treatment, preceded by any necessary pre-treatment to separate waste that contains POPs from that which does not (or does so below the limit value). Waste below that limit can be recovered or disposed of by other means, **including recycling** (subject to limits in Annex I) or **landfilling** in a non-hazardous waste landfill.

For a limited number of waste streams, possible recovery operations, as defined in Annex II of the Waste Framework Directive, permitted below the Annex IV value, include operations R5 "recycling/reclamation of other inorganic materials"[44] and R10 "Land treatment resulting in benefit to agriculture or ecological improvement".

These operations are **relevant only to a few waste streams** containing relevant concentrations of POP substances in scope of this study. As further explained under the

[44] Which includes recycling of inorganic construction materials and recovery in the form of backfilling

relevant substance sections in section VI, and in the description of the methodology in Annex IV of this report, such specific waste treatments are generally better addressed separately via dedicated legislation (e.g. via EU and/ or national sewage sludge legislation, EU and national legislation dealing with fertilisers).

2.2.3. There are insufficient means for sorting and decontaminating POP waste

Once problematic substances such as POPs are introduced into materials, for instance flame retardants in plastics or the biocide pentachlorophenol in wood, it is **very difficult to remove them** without destroying those materials. This often jeopardises any future recycling of the material based on technical or economic feasibility[45].

To a lesser extent, the same happens with attempts to **separate waste parts or fragments** containing POP substances (or POP substances above a certain concentration) **from those that do not**. This situation presents itself when dealing with waste from the **collection and sorting of materials**, complex articles and other products where the presence and amount of the relevant POP substance is variable and results in some being contaminated, and some not. Examples of this are shredded plastics from the treatment of end-of-life vehicles, from the treatment of electrical and electronic equipment, or insulation material or wood from the demolition of buildings.

Therefore, one crucial element in the assessment of how to deal with POPs in waste is having a sound understanding of the **state-of-the-art in sorting and decontamination technologies**, that could be applicable and economically feasible to treat any given waste. The availability of technologies and treatments to **extract POP substances** from materials or to **separate contaminated from clean material**, enables the production of clean (or cleaner) materials from POP waste and contributes to increase recycling rates. This also potentially **enables the setting of lower annex I and IV limit values**, reducing the likelihood of having an impact on recycling rates.

The relevance of this is recognised in the new Circular Economy Action Plan that states that to increase the confidence in secondary raw materials the Commission will, among other actions:

"support the ***development of solutions for high-quality sorting and removing contaminants from waste****, including those resulting from incidental contamination".*

Furthermore, the Chemicals Strategy for Sustainability indicates that:

"Regulatory actions need to go hand-in-hand with increased investments in innovative technologies to address the presence of legacy substances in waste streams, which could in turn allow to recycle more waste."

Unfortunately, proven and **effective industrial scale decontamination** technologies are **extremely limited** and applicable **detection and sorting** technologies, relevant to the POP substances and waste types under discussion are still also quite scarce.

In light of the above, it seems clear that sorting and decontamination technologies have a **key role** to play in achieving more abundant and cleaner flows of recycled materials. A

[45] As a minimum for uses of the recovered substance which would result in human or environmental exposure.

number of relevant projects are currently underway, financed by Horizon 2020[46]. New funding opportunities are available in calls for proposals under the current programme[47] and will soon also be available under Horizon Europe[48].

2.2.4. Deficiencies in the interaction between the legislation on chemicals, products and waste

The Commission Communication on the interface between the legislation on chemicals, products and waste[49] identified four main issues that are a **barrier to the implementation of a more circular economy** in Europe:

1. lack of information about the presence of substances of concern (including POPs) in articles;
2. lack of agreed methodologies to support decisions on how to deal with such substances in recycled materials;
3. uncertainties about when a material is waste or not; and
4. Inconsistencies and implementation problems in the way we classify waste as hazardous waste (as compared to how we classify substances and mixtures).

All these issues can be relevant in dealing with waste streams containing POPs and can lead to highly granular impacts which are associated to specific substances and waste streams. An example of this are the **diverging national / regional ways of implementing waste classification rules** that make certain plastic waste containing flame retardants (PBDEs) at or above the Annex IV limits be considered **hazardous waste in some regions but not in others** (as reported by some stakeholders[50])**.** This in turn has an influence on the **cost and administrative burden associated to moving this waste** across Europe (for recycling) and on the **operational costs and permit requirements** for the treatment installations.

Such aspects, which are not a direct consequence of the limit values to be determined are discussed in the relevant sections, in particular for WEEE plastics containing PBDEs, but there is not enough information to quantify their (possible) additional impact nor to propose specific measures to address it. Further actions to address these problems are taking place in the context of the new Circular Economy Action Plan and the Chemicals Strategy for Sustainability as well as under the on-going amendment of the Waste Shipment Regulation where the issue of the cross-border movement of wastes, the nature of the notification requirements for waste and the associated procedures are regulated.

---

[46] PLAST2bCLEANED https://plast2bcleaned.eu/; CREAToR https://www.creatorproject.eu/ ; NONTOX http://nontox-project.eu/ ; REMADYL http://www.remadyl.eu/ ; REACT - https://www.react-project.net/

[47] Innovative, systemic zero-pollution solutions to protect health, environment and natural resources from persistent and mobile chemicals https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/lc-gd-8-1-2020 ; Fostering regulatory science to address combined exposures to industrial chemicals and pharmaceuticals: from science to evidence-based policies https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/lc-gd-8-2-2020

[48] https://ec.europa.eu/info/horizon-europe_en#proposal

[49] COM(2018) 32.

[50] Informal consultation with Member States, carried-out in the course of drafting this impact assessment, have not allowed to identify any country that uses Annex IV values, other than for those substances listed in Decision 2000/532/EC, as a criterion to classify waste as hazardous (although responses from all Member States have not been obtained).

2.3. How will the problem evolve?

In very general terms the baseline is expected to result in **maintaining the current emission levels** of POPs to the environment, leading to **increased pressures on the environment and on human health** which is already largely impacted by the presence of hazardous chemicals in the environment[51] [52].

The evolution of the problems outlined above, in a business-as-usual scenario, is nonetheless rather **case specific** and depends on the waste streams concerned, the current practice, specific legal requirements and the status of the relevant treatment technologies. On the one hand, **for substances that have not been in use in the EU for years, sometimes decades, such as the pesticide dicofol, the amount of waste that remains to** be generated is very small and, consequently so is the impact and their contribution to the overall problem.

On the other hand, **other waste streams are expected to** become more **important** in terms of both the volumes generated and the time over which this will happen (Ramboll, 2019). This includes waste from **electrical and electronic equipment** (that may contain certain brominated flame retardants) - one of the **fastest growing waste streams** in the EU - or from **long life-cycle materials**, such as expanded polystyrene **insulation panels used in buildings** (that may contain another POP-listed flame retardant, HBCDD).

As detailed in section 2.2, **action will be taken on problem drivers to improve the interaction between chemicals, product and waste legislation**, including on the better tracking of substances to support the development of sorting and decontamination technologies. This will allow for better identification and management of waste that contains POPs, ensuring its sound environmental management in a manner that maximises elimination of the POP substances and the recovery of materials.

For some of these waste streams the development of **novel sorting or decontamination technologies** could have a profound impact on the treatment and potential recovery of material from POP-contaminated waste. A promising example of this is the **PolyStyreneloop** project[53] for the treatment of polystyrene insulation foams, partially funded through the LIFE program and currently being implemented in a demonstration industrial plant under construction in the Netherlands.

Further analysis of each of these cases is provided in the relevant substance chapters of supporting study by RPA (2021) [*Study to support the assessment of impacts associated with the review of limit values in waste for POPs listed in Annexes IV and V of Regulation (EU) 2019/1021*. European Union 2021. ISBN 978-92-76-41943-3].

2.4. Who is affected and how?

Society as a whole: (people): Human health and environmental **burdens associated to emissions** resulting from insufficient management of POP waste, including from recycling POP-contaminated materials into new products, have environmental, social and economic consequences that are **often not well accounted for**. The positive impacts

[51] The European environment - state and outlook 2020 (SOER 2020). European Environment Agency 2019.

[52] IPBES (2019): Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany.

[53] https://polystyreneloop.eu/

associated to enhanced recycling, including the avoidance of greenhouse gas emissions and the reduction in the use of primary raw materials, also have to be factored in.

EU consumers: EU consumers currently do not have sufficient, reliable and comparable information on the possible presence of POP substances in recycled materials or how this can relate to the articles they buy. Their safety and confidence in recycled materials can consequently be affected. The provision of different types of product-related information is within the scope of actions under the Sustainable Products Initiative, currently being developed by the Commission.

Non-EU consumers: Imposing new or more demanding limits on the POP content of certain wastes, and setting limitations to their recycling in Europe, may lead to increased shipments of waste (particularly of illegal shipments) for recycling or disposal in other parts of the world with lower treatment and consumer protection standards than in Europe. Whether these shipments take place also largely depends on the **classification of wastes** as hazardous or not[54] and on the specific applicable provisions for the shipment of waste to the receiving countries.

Recyclers: Recycling companies, such as those processing waste electrical and electronic equipment can be impacted by changes in limit values that reduce the amount of waste that can be ultimately recycled. Reductions in Annex IV limit values can decrease, at least in the short term, the amount of **recyclable material** and, potentially, also their revenue. Additionally, higher waste management costs associated to treatment of non-recyclable fractions can be expected[55]. **Additional impacts** in terms of the logistics of collection, transport and operation of recycling installations is also likely if changes in Annex IV values would result in the classification of the waste as **hazardous waste**[56].

Other waste operators: Waste operators other than recyclers will potentially benefit from the diversion of previously recyclable material to other treatments, such as **incineration, landfilling or physical-chemical treatments**. These flows may originate from recyclers, having to dispose of greater fractions of their incoming waste or directly from waste producers. Therefore, some of the costs identified in this impact assessment are **distributional costs**.

Waste producers: Producers of waste may **lose revenue** and even incur in **additional waste management costs** due to having to dispose of waste subjected to stricter requirements that require disposal rather than recycling, or having to bear additional sorting and pre-treatment costs.

Users of secondary raw materials: Reduced availability of recycled materials and the consequent need to source primary materials may have a **negative impact on the supply**

---

[54] It should be noted that not all POP waste is classified as hazardous waste according to EU rules. However, shipment restrictions apply also to relevant non-hazardous waste that may contain POPs. For example, new rules in Commission Delegated Regulation (EU) 2020/2174 ban the export of plastic waste from the EU to non-OECD countries, except for clean plastic waste sent for recycling. Exporting plastic waste from the EU to OECD countries and imports in the EU will now be more strictly controlled. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2020.433.01.0011.01.ENG&toc=OJ%3AL%3A2020%3A433%3ATOC

[55] Where rules on extended producer responsibility exist at EU or national level, certain costs of waste treatment may be covered by the producers who put the materials on the Union market, e.g. electric and electronic equipment. Articles 5 and 12, respectively, of the ELV and WEEE Directives, establish the responsibility of producers of these products on bearing part or all of the costs associate to the take-back and treatment of such products, upon becoming waste.

[56] For all substances considered in this assessment, other than for dioxins and furans and for PCBs, this is not a direct legal consequence of the Annex IV limit value (as determined by the EU waste legislation). However, WEEE recyclers report that in some regions, in some Member States, Annex IV limit values for PBDEs are used to classify waste as hazardous.

secondary materials and a negative economic impact upon their users, therefore also undermining the trust in secondary raw materials markets. The reduction in availability of material for recycling can have impacts on the ability to ensure compliance with **mandatory recycling targets** for the affected materials / product categories where such requirements are set or may be set in the future[57]. On the other hand, reduced POP concentrations in secondary materials result in **greater customer confidence** on their quality and safety which, next to supply issues, is a key factor to establish trust and consequently uptake of secondary raw materials.

Public authorities: Public authorities are responsible for implementing the relevant EU *acquis* and, as regards waste, for ensuring that waste is managed in an environmentally sound manner, without overall adverse effects on human health and the environment. The introduction of new or stricter limits affecting waste streams has as an immediate effect on control and enforcement activities, which can require **increased inspection, analytical or enforcement work** as well as vigilance of potential increase in illegal waste management and shipment.

In the particular case of **domestic incineration ashes** contaminated with dioxins and furans, analysed in this impact assessment, additional costs could apply derived from the need to establish separate collection systems for new streams of hazardous household waste (further information provided in section 6.3).

3. WHY SHOULD THE EU ACT?

3.1. Legal basis

Pursuant to Article 192(1) of the Treaty on the Functioning of the European Union, the European Parliament and the Council of the European Union adopted the Regulation (EU) 2019/1021, of 20 June 2019, on Persistent Organic Pollutants (recast). The initiative is in an area of shared competence, but its necessity and its EU-added value have been clearly recognised throughout the years. The risk that POP substances may be introduced into products via recycled materials is addressed in the basic act and for specific chemicals listed in the Stockholm Convention. Therefore, it is necessary to establish concentration limits as a **management measure** to ensure that the amount of POPs in waste that is to be recycled into such materials is low.

Article 3(6) of the POPs Regulation determines that waste consisting of, containing or contaminated "by any substance listed in Annex IV", is regulated by Article 7. That article determines **how POP waste should be controlled and managed in the Union**. Together with Annexes IV and V, **Article 7 provides the framework to implement the obligation of ensuring environmentally sound management of waste, established under the Stockholm[58] and Basel[59] Conventions**.

[57] This can be particularly the case if changes (e.g. of Annex IV limit values), bringing about such reductions in availability of secondary raw materials, take place after recycling targets have been set (based on prior baseline conditions). Union recycling targets are to be set for example for construction and demolition material streams and textiles in accordance with Article 11 of Directive 2008/98/EC by 2024.

[58] As specified in Article 6(1) and 6(2) of the Stockholm Convention.

[59] Article 2(8) of the Basel Convention defines that "Environmentally sound management of hazardous wastes or other wastes" means taking all practicable steps to ensure that hazardous wastes or other wastes are managed in a manner which will protect human health and the environment against the adverse effects which may result from such wastes.

Article 15(2) on amendment of Annexes of the Regulation specifies that:

"*The Commission shall keep Annexes IV and V under* ***constant review*** *and shall,* ***where appropriate****, make legislative proposals to amend these Annexes in order to adapt them to the changes to the list of substances set out in the Annexes to the Convention or the Protocol or to modify existing entries or provisions in the Annexes to this Regulation in order to adapt them to scientific and technical progress*".

All aspects regarding the general motivation to act, the instrument chosen and similar considerations were addressed and **validated by the co-legislator** during the recast of the POPs Regulation in the year 2019. In revising Annexes IV and V the Commission has limited room of manoeuvre. In practice the Commission has to propose the **listing of new substances** identified as POPs under the Stockholm Convention in Annex IV and V (to meet its international commitments[60] under the Convention). For substances listed in Annex IV (and V) the Commission **has discretion on the choice of the numerical values** that will be proposed (in establishing a value for the first time or in deciding to review it), given that the "low POP content" values provisionally listed in Table 2 of the General POPs Technical Guidelines developed under the Basel Convention are not legally binding. These define the different options considered in the current impact assessment.

Further information on legal aspects relative to POP substances is provided in Annex V to this impact assessment report.

3.2. Subsidiarity: Necessity of EU action

Pollution by POPs cannot be solved by the Member States acting alone. The chemical substances considered are transported across internal EU boundaries far from their sources. Avoiding releases from waste is a priority in this respect. The protection of the environment and of human health through a system that guarantees the **sound management of POP waste** can only be efficient if **common rules** are defined and established at the EU level. This matter is further explained in section 2.1. on "problem definition", in section 2.2.4 as regards the interface between chemical, product and waste legislation and is further illustrated by the reported implementation issues described in footnote 50 and in section 6.1.3, relative to PBDEs, of this impact assessment.

Consequently the measure supported by this impact assessment addresses at an EU level wastes containing newly listed POP substances under the Stockholm Convention, adapting to technical progress, as appropriate, the limit values of some substances already listed. Such obligations arise as a consequence of the implementation of the POPs Regulation, adopted in the year 2004 and recently recast in the year 2019.

No further considerations, regarding subsidiarity of this initiative, to specifically amend the waste annexes of the POPs Regulation, are considered necessary as these obligations **stem from the existing legal framework**. Further information on the processes of the Stockholm Convention, its Parties and on the operation of the POPs Regulation are

---

Furthermore, Article 4 contains a number of general provisions that requires Parties to **ensure that waste is managed in an environmentally sound manner**.

[60] Given that the applicability of the obligations defined under Article 7 of the POPs Regulation to ensure the environmentally sound management of waste that contains POP substances **depends upon the listing of the relevant POP substances in Annex IV**, and also on the provisions relative to Annex V in Article 7(4)(b), the Commission has always considered it appropriate to propose listing in Annex IV and V all POP substances newly listed under the Stockholm Convention.

provided in the introduction, in section 1.3 and in Annex V of this impact assessment report.

3.3. Subsidiarity: Added value of EU action

If national regulations were in place, cross-border effects could appear such as imbalances in the level of treatment of POP waste and there would be a risk of fragmentation of the Internal Market for the associated waste and recovered materials leading to unfair competition and uneven protection of human health and the environment, that should be avoided (see sections 2.1 and 2.2).

Following a similar reasoning, providing common limits and treatment standards for POP waste, including those that enable the recycling of certain materials from POP waste, provide **legal certainty** and thereby contribute to enhancing the recycling of materials from waste, for instance from WEEE, and the uptake of secondary raw materials in the EU.

4. OBJECTIVES: WHAT IS TO BE ACHIEVED?

The aim of this regulatory intervention is to update the threshold values set in Annexes IV and V of the POPs regulation, which determine how waste is treated, particularly whether waste can be recycled or it should be destroyed or irreversibly transformed. **The POPs Regulation's overarching objective** is the **protection of human health and the environment against POP substances**.

4.1. General objectives

Taking into account the overarching objective of the POPs Regulation, the general objectives of this initiative are **to ensure** – to the extent possible – **an optimal balance with the European Green Deal's ambitions** related to toxic-free material cycles, increasing recycling and circularity and reducing GHG emissions.

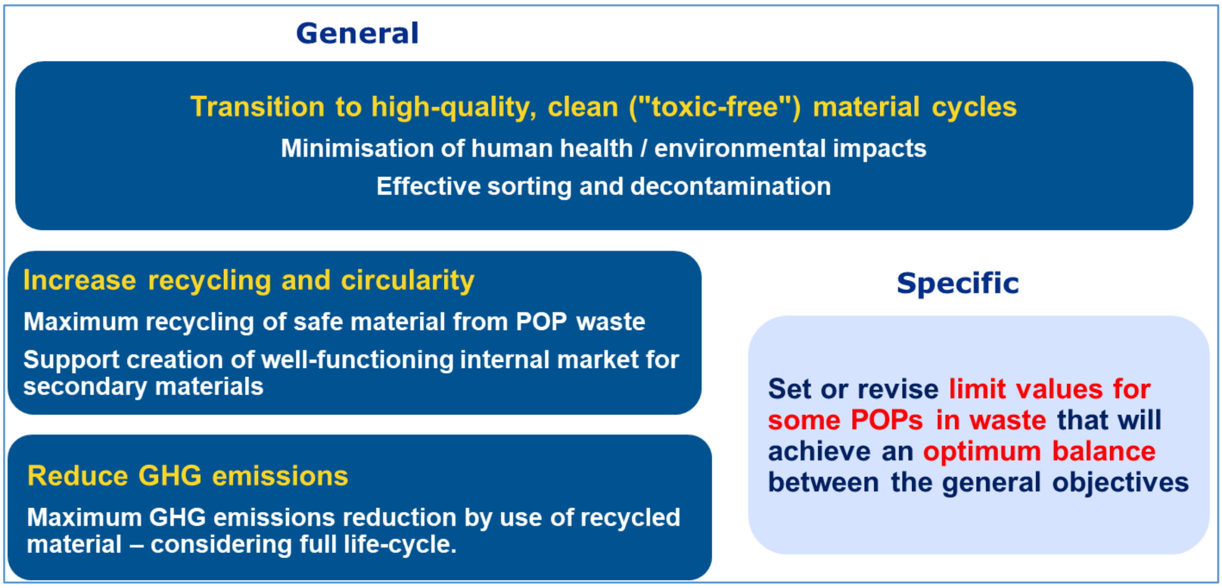

Figure 2: Objectives tree of the measure.

Transition to high-quality, toxic-free material cycles

As indicated the main objective of the POPs Regulation is the protection of human health and the environment against the adverse effects caused by POP substances. This overarching objective is embodied in this first general objective whereby management of POP waste, including is recycling where this is possible, should be carried out in an environmentally sound manner, with a minimal impact on human health and the environment. The resulting secondary materials should **always be safe** and fit-for-purpose and, to the greatest extent feasible, **free of toxic substances**. It will also reduce the extent of leaching of toxic substances to the environment, and thus contribute to the Zero-Pollution Ambition by reducing environmental and health impacts[61]. In order to achieve this, suitable, state-of-the art sorting and decontamination technologies must be available.

Increase circularity and recycling

It is essential to **boost the production and uptake of secondary raw materials** and to support the creation of a **well-functioning internal market** for them. This is one important part of the way towards a more circular economy, where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised. This is also an essential contribution to the EU's efforts to develop a **sustainable, low carbon, resource efficient and competitive economy**.

A transition towards secondary materials of comparable quality and composition to primary materials must be ensured to strengthen their supply chain and the **confidence of consumers in recycled materials** and in products made from them.

Reduce Greenhouse Gas Emissions

All policy actions should to the extent possible contribute to the overarching objective of making the EU a **carbon-neutral economy by 2050,** as well as to meeting intermediate greenhouse gas emission reduction targets. Consequently the net greenhouse gas emissions resulting from the policy options chosen, taking into account the **full life-cycle** of associated materials and products, **should not run counter to this objective**.

4.2. Specific objectives

In very specific terms the objective of the measure is to **list** in the POPs Regulation **new substances** listed under the Stockholm Convention and to **introduce or revise the limit values in its Annexes IV and V**, for a defined set of substances, ensuring that the best possible balance is achieved in fulfilling the three general objectives listed above, taking into account the hierarchy of objectives described below.

4.3. Hierarchy of objectives

The **objective of protection of transition to high quality, clean (toxic-free) material cycles** captures the importance attached to **human health and the environment and the precautionary principle.** Therefore this objective is given a greater weight in the methodology used to propose limit values for POPs in waste, which is described in further detail in section 5.2 below and in Annex IV of this report.

[61] Including for example the objective of reducing or phasing out the emissions of POPs listed as Priority (Hazardous) Substances under the Water Framework Directive.

In addition to including a **human / environmental health benchmark** values for each substance, associated to risks that may occur during waste disposal / recovery, the method applies a so called "target function" as an approach to apply the precautionary principle. This approach is further explained and illustrated in Annex IV, but in practice it results in proposing values which are as low as possible, limited only by analytical, practical or proportionality limitations. The proposed value is thereby usually the highest of the lower limitation criteria values determined.

The POPs Regulation also requires consideration of **proportionality.** The principle of proportionality is laid down in Article 5 of the Treaty on European Union. It seeks to set actions taken by EU institutions within specified bounds. Under this rule, the action of the EU must be limited to what is necessary to achieve the objectives of the Treaties. In other words, the content and form of the action must be in keeping with the aim pursued (in this case protection of human health and the environment). Article 5 of Protocol number 2 to the Treaty, on the application of the principles of subsidiarity and proportionality, further indicates that "*draft legislative acts shall take account of the need for any burden, whether financial or administrative, falling upon the Union, national governments, regional or local authorities, economic operators and citizens, to be minimised and commensurate with the objective to be achieved*".

Article 7(1) of the POPs Regulation requires that producers and holders of waste undertake **reasonable** efforts to avoid contamination of waste with POP substances and recital 34 of the Regulation also recalls the principle of proportionality. Consequently, although the overarching objective of the limit values proposed in the impact assessment is **human health and environmental protection**, the Commission is still required to assess aspects associated to the other Green Deal objectives and aspects included in the methodology, such as economic feasibility or disposal capacity, in order to get to a balanced and proportionate proposal for the preferred policy option.

5. WHAT ARE THE AVAILABLE POLICY OPTIONS?

5.1. What is the baseline from which options are assessed?

The baseline describes a situation where **no changes would be introduced** in Annexes IV and V to the POPs Regulation. This means that newly listed substances under the Convention would not be included in the relevant Annexes[62]. In the case of substances for which limits have already been set under the POPs Regulation, and for which scientific and technical progress advises that the values be reviewed, this change would also not happen.

In all of these cases, and beyond the fact that such inaction would mean, in the first case, failing to implement its obligation to ensure environmentally sound management of waste under both the Stockholm and Basel Conventions[63], the result would be that the **existing situation is maintained**. Given that all options considered comprise the introduction of new limit values for newly listed substances or the tightening of existing ones, a general consequence can be deduced: under the baseline scenario waste

[62] As explained in section 3.1, this is in effect a purely hypothetical "business-as-usual" policy option given such listing is mandatory and not listing these substances in Annex IV would not enable the EU to meet its obligation to ensure environmentally sound management of POP waste.

[63] See section 3.1 and footnote 59.

containing the different POP substances **would continue being managed as usual and less POP-containing waste would be destroyed** than under the other options.

Any situation that does not lead to destruction or irreversible transformation of the POP substances is a potential source of future emissions. This can happen by reintroduction into the economy in products (which may result in exposure and emissions during their service life and upon becoming waste) or as leakage into the environment as a result of non-destructive waste management options (e.g. landfill, disposal on land for agricultural purposes, etc.). To a greater or lesser extent this unavoidably contributes to increased pollution by POPs, resulting in additional pressures on the environment and in the associated **adverse impacts on human health, ecosystems and biodiversity.**

The precise baseline is **different for each substance** and its related waste streams. A summary of the baseline and of the impacts associated to the options is provided in sections 6 and 7 of this report and further supporting information can be found in Annex VI to this report and, particularly, in the individual substance chapters in the support study by RPA(2021)[64].

5.2. Methodology to set the limit values

The approach used to set the limit values is based on an **established methodology**. This methodology was originally developed in a study by BiPRO (2005) and subsequently used in further studies in support of the review of limit values for waste under the POPs Regulation done by ESWI (2011) and Ramboll (2019). Consequently this methodology was developed and promoted by the European Commission and has been subsequently introduced in **guidance**[65] issued at the international level under the **Basel Convention**. This methodology has been used **in support of all previous amendments of annexes IV and V of the POPs Regulation** (since 2004) and is, to our knowledge, broadly accepted by stakeholders.

The Commission considers the technical studies underpinning this assessment **to constitute the best available evidence base**. It takes account of hundreds of peer-reviewed and non-peer reviewed reports. The Commission services have reviewed the support studies and these are subject to quality control by the consultants that developed them. The Commission's analysis is highly valued by members of the international community and are one of the few detailed inputs into the discussions on low-POP content limit values under Basel. The Commission is not aware of similar reports by other Parties that aggregate and analyse published information about POP substances in waste for proposing limit values in waste (other than a report published by Germany in 2015 in the context of the POPs Regulation).

[64] Study to support the assessment of impacts associated with the review of limit values in waste for POPs listed in Annexes IV and V of Regulation (EU) 2019/1021. European Union 2021. ISBN 978-92-76-41943-3. This study constitutes the main reference for this impact assessment. It builds up and refers to previous studies by Ramboll (2019) and provides exhaustive information, for the different substances and waste streams concerned, on the baseline, impacts estimated for the different policy options, their justification and recommendations towards Annex IV and V values.

[65] This methodology was developed within a study in 2005 and has since then been applied, with some refinements, to subsequent revisions of the waste annexes of the POPs Regulation. Its main elements have been incorporated internationally into the Basel Convention General Technical Guidelines on POP waste (which are non-binding but provide guidance to the Parties).

This section summarises the key elements of this methodology. Further details can be found in **Annex IV of this impact assessment**.

5.2.1. Setting the limit values

The basic principle of the method to determine the Annex IV values is based on establishing the **concentration range** for a possible limit value for each of the relevant substances by means of a set of different **lower and upper limitation criteria**

To determine the range of possible limit values for every substance, **four lower and two upper limitation criteria** are applied. The actual range is determined by the highest of the lower limitation criteria and the lowest of the upper limitation criteria.

The lower limitation criteria are the following:

- **Analytical potential (A):** It must be possible to control limit values analytically. Values presented in Annex VI correspond to quantification limits achievable in most laboratories, for unfavourable waste matrices and therefore are not the most sensitive quantification limit possible. This explains why for some substances these reported values are higher than reported background values.
- **Background contamination (B):** Limit values should be above existing environmental background contamination.
- **Disposal and recovery capacities (C):** Limit values should be established in a way that the (new) required capacities for waste recovery and disposal are realistically available.
- **Economic feasibility (D)**: costs to economic operators should not be disproportionate.

In addition, where a relevant unintentional trace contaminant (UTC) value has been defined in Annex I of the POPs Regulation, this value is also **used as a lower limitation criteria**. It is not considered proportionate to impose a stricter limit for the purpose of waste management that for the placing on the market of products.

The upper limitation criteria are the following:

- **Risks (Y)** (possible adverse effects on human health and the environment): Limit values should be established in a way that **adverse effects on human health and the environment are avoided** and human health and the environment are protected from persistent organic pollutants as far as possible.
- **Existing limit values (Z)** agreed at Union level: Limit values should not conflict with existing limit values (e.g. by exceeding them).

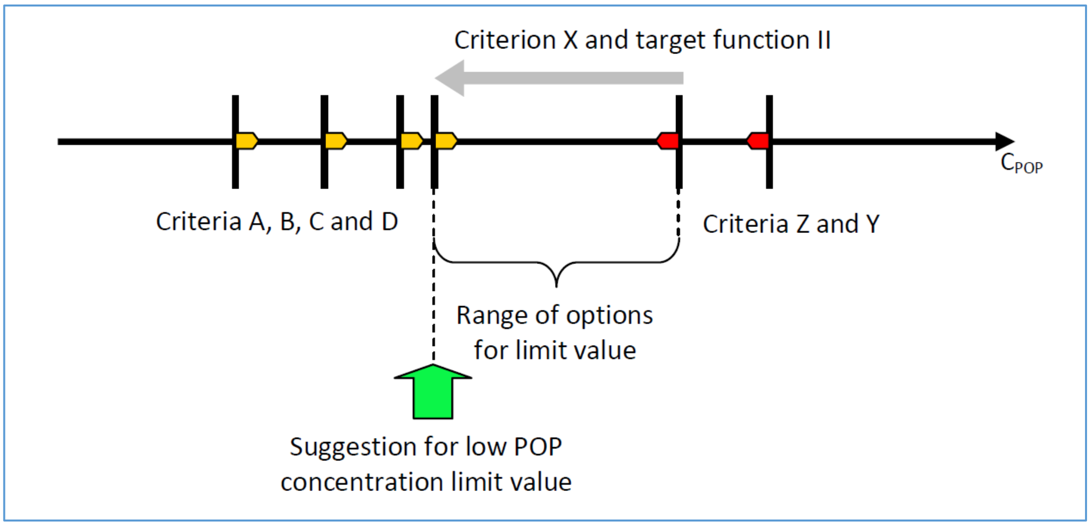

Figure 3: Methodology: lower and upper limitation criteria (ESWI 2011).

To reduce the range that results from these limitation criteria to a specific POP concentration limit the methodology applies two **“target functions”**:

- **Target function I:** "Reduce results for different waste matrices to the most unfavourable waste matrix". This function refers to the analytical potential criterion and ensures that a value is selected that is **feasible and implementable** for all relevant waste streams.

- **Target function II:** “Reduce the limit value to the lowest limit value within the feasible range of options” in the final decision on an Annex IV limit proposal in the range between upper and lower limitation criteria. This function contributes to ensuring the **highest level of protection** to human health and the environment via the application of the precautionary principle (referred to as “criterion X” in ESWI (2011). See for instance the limitation criteria diagrams for HBCDD and SCCP in Annex VI where, in application of this criteria, and to take due account of difficulties in determining reliable health based limit values for some substances (see footnote 11 and Annex IV, section 4.3), the values proposed are lowered from the health based / existing limit value (upper limitation criteria to the highest of the lower limitation criteria.

5.2.2. The precautionary principle and the principle of proportionality

The precautionary principle is detailed in **Article 191 of the Treaty on the Functioning of the European Union** (TFEU). It aims at ensuring a higher level of protection through preventative decision-taking in the case of risk. It is also included in the **Stockholm Convention** (Articles 5-7). This is done in this impact assessment through **"Target function II"** of the methodology (cfr above), which puts the limit values at the lowest possible values.

As already indicated in section 1 (see footnote 11) for many POP substances, due to the **non-threshold nature of some of their effects** and because of their **extreme persistency**, it is not possible to scientifically define safe, no-effect limit values, at least for some of their adverse effects. This report compiles and uses such limits, where it has been possible to determine them, but the referred target function II, which implements the precautionary approach, takes this element of uncertainty into account by **reducing the limit values proposed**, to the extent feasible.

It flows from the Union principle of proportionality and from the specific reference to ‘reasonable efforts’ by producers and holders of waste in Article 7(1) of the POPs Regulation that, in implementing the POPs Regulation, the precautionary principle is to be applied in a **proportionate manner**. The principle of proportionality, set out in Article 5 of the Treaty on European Union, and recalled in recital 34 of the POPs Regulation, **has been upheld in this impact assessment in three ways**. First, in the methodology to set the limit values, **"Target Function I"** ensures that limit values are feasible and implementable for all relevant waste streams (cfr above)..

Furthermore, when assessing the proportionality of the proposed limit values, an assessment of economic feasibility for the main operators affected is carried-out. For transparency, diagrams provided in Annex VI for each substance provide, where relevant, several benchmarks for economic feasibility, associated to the different options under consideration (e.g for PBDEs and PCDD/Fs). Each assessment is case-specific and made, to the best judgement of the assessors in the responsible Commission service, on the basis of available information. Aspects such as the number, size and nature of stakeholders affected and their estimated capacity to absorb additional costs and investments, are taken into account, normally based on a qualitative analysis.

Second, as explained in Sections 4 and 6, the assessment of the impacts of the different options not only takes into account health and environment considerations, but also **the Green Deal's objectives of toxic-free material cycles, increasing recycling and reducing GHG emissions**

Third, **a policy choice** has been made as regards waste treatments that result in application on land, which **avoids double regulation.** This is done by leaving **the regulation of limit values for POP substances associated very specific and sensitive waste treatment operations[66] to existing specific legislation**, where relevant. This includes Directive 86/278/CEE (the Sewage Sludge Directive), currently under review and where limits are being considered for relevant organic pollutants; and Regulation (EU) 2019/1009 on EU fertilising products where limits for relevant organic substances are set for waste derived materials incorporated into fertilisers (which are applied on land).

5.3. Policy options

5.3.1. Description of the policy options

Given the existing provisions under the Stockholm Convention and the POPs Regulation, the Commission has no discretion regarding the choice of instrument or the substances to address. Consequently, the policy options considered in this impact assessment to support the initiative are exclusively linked to the **precise limit values** to be proposed for

[66] To this respect it must be noted that Article 7(4) of the POPs Regulation, as a derogation from Article 7(2), **does not envisage the adoption of treatment-specific concentration limits in Annex IV**. Nor do the annexes themselves. Therefore, **only one limit value can be set per POP substance in Annex IV of the POPs Regulation**. Consequently, although the methodology described in Annex IV of this impact assessment allows to determine, where relevant, treatment-specific limits (e.g. for landfilling or for application on land), only one value can be listed. Below the concentration limits set forth in Annex IV, the only limit to the disposal or recovery operations is the general provision in 7(4)(a) that it must be “in accordance with the relevant Union legislation”.

each substance concerned[67] and, potentially to the **time for entry into application** and the transitional periods.

As discussed in the problem definition section **nine substances or substance groups** are addressed in this impact assessment. They are all in the scope of the proposed amendment to adapt entries in Annexes IV and V of the POPs Regulation to changes in the substances listed in the Annexes to the Convention. The initiative also seeks to modify existing entries in these Annexes to adapt them to **scientific and technical progress**.

The obligations of the Commission regarding each of the substances in scope are summarised in the table below:

Substance	**Obligation to act**
PBDEs	Proposal to review of limits "as appropriate" according to Article 15(2) of the POPs Regulation. There is an indication from the co-legislator in the POPs Regulation should propose to review the Annex IV value to 500 mg/kg, "where appropriate", by 16 July 2021.
HBCDD	At the discretion of the Commission. Proposal to review of limits "as appropriate" according to Article 15(2) of the POPs Regulation. There is an indication from co-legislator in the POPs Regulation to review the Annex IV value by 20 April 2019.
PCDD/Fs (dioxins and furans)	At the discretion of the Commission. Proposal to review of existing limits "as appropriate" according to Article 15(2) of the POPs Regulation.
Dioxin-like PCBs	At the discretion of the Commission. Adaptation to technical progress and proposal for a modification of the existing entry for PCDD/Fs, and to include or not, based on its assessment, dioxin-like PCBs into this limit value, "as appropriate" according to Article 15(2) of the POPs Regulation.
Short-chain chlorinated paraffins SCCPs)	At the discretion of the Commission. Proposal to review of existing limits "as appropriate" according to Article 15(2) of the POPs Regulation.
PFOA, its salts and related compounds	Required. Proposing to list the substance in Annex IV and V of the POPs Regulation is necessary to comply with the obligation under the Basel and Stockholm Conventions to ensure the environmentally sound management of waste containing these substances. A limit value in Annexes IV and V is to be proposed "as appropriate" according to Article 15(2) of the POPs Regulation
PFHxS, its salts and related compounds	Required. Same as above.
Pentachlorophenol (PCP) its salts and esters	Required. Same as above. Furthermore, these substances were already listed under Regulation (EC) 850/2004 (previous POPs Regulation).
Dicofol	Required. Listing the substance in Annexes IV and V of the POPs Regulation is necessary to comply with the obligation under the Basel and Stockholm Conventions to ensure the environmentally sound management of waste containing these substances. A limit value in Annexes IV and V is to be proposed "as appropriate" according to Article 15(2) of the POPs Regulation.

[67] As explained in the introduction and in section 3.1. the Commission has no discretion as regards proposing the listing of substances identified as POPs under the Stockholm convention, into Annexes IV and V of the Stockholm Convention, only on the limit values it will propose.

Table 2: Summary of reason to act, per substance in scope.

Policy Option 1: Baseline

Assuming no change under the baseline, the following would be the situation for the different substances or substance groups:

New Substances (for which there is no value in Annexes IV or V)

- **Perfluorooctanoic acid (PFOA), its salts and PFOA-related compounds and dicofol** – these are newly listed substances under the Stockholm Convention, and have to be included in the POPs Regulation with **new limit values set for them for the first time**. Under the baseline, this would not happen and the EU would be in breach of its international obligations.
- **Perfluorohexane sulfonic acid (PFHxS), its salts and PFHxS-related compounds** - these are envisaged to be listed by the Stockholm Convention in 2022[68]. At this point, and based on the current assessment, the Commission[69] together with the European Parliament and the Council[70] will need to include them in the proposal to amend Annexes IV and V of the POPs Regulation.
- **Pentachlorophenol (PCP), its salts and esters** – these substances were listed in annexes A and C of the Stockholm Convention in May 2015 and were introduced in Regulation (EC) No. 850/2004 in the year 2019. Due to administrative and procedural reasons these values could not be included in the POPs recast and consequently are currently not listed in Annexes IV or V of the POPs Regulation. A proposal has to be made to introduce this substance in Annexes IV and V of Regulation (EU) 2019/1021 (after it repealed the previous Regulation).

POPs listed in the POPs Regulation for which limit values are already set

- **PBDEs, HBCDD, SCCP, Dioxins & Furans (PCDD/Fs)** – these are already listed substances so under the baseline they would **remain at their current limit** values because their review is not considered appropriate (e.g. because of disproportionate impacts or no benefits expected).
- **Dioxin-like PCBs** – These are currently addressed by the existing "group" entry for polychlorinated biphenyls (PCBs) in Annex IV which covers all 209 congeners (variants) of this substance. This report assesses the option of addressing a subgroup of 12 PCBs, known as **dioxin-like PCBs**, that closely resemble the toxic properties of dioxins and furans. Two approaches are possible, dealing with them on their own, as a separate group of substances, or together with dioxins and furans. Under the baseline, dioxin-like PCBs would not be addressed specifically (but only in a limited way under the current group value covering all PCBs).

[68] Discussions of these matters in Stockholm Convention COP-10 have been delayed, as a consequence of the COVID 19 pandemic, from July 2021 to June of 2022.

[69] Or by the co-legislator if a Commission proposal is adopted, as expected, before a decision for listing is taken at the Stockholm COP 10 in June 2022.

[70] It is envisaged that at that time an adopted Commission proposal will in discussions under the ordinary legislative procedure.

Policy Option 2 – Medium value

In Policy Option 2, new limit values under Annex IV are established for the new substances and limit values are tightened for certain listed POPs where this could be justified. The former is the case for the newly listed substance PFOA, its salts and PFOA-related compounds as well as for PFHxS, its salts and PFHxS-related compounds, which are expected to be listed in the face-to-face segment, planned for June 2022, of the 10th meeting of the Conference of the Parties of the Stockholm Convention.

Exceptions where no medium level values are considered are:

- the new substance dicofol, because introducing a lower (stricter) limit value aligned with that of other listed organochlorine pesticides would be effective and have no measurable economic impact. Therefore only a single (lower) policy option is considered, captured under "option 3".
- the pesticide PCP, which had been listed under the previous POPs Regulation and for which such value **had already obtained political agreement** in 2019. Therefore only a single (lower) policy option is considered, captured under "option 3".

For the remaining existing substances in scope – PBDEs, HBCDD, SCCPs and dioxins & furans (including dl-PCBs) a middle limit value is considered in the impact assessment.

Policy Option 3 – Low value

Under Policy Option 3, stricter limit values under Annex IV are established for eight substances[71]. In the case of PBDEs Option 3 is analysed as two sub-options whereby Option 3a results in implementing the lower limit value immediately (estimated in 2021 for the purpose of calculations) and Option 3b with delayed implementation in 2027 (with Option 2 being implemented in the interim).

In the case of PCDD/Fs, as explained also for option 4 below, an additional sub-option applicable only to direct application of waste on land was analysed, with a value based upon risk estimates of dioxins via the food-chain done by BiPRO in 2005.

Policy Option 4

A fourth policy option with an additional lower value, has been considered for dioxins and furans (PCDD/Fs). The reason for this additional option is to assess the proposal made by some NGOs to set a lower Annex IV value for these substances, as well as the additional sub-option to set a lower specific value to be used only as a limit for untreated waste applied directly on land (e.g. in agricultural applications).

It should be noted that for most substances and related waste streams in scope of this report, application on land (e.g. for agricultural purposes) is not relevant or the establishment of a single limit value protective of human / environmental health is possible, without causing a conflict between the upper and lower limitation criteria (e.g. where by setting a very low limit to mitigate specific risks associated to application on land would not at the same time create disproportionate economic impacts due to the

[71] Note that for dioxin-like PCBs the assessment focuses on its integration into the limit value for dioxins and furans.

associated impossibility to dispose of waste via a much lower risk disposal operation such as **non-hazardous waste landfill**, to which the same limit would apply).

When such conflict occurs, as in the case of PCDD/Fs, and as further explained section 6.3 and in Annex IV, a general limit is proposed, based on the health-based criterion associated to landfill disposal, and not that for land application.

5.3.2. Summary of policy options – Annex IV

Given that the scope, in terms of substances concerned, stems from the obligation to consider introducing or amending limit values for POP substances in waste, as required by Article 15(2)[72] of Regulation (EU) 2019/1021, the options analysed in this impact assessment are limited to the precise value to be set for the nine different substances of this initiative. In the case of dioxin-like PCBs, the assessment is done under the working hypothesis that, if the scientific-soundness of dealing with them specifically is confirmed[73], they would be addressed via their possible incorporation into the group value for dioxins and furans.

The following table presents a range of values (policy options) for Annex IV for each substance / substance group considered:

	Option 1 (baseline[74])	**Option 2**	**Option 3**
PFOA its salts and PFOA related compounds (mg/kg)	-	50 for PFOA and salts; 2000 for related compounds	0.025 for PFOA and salts; 1 for related compounds[#]
PFHxS, salts and PFHxS related compounds (mg/kg)	-	50 for PFHxS and salts; 2000 for related compounds	0.025 for PFHxS and salts; 1 for related compounds[#]
Dicofol (mg/kg)	-	-	50
Pentachlorophenol (PCP), its salts and esters (mg/kg)	-	-	100
Sum of PBDEs (mg/kg)	1,000	500	200
SCCPs (mg/kg)	10,000	1,500	420

[72] "The Commission shall keep Annexes IV and V under constant review and shall, where appropriate, make legislative proposals to amend these Annexes in order to adapt them to the changes to the list of substances set out in the Annexes to the Convention or the Protocol or to modify existing entries or provisions in the Annexes to this Regulation in order to adapt them to scientific and technical progress."

[73] The impact assessment considers in the first place whether the scientific information on the toxicity of these substances is robust enough to justify addressing them in terms of their toxicity equivalence to dioxins. As a second step, the impact assessment considers the option of integrating these substances in the value for dioxins and furans.

[74] Current baseline values in Annex IV of the POP Regulation.

HBCDD (mg/kg)	1,000	500	100

Note: No baseline value is available for PFOA, PFHxS, dicofol and PCP given these are newly listed substances.

Table 3: Policy options for substances in scope of the impact assessment (except PCDD/Fs)

	Option 1 (baseline)	Option 2	Option 3	Option 4
Dioxins & furans* (mg/kg)	0.015	0.010	0.005+ (0.001)#	0.001++ (0.00005)#

Table 4: Policy options for PCDD/Fs

*: The appropriateness of including dioxin-like PCBs in the group value for dioxins & furans is also assessed.

+/++: For dioxins and furans, Options 3 and 4 define a generally applicable value to all waste management operations. They each include a possible sub-option which would include an additional specific limit value (in brackets) that would apply only for application of waste on land.

#: This sub-option is studied under the hypothesis that it may be appropriate to define a separate limit value in Annex IV that would be only applicable to certain waste management operations involving the application of the POP waste on land (e.g. spreading of sewage sludge or ashes on land for agronomic purposes). It would apply in addition to a "general value", listed in the top row, applicable to all waste. This sub-option is considered in the impact assessment, regardless of other legal or practical considerations regarding whether separate waste-treatment specific values, can be listed in Annex IV of the POPs Regulation.

5.3.3. Annex V values

Annex V values are referred to in Article 7(4)(b) of the POPs Regulation and are also known as "maximum POP concentration limits" (MPCLs). They define the **maximum concentration limit** in waste to which exemptions from destructive treatment apply for waste listed in part 2 of Annex V (and which meet or exceed the Annex IV value). Furthermore, footnote 1 of the table in Part 2 of Annex V of the Regulation also specifies that, for the specific wastes listed in part 2 of Annex V, disposal in a **permanent underground storage facility for hazardous waste** is permitted[75], **even in the maximum value in Annex V is exceeded**.

Annex V values are **very rarely used,** have no influence on the recycling of waste and only determine a specific aspect of the final disposal of a limited set of waste types. Contrary to Annex IV values, Annex V values do **not have an equivalent in the Stockholm Convention** or in the technical guidelines developed under the **Basel Convention**. Further information is provided in section 4.1 of Annex IV to this impact assessment report.

Annex V values are considered and proposed for: PFOA, PFHxS, Pentachlorophenol and dicofol for which currently no values have been determined. In addition, a proposal is made to include the substance decaBDE into the Annex V group value for the other PBDE flame retardants. This is done for consistency reasons given the other listed

[75] Such facilities only have important relevance in Germany.

PBDEs already have a group limit value in Annex V, but when decaBDE was first listed in Annex IV in 2019, such a change was not introduced in Annex V.

5.4. Options discarded at an early stage

The substance **dicofol** has been assessed but has not been subjected to a detailed impact assessment nor included in the support study (RPA(2021)). According to the information available from a previous study[76] there is sufficient evidence to conclude that waste streams containing this substances are no longer relevant in the EU. Hence, a limit is proposed to be set in Annex IV in line with the Union's international commitments but will probably not have any significant impact on the ground in relation to waste streams.

The substance **hexachlorobutadiene (HCBD)** was initially assessed in the Ramboll (2019) study because of its inclusion in 2017 into Annex C of the Stockholm Convention (which lists unintentionally produced POPs which are subject to measures to reduce or eliminate releases from unintentional production). A value in Annex IV for HCBD already exists and HBCD is listed in Annex III of the POP Regulation (which addresses substances in Annex C of the Convention). Consequently, considering that the listing of the substance in Annex C of the Stockholm Convention does not require changes in the current Annex IV or V values, no further action is envisaged and this substance was **excluded from the scope** of this proposed amendment.

6. IMPACTS OF THE POLICY OPTIONS AND HOW THEY COMPARE

The impacts of the policy options (Annex IV limits)[77] for each of the substances have been analysed based on the main problems and drivers identified (see Section 2) and on the general objectives (see Section 4). More specifically the focus of the analysis was to determine the following environmental, social and economic impacts associated to the different options, for each of the substances and related waste streams:

- Changes in the mass flows of POPs – how much is removed / destroyed?
- Estimated health and environmental benefits associated to the reduction in POPs emissions (e.g. in terms of reduced healthcare costs incurred). Reduction in emissions as proxy. Impacts on workers' health and on the general population (consumers).
- Effectiveness of the measure. How do emission reductions projected compare to other existing emissions / sources of exposure? To what extent does the measure contribute to addressing the problem of exposure to the relevant POPs? Would other measures / instruments be better suited?
- Changes in the amounts of waste directed to different treatment options (recycling, incineration, landfill, etc.).

[76] Study to support the review of waste related issues in annexes IV and V of Regulation (EC) 850/2004. http://ec.europa.eu/environment/waste/pdf/Study_POPS_Waste_final.pdf

[77] Only one Annex V value is proposed for each of 4 newly listed substances which currently do not have one. These values are very rarely applied and in practice. It has not been considered possible or necessary to estimate the impact of such rare events that involve disposal operations which, generally, have similar costs (hazardous waste landfill versus underground storage in a hazardous waste facility) and affect limited amounts of waste.

- Costs and benefits for waste producers and waste operators (especially for SMEs) resulting from the different treatment outcomes. This includes investment costs in equipment as well as additional monitoring / operational costs (e.g. analytical costs). Impacts on employment.
- Changes brought about in the availability / implementation of technologies – e.g. waste sorting and decontamination technologies.
- Administrative burden for both operators and public administrations. Need for additional controls, differences on permitting, administrative costs, enforcement costs.
- Indirect impacts brought about by changes in limit values – differences in national / regional implementation of rules on waste classification (hazardous – non-hazardous) and on waste shipments. Impact on customer perception and behaviour to recycled material.
- Changes in the amount of available secondary material resulting from recycling. Impacts on supply and quality of secondary materials including impact on users of secondary material. Impact on competitiveness and trade.
- Changes in greenhouse gas emissions associated to the different options.

Information on the identity of waste streams concerned, mass-flows, treatments and on the different types of impacts listed above have been obtained via desk research and stakeholder interviews carried out in the two main studies supporting this impact assessment [Ramboll (2019), RPA (2021)]. Information on stakeholder consultation and its outcome is provided in Annex II of this report with further details provided in the relevant sections of the two supporting studies.

Estimation of **direct and indirect human health and environmental impacts**, and allocation of these to the specific policy options **is extremely challenging** and in most cases impossible to do in a quantitative manner. This is due to the lack of specific information on exposure associated to specific substances and waste streams, the lack of specific health and environmental impact information associated to specific substances or even of agreed methodologies to quantify and monetise these. **Risk profiles and risk management profiles** for the different substances concerned, developed under the Stockholm Convention as part of the process to list the substances have been examined. Unfortunately, specific **cost-benefit information** associated to the restriction of the substance **is scarce** and when available are related to substitution costs for manufacturers and users of the substance, rather than to broader health and environmental impacts or aspects specifically related to POP waste.

Where quantitative information cannot be provided, assumptions are made based on broader impact studies and qualitative assessments. The **underlying rationale is that any reduction in the emission of POPs will bring about a reduction in exposure and in overall environmental burden and, therefore, will be beneficial** from the point of view of protection of human health and of the environment. This is underpinned by the application of the **precautionary principle**, one of the key elements considered in the development and implementation of the Stockholm Convention. The preferred policy option is determined, applying the methodology outlined in Annex IV to this impact assessment report, taking into account all elements, including information on estimated socio-economic impacts.

The consideration of **CO_2 emissions** associated to the different policy options and their contribution to **climate impacts** is considered in this report **for the first time** and is addressed separately in the impact assessment by providing an estimate of the emissions. Figures used to assign an **economic value to every tonne of emissions avoided**, in terms of CO_2 equivalents, are those published in the Handbook on the External Costs of Transport published by DG MOVE[78]. These values are based on mitigation modelling estimates.

Finally, the **COVID-19 pandemic** has resulted in **unprecedented global economic impact**, including on commercial and industrial activity. Although, generally, the waste management sector has continued its operations, often recognised as an "essential service" by many countries, the pandemic has also brought about some changes. As reported by the International Finance Corporation[79] **industrial and commercial waste production fell drastically**, medical waste increased by up to 40%, **recycling of plastic products slowed down substantially**, **disposal at landfills increased** and use of single use plastics is increasing, largely driven by the use of personal protective equipment. Although **none of these aspects are directly linked to the substances or policy options assessed**, they describe a situation of **high economic uncertainty** that impacts on all activities[80]. This has been considered in defining the preferred policy option for some of the substances, where a cautious approach to mitigate impacts on the operators concerned is proposed.

6.1. Polybrominated diphenylethers (PBDEs)

6.1.1. What are they and why are they a problem?

Polybrominated diphenyl ethers (PBDEs) are a family of substances which are added to plastics and textiles and to a lesser extent to adhesives, sealants and coatings to **make it more difficult that they catch fire** and to slow down its propagation (these substances are known as flame-retardants). This impact assessment addresses five specific members of the PBDE family of brominated flame-retardants which are listed in Annex IV of the POPs Regulation: tetraBDE, pentaBDE, hexaBDE, heptaBDE and decaBDE.

Most PBDEs are not used or have been banned in the EU under the POPs Regulation for over a decade, although other brominated flame retardants such as decabromodiphenyl ethane (EBP) or TBBPA remain in use. DecaBDE was only banned, with some exceptions, in 2019 although its use as a flame-retardant in Europe was declining years before the ban. Under Directive 2011/65/EU (the **RoHS Directive**), **PBDEs in electrical and electronic equipment** should account for no more than 0.1% (1,000 mg/kg) by weight in homogenous material.

PBDEs can end up in the food and the water that we consume. They are persistent and accumulate in the bodies of animals and humans. In doing so they exert adverse effects on the organisms in which they accumulate. Exposure to PBDEs brings about **disruption in the thyroid gland** in humans and is associated with **neurodevelopmental**

---

[78] Handbook on the external costs of transport - Version 2019 – 1.1. https://op.europa.eu/en/publication-detail/-/publication/9781f65f-8448-11ea-bf12-01aa75ed71a1

[79] IFC, World Bank Group. June 2020. https://www.ifc.org/wps/wcm/connect/dfbceda0-847d-4c16-9772-15c6afdc8d85/202006-COVID-19-impact-on-waste-sector.pdf?MOD=AJPERES&CVID=na-eKpI

[80] See for instance: European Demolition Industry – Report about the impact of the COVID-19 on the demolition companies https://www.europeandemolition.org/library/european-demolition-industry-report-about-the-impact-of-the-covid-19-on-the-demolition-companies

deficits, reproductive changes and cancer. The most significant known impact of PBDE exposure is the effect on neuropsychological development of children. From the environmental impact point of view PBDEs are endocrine disruptors and affect neurological and thyroid activity of many species and have potential impacts on population size and resilience.

Widespread contamination by PBDEs is estimated[81] to have human health costs in the EU of around €10 billion / year.

6.1.2. Baseline

PBDEs are found in plastic and textile waste from electrical and electronic equipment (WEEE) and end-of-life vehicles (ELV) as well as in some plastic construction and demolition waste and in other textiles such as the upholstery of furniture. In most of its applications in articles the substance is used at high concentrations (usually from several percentual units up to 15%) so that individual parts of the waste and **waste fragments usually either contain a lot or very little**, depending on whether they originate from treated or untreated articles (or parts of articles).

According to the available information[82], obtained from 37 published studies between 2011-2018, at least 60-85% of WEEE plastics, 55%-80% of ELV plastics, 70-99% of construction & demolition (C&D) waste plastics and 60-95% of textile waste can be expected to contain less than 200 mg/kg PBDEs. In terms of their current and possible future recycling, **WEEE and ELV plastic waste are the most important fractions**. Demolition plastics containing PBDEs do not currently seem to be a very relevant waste stream but amounts generated will increase in the future. Very limited information is available on textile waste other than from ELV. Most is landfilled or incinerated and has a relatively short lifetime. It is envisaged that most remaining textile waste treated with PBDEs (e.g. upholstered furniture) will become waste in the decade of 2020 and will be disposed of (textile recycling is currently very limited).

WEEE and ELVs are currently **recycled by undergoing a sequence of pre-treatments and treatments** which generally imply limited manual separation of the most problematic (batteries, cathode ray tubes, etc) or economically relevant components (such as printed circuit boards containing valuable metals). This is followed by shredding into small fragments and separation of the different components via a number of automated processes. For smaller equipment, shredding often occurs without any prior treatment.

Mixed plastic fragments from WEEE and ELV are usually delivered in bulk to a **limited number of specialised treatment facilities** (some 30 are estimated to exist in the EU) where, by using different technologies, mixed plastics are separated into different types of plastic (e.g. ABS, HIPS, PP, etc.). The **sorting process** generally relies on the **different densities** of the plastics that contain PBDEs and other brominated flame retardants (which are heavier than plastics that do not contain them as additives) and

[81] Trasande et al (2016). Burden of disease and costs of exposure to endocrine disrupting chemicals in the European Union: an updated analysis. https://onlinelibrary.wiley.com/doi/full/10.1111/andr.12178

[82] See table VI-3 in Annex VI and discussion in sections 3 and 11 of RPA (2021). Original source in Hennebert (2020) https://digital.detritusjournal.com/issue/volume-12--september-2020/363

results in a **“high-bromine” heavier fraction** and a **“low-bromine” lighter fraction** being ultimately produced[83].

Currently the high bromine fraction contains about 92% of all the PBDEs in the incoming mixed plastic and after sorting it is disposed of, generally via incineration. For WEEE treatment facilities implementing CENELEC standards (series EN 50625 on WEEE treatment), the remaining PBDEs in the “low-bromine” fraction must comply with the depollution requirements according to which the “low-bromine” fraction must contain **no more than 2,000 mg/kg of bromine**. This value was, at the time[84], demonstrated via sampling and analysis to statistically ensure that by meeting said bromine content limit value, the plastic waste complied, on average, with the **limit of 1,000 mg/kg** for the sum of listed PBDEs established in Annex IV of the POPs Regulation.

Currently about 1,300,000 t of **WEEE plastics** are separately collected every year in the EU resulting in **560,000 t of plastic being recycled** (still containing some 60 t of PBDEs). The rest is mostly incinerated resulting in the **destruction of some 730 t of PBDEs** with another 25 t ending up in landfills. As regards ELV plastics, some **350,000 t are collected which results in some 100,000 t being recycled**, together with 19 t of PBDEs. The rest of the material is landfilled (19 t PBDEs) or incinerated (13 t PBDEs). **ELV textiles and other textiles represent a much smaller stream** and are either not recycled or recycled to a rather small extent. **Construction & demolition plastics are rarely separately collected** (other than to some extent PVC) and are therefore currently subject to very limited recycling. It is estimated that 10,000 – 60,000 t of plastic C&D waste that contains PBDEs are generated each year and are mainly landfilled or incinerated.

According to Sofies (2020)[85] a very substantial amount of WEEE plastic generated in the EU is either **unaccounted for** (some 775,000 t), recycled via alternative sub-standard processes (307,000 t) or wrongly discarded as mixed municipal waste (226,000 t). A fraction of the first two is exported. This situation will continue to occur **regardless of which of the policy options discussed in this study is adopted** and represents a relevant source of pollution that has to be addressed by other means (e.g. by increasing separate collection rates, enforcement and tighter controls on waste exports).

6.1.3. Impacts of the policy options

Three options are considered for the Annex IV value for the sum of the 5 listed PBDEs:

- Option 1 is leaving the current baseline value of 1,000 mg/kg untouched;
- Option 2 is lowering to 500 mg/kg as requested by the co-legislator[86] during the recast of the POPs Regulation (and also equivalent to current UTC value in Annex I); and

[83] This separation is **not specific to PBDEs** and relies on the higher density of flame retardants that contain bromine. Detailed information on the sorting of WEEE and ELV Plastics containing PBDEs is provided in chapters 3 and 11 of RPA(2021).

[84] The value of 2,000 is quoted in CLC/TS 50625-3 of January 2015. As reported in Sofies (2020) in 2010 a limit of 1,000 mg/kg for listed PBDEs was met by an equivalence of about 2,500 mg/kg bromine.

[85] https://www.bsef.com/wp-content/uploads/2020/11/Study-on-the-impact-of-Brominated-Flame-Retardants-BFRs-on-WEEE-plastics-recycling-by-Sofies-Nov-2020.pdf

[86] Recital 15 and the entry in Annex IV of the POP Regulation require the Commission to review the concentration limit for PBDEs in Annex IV and, where appropriate, lower it to 500 mg/kg. This should happen no later than 16

- Option 3 represents the lower value option, decreasing the limit to 200 mg/kg, which is the lower limit proposed in Ramboll (2019) based on the methodology described in Annex IV of this report. Two sub-options are considered: immediate implementation[87] and delayed implementation in 2027.

In terms of its **current recycling**, the most relevant waste stream under consideration is plastic waste from EEE and from ELV. These are the waste streams for which more information is available and where impacts are expected to be greater. Consequently the impact assessment focuses on them. Further detailed supporting information on PBDEs can be found in annex VI of this impact assessment and, particularly in chapters 3, 11 and Annex 1 of RPA(2021).

Information on PBDE concentrations and arisings of PBDE-containing waste from **construction and demolition and from textiles is very limited**. RPA(2021) estimates that a relatively small amount of between 10,000 and 60,000 t of plastic C&D waste that contains PBDEs is generated every year and is either landfilled or incinerated. These amounts are expected to increase and plateau in 2040-2060. Some **190,000 t of ELV textiles are estimated to be generated every year**, 92% of which is either incinerated or landfilled, mostly together with the shredder light fraction from ELV treatment. No information is available on the amounts **of other textile waste** currently generated that may contain PBDEs (e.g. from the upholstery of furniture).

The information available suggests that the **impacts of Option 3 on C&D plastics and on textiles are likely to be very limited** given their very low current recycling rates and, in the case of textiles, the relatively quick envisaged disappearance of PBDEs from the waste stream (shorter service life due to limited durability of textile material). These textile streams may deserve a more detailed assessment in the context of the upcoming **Textiles Strategy**.

The amounts of material diverted to different waste treatments under Options 2 and 3 over the period 2021-2035 have been estimated based on information on the distribution of concentrations of PBDEs in WEEE and ELV waste obtained from studies analysed by RPA (2021). **No change with respect to the baseline is expected for Option 2**. Two scenarios have been calculated for Option 3, one assuming implementation of the measure in 2021 and another where Option 2 would be implemented first, followed by Option 3, that would be implemented in the year 2027. The expected amounts are summarised in the table below.

Impact on final treatment – tonnes diverted from recycling or landfilling over 2021-2035						
Waste stream	**Option 3 (200 mg/kg) Immediate application in 2021**			**Option 3 (200 mg/kg) Application as from 2027**		
	Incineration	**Recycling**	**Landfill**	**Incineration**	**Recycling**	**Landfill**
WEEE	7,100	-5,300	-1,800	0	0	0
ELV	76,100	-28,200	-47,800	38,900	-14,400	-24,400
Total	***83,200***	***-33,500***	***-49,600***	***38,900***	***-14,400***	***-24,400***

Table 4 Impact on final treatment – tonnes diverted from recycling or landfilling over 2021-2035

July 2021. 500 mg/kg is also the current UTC limit in articles in Annex I of the POPs Regulation (placing on the market).

[87] Calculations are based on the year 2021.

No additional EEE or ELV waste is expected to be diverted to incineration under Option 2 (500 mg/kg). Under **Option 3** it is estimated that **1% of EEE plastic waste and 2% of ELV plastic waste** that are currently recycled or landfilled would be diverted to incineration[88]. **Under Option 3 (200 mg/kg), a total of 83,200 tonnes** is expected to be additionally incinerated over 2021-2035**.** This value is **reduced to 38,900 t** if the implementation of the measure is delayed to 2027[89].

Analytical results obtained from relevant articles and from EEE and ELV plastic waste fractions described in a number of studies [(further information in Annex VI and in RPA(2021)][90] indicate that a **large part of the sorted, low bromine fraction of WEEE and ELV waste already meets the 200 mg/kg limit**. Given there are some **uncertainties about the representativeness** of these values to the whole industry and the **influence of different input materials** (such as highly brominated CRT[91] plastic), a **typical value of 350 mg/kg**, obtained from Sofies (2020)[92], is taken as a realistic average concentration value, generally achievable today, for the listed PBDEs in sorted plastics from WEEE and ELV.

This decrease in concentration of listed PBDEs is the result of previous upstream bans on these substances in products. Their concentrations in sorted WEEE plastics are **expected to reach levels below 200 mg/kg in the mid-2020s** whereas for sorted ELV plastics average concentrations of PBDEs are expected to **remain of the order of 350 mg/kg until the early 2030s** (due to the longer lifetimes of vehicles) and are envisaged to drop to below 200 mg/kg in the mid-2030s.

There is little doubt that the limit of 500 mg/kg can be met today as an average value for a homogeneous sample of sorted WEEE or ELV plastic waste given that recyclers confirm they **are complying with the limit in Annex I** of the POPs Regulation (established in 500 mg/kg since 2019). This limit applies to the plastic recyclate that recyclers place on the market, which is obtained by melting, homogenising and extruding the sorted low-bromine plastic waste fraction into pellets.

For WEEE and ELV plastic recyclers the diversion from recycling to incineration under Option 3 is estimated to result in a **loss of revenue of 11 M€ plus additional waste management costs (incineration) of 7 M€, over the period 2021-2035** leading to maximum annual net losses of 3 M€[93] for the sector. If option 2 is implemented first, followed by Option 3 applicable as of the year 2027, these costs would be reduced, amounting, respectively to **4 M€ and 2,5 M€** in that period and maximum annual net losses for recyclers of **1.1 M€** in 2027.

Some waste which is currently sent to landfill[94] would also have to be sent to incineration resulting in a **decrease in revenue of 6 M€ for landfill operators (or 3 M€** if implementation is delayed to 2027**).** It is not clear which actors would bear the **additional cost of 10 M€ (or 4 M€) resulting from incinerating waste that was being previously landfilled** but this report assumes that this would also be borne by waste

[88] See Table 3.17 of RPA(2021).

[89] See table 3-21 of RPA(2021).

[90] See in particular sections 3.2.1 and 3.3.2. and table 3-5 of RPA(2021).

[91] Plastic from cathode ray-tubes of old television equipment was very highly additivised with PBDEs

[92] Ibid.

[93] Losses are not distributed evenly over this period. They are higher in the first years given the average concentration of PBDEs in the low-bromine fraction decreases over time. See tables 3-15 and 3-16 in RPA(2021).

[94] Waste plastic below Annex IV value but which cannot be recycled, for instance mixed high density plastics. It is assumed that 50% of this waste was being sent to hazardous waste landfills and the other 50% to non-hazardous waste landfills.

treatment operators (recyclers) in several of the steps of the WEEE/ELV treatment process. It is **unclear** whether part of the costs borne by **recyclers are effectively covered by the producers of those products under Union and national extended producer responsibility systems (EPR)** mandated by Directives 2000/53/EC (ELV) and 2012/19/EU (WEEE) and, ultimately to consumers[95].

In the same period **operators of incinerators** are envisaged to experience an **increase in revenue of 17 M€** (or **7 M€** in the delayed implementation scenario) as a result of dealing with the waste than can no longer be recycled or sent to landfill under stricter Option 3 values. As can be seen, **most of these economic impacts are distributional** where the decrease in revenue by landfill operators results in an increase by incinerators and where a **decrease in revenue for recyclers** from the sale of recovered materials results in an **increase in the revenue of producers of primary plastics**.

In addition, in order to be able to systematically meet the limit in Option 3 some specialised WEEE/ELV plastic r**ecyclers will need to invest in improving their sorting efficiency**. Based on the assumption of 30 specialised facilities[96] in the EU, of which 50% would have to invest in improvements, this would result in a one-off capital expenditure of 7,5 – 15 M€ for the sector or of **500,000 – 1,000,000 € per company**. If option 3 is implemented only in 2027 these costs would be reduced to a maximum of approximately 800,000 € per company.

Impacts on operators of waste incineration plants have also been estimated. Under Option 2 no impacts are expected but under Option 3 a total of **33,500 t of secondary plastic** that could be recycled under current limits would be **diverted to incineration** in the 2021-2035 period. This figure would be reduced to **14,400 t in the event of delayed implementation and would affect only ELV plastics**. Given the amounts of waste deviated are relatively modest it is expected that the **waste incineration industry will be able to absorb this additional material** without any major problems.

Based on the above figures for Option 3 the maximum amount of WEEE plastic waste diverted from recycling in a given year has been **estimated to be 2,800 tonnes,** which would have a **negligible impact on WEEE plastic recycling rates**[97]. This impact would be even smaller on the overall WEEE recycling rates and therefore also on the achievement of the WEEE recycling targets set out in the WEEE Directive.

Producers of articles having to substitute this recycled material by primary (virgin) plastic would incur increased cost of 17 M€ over this period (due to higher price of primary plastic) which would be **reduced to 6 M€** in the event of delayed implementation in 2027. According to the predictions of the model the costs per year start at **€3.1 million in 2021 and decline to €0.2 million in 2035.** Given this impact would be spread over many companies it is estimated it would be very small per individual company.

No significant impacts on the market or on employment are expected from the introduction of Option 2 given that WEEE and ELV recyclers in the EU already produce recyclate compliant with this limit, obtained from the sorted low-bromine plastic waste

[95] Articles 5 and 12, respectively, of the ELV and WEEE Directives, establish the responsibility of producers of these products on bearing part or all of the costs associate to the take-back and treatment of such products, upon becoming waste.

[96] It is estimated 30% are small companies, 50% are medium-sized companies and 20% are large companies.

[97] The recycling rate of WEEE plastics would be reduced from 43.1% to 42.9% - this is comfortably within the margin of uncertainty of the overall data.

fraction[98]. As indicated above, a limited **impact is expected from Option 3**, especially on smaller recyclers, which would have to bear losses of revenue, additional waste management costs and potentially **one-off expenses** in improvement of their sorting equipment. This impact would be reduced in the event of delayed implementation.

It is important to note that stakeholder associations representing WEEE and ELV recyclers, a majority of which are SMEs, have indicated that **both Options 2 and 3 would cause significant disruptions in recycling**. A number of reasons have been given for this including concerns that the required limits **cannot be achieved** in a consistent manner with the current technology in place and that the available **analytical method** to check compliance with the limit values on-site is **not validated to reliably measure these values**. In addition, these stakeholders consider that revising the limit value for PBDEs, which were **reviewed already in 2019**, introduces uncertainty and does not promote investment in upgrading existing installations or investing in new ones. These **stakeholders call for stability and legal certainty** and consider themselves to be **over-regulated**, not only by the POPs Regulation but also by other relevant legislation such as REACH, the WEEE Directive and the RoHS Directive.

The information available regarding concentrations of PBDEs in sorted and unsorted WEEE/ELV plastics, although subject to some uncertainty about its representativeness for the whole recycling sector, **do not support the first claim**. This is especially so for Option 2. There are indications that **Option 3 values are also often already be met** but may still require a number of years, together with the introduction of improved sorting equipment, to be systematically achieved by a majority of recyclers[99].

The second claim, regarding the **lack of a validated analytical method is not supported by the operating range reported in the relevant European standard**[100] , nor its underlying validation data which includes samples below 100 mg Br/kg[101]. Other stakeholders, including NGOs and managers of hazardous waste, do not support these claims. Regardless of this, given that according to Sofies (2020) available statistical information indicates that currently the measured bromine concentration in WEEE/ELV plastic correlates with 1/6 of this value expressed as content in listed PBDEs. Therefore, measuring 1000 mg/kg **bromine will enable detecting 170 mg/kg of listed PBDEs.** This is below the Option 3 limit and, therefore, measurable within the claimed validated interval[102].

The discussion on the analytical method is complicated by the difference between what actually is being measured with the mentioned standard method (Br content) and the basis of the legal requirement (content of 5 listed PBDEs). The future reliability and performance of the EN standard method in terms of the required limit for PBDEs

[98] And where dilution to achieve compliance is not permitted.

[99] Information on the distributions of average concentrations of listed PBDEs is provided in table VI-3 of Annex VI as well as in chapters 3 and 11 of RPA (2021). Detailed considerations on sampling and analysis of PBDEs in WEEE plastic waste are provided in Chapter 11 and Annex 1 of RPA (2021).

[100] EN 62321-3-1:2014: Determination of certain substances in electrotechnical products. Screening. Lead, mercury, cadmium, total chromium and total bromine by X-ray fluorescence spectrometry

[101] A consultation made by the Commission services to experts in CENELEC CLC/TC 111X, responsible for the standard, indicated that EN 62321-3-1:2014 has been tested to measure bromine in polymers at concentrations ranging from 25 to over 100,000 mg Br/kg. For a working range below 1000 mg Br/kg an accuracy of about 10 %, with a relative standard deviation of 13 % is achieved (values expressed with 95% confidence interval). In terms of specific polymer types, the validated concentration ranges are published in Table 5 of the standard. Section A3 of the standard also reports for bromine measurements a relative uncertainty of 30% with respect to the target limit value.

[102] If in the future other bromine-containing flame retardants were to be listed as POPs this assumption may no longer be valid.

depends on the evolution of the fraction of Br in plastic that comes from listed PBDEs in comparison with the fraction of the Br in plastic that comes from other Br-containing substances. Assuming that the use of the listed PBDEs will decrease faster than the use of other Br-containing substances, the current (indirect) PBDE-detection limit would decrease over time. It is important to observe this trend in the coming years.

The same stakeholders, representing WEEE and ELV recyclers, have also expressed concern that the lowering of Annex IV limits to Option 2 and 3 values will have an **impact on the classification of the plastic waste as hazardous**. This in turn would **increase waste transport and management costs** and create **additional barriers to the shipment of these waste** within the EU resulting in **greater costs, administrative burden[103] and reduced availability of material** for recycling. They also consider that by making it more difficult that WEEE/ELV waste reaches authorised operators like themselves there is a high likelihood that larger amounts of these wastes will be exported, recycled under sub-standard conditions or directly disposed of in landfills or dumped illegally.

In this regard it is important to recall that meeting or exceeding Annex IV values for PBDEs does not determine, according to current EU waste legislation, whether waste will be classified as hazardous or not, so **lowering these values should, as such, have no impact on the classification of plastic WEEE/ELV waste as hazardous[104]**. It is acknowledged that, based on stakeholder reports, there may be national / regional implementations of the Waste Framework Directive that result in WEEE/ELV plastic waste being classified as hazardous waste[105], or being subjected to additional provisions[106] and that this may cause disruptions in the availability and trade of these wastes. It has **not been possible to confirm or determine the magnitude of these potential impacts[107]** which, in any event, **seem difficult to address in the context of this impact assessment**, given they do not result from any legal obligation under the EU legislation associated to the options being considered.

It would seem that any potential impacts that may arise from the referred national / regional implementations **should be addressed**, as appropriate, together **with Member States, in the context of the implementation of the Waste Framework Directive** and of the **Waste Shipment Regulation** (currently under review).

The different options considered also have an impact on **CO_2 emissions associated to waste management**. These occur due to 1) displacement of recycled plastics with virgin plastics; 2) direct emissions from incineration; and 3) transport emissions. It has been estimated that Option 2 has no impact and that implementing Option 3 would result in

[103] Such additional burdens may in any case occur because of the classification of plastic waste with POP content above the Annex IV level but below the level to classify it as hazardous waste, as Y48/EU48 under the Waste Shipment Regulation [as amended by Commission Delegated Regulation (EU) 2020/2174)]. This would make the waste to be subject to shipment prior consent procedures.

[104] DecaBDE, currently the most abundant of listed PBDEs in WEEE Plastics, has no harmonised classification in Annex IV of Regulation (EC) No. 1272/2008 (CLP). Consequently, no threshold is directly applicable for the classification of waste containing this Substance as hazardous, according to Annex III of the Directive 2008/98/EC.

[105] This is reported by some recyclers to be the case in some regions of Germany and France.

[106] The German POP Waste Control Ordinance establishes specific provisions regarding the management of waste containing POPs which exceed Annex IV values but are not classified as hazardous waste. https://www.bmu.de/gesetz/verordnung-ueber-die-getrenntsammlung-und-ueberwachung-von-nicht-gefaehrlichen-abfaellen-mit-persistente/

[107] Preliminary consultations done by the Commission with Member States indicate that use of Annex IV limits to classify WEEE plastics as hazardous waste is not a common practice. A full overview of the situation is however not available.

additional CO_2 emissions of approximately **153,000 t over the period 2021-2035**. **These emissions are relatively minor representing 0.004% of the total GHG generated by households and industry** in the EU-27 in one year (4 billion tonnes of CO_2 equivalents in 2018[108]). If implementation of Option 3 is delayed to 2027 the additional emissions would be of about **74,000 t CO_2 equivalents** over the period 2027-2035.

In addition to CO_2 emissions, **polybrominated dibenzo-p-dioxins and dibenzofurans** (PBDDs/PBDFs) can be generated from combustion and incineration of waste containing PBDEs. These substances are thought to **have similar toxicity to dioxins and furans** although no toxicity equivalence factors have been assigned to these by the WHO. The additional incineration of WEEE/ELV plastic waste resulting from Option 3 could result in the **emission of additional amounts of PBDDs/PBDFs to the atmosphere**. It has not been possible to estimate the amount of these emissions nor the magnitude, if any, of its effects. If incineration is carried out according to technical standards currently specified in the Industrial Emissions Directive it is expected that these emissions will be very small.

6.1.4. Conclusion on preferred policy option

As described in the limitations criteria table and diagram in section 6.6 of the Annex to this report, the highest of the lower limitation criteria is determined by the current unintentional trace contaminant limit of 500 mg/kg, below which PBDEs can be placed on the market in mixtures and articles. This corresponds to Option 2 in this impact assessment.

In view of all the above it seems clear that Option 2 is already being achieved by WEEE and ELV recyclers and therefore any impacts, both positive or negative will only result from the implementation of Option 3. However, given that:

1. there is some **uncertainty** about the capacity of specialised WEEE and ELV plastics recycling facilities to be able to **consistently produce a low-bromine plastic fraction** that would meet the Option 3 limit and;
2. some years would be required to carry out and implement the **necessary investments to improve sorting equipment**, as well as take advantage of the naturally declining concentrations of PBDEs in this type of waste;
3. some uncertainties exist as regards indirect impacts, unrelated to the measure itself, but associated to a) **national / regional implementation of rules on hazardous waste classification** and their relation with Annex IV limits and b) revised waste shipment rules for plastic waste, which may require further consideration by the Commission together with Member States;
4. considering that the current limit in Annex I of the Regulation, applicable to products placed on the marker is set at 500 mg/kg (subject to review);

it is concluded that it would be appropriate to define **Option 3 (200 mg/kg) as the preferred policy option** but **delaying** its implementation by 5 years after the adoption of the Regulation amending Annexes IV and V of the POP Regulation (estimated in 2021/2). This option is consistent with the application of the methodology described in Annex IV of this report (where after the UTC lower limitation criterion, the following lower limiting criteria are economic criteria E1 (200 mg/kg) and E2 (350 mg/kg), having

[108] See https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Greenhouse_gas_emission_statistics_-_air_emissions_accounts#Greenhouse_gas_emissions

different economic impact levels. The preferred policy option is consistent with the methodology outlined in Annex IV, given the proposal for a lower limit value to be applied five years after adoption is made under the assumption that the UTC value of 500 mg/kg, which currently is the highest of the lower limitation criteria, will have been reduced by then, with values E1 and the closely related A2 (170 mg/kg) becoming the new lower limitation criteria (rounded to 200 mg/kg).

Consequently, and based on the proportionality and effectiveness considerations outlined above, reduction in two steps of the Annex IV limit for PBDEs is proposed.

This translates into the initial application of Option 2 (500 mg/kg) and its subsequent automatic lowering to 200 mg/kg 5 years after entry into force[109] of the initial measure (i.e Option 3 limit would apply approximately in the year 2027). This is consistent with the fact that, currently, the limit in Annex I of the POP regulation is set at 500 mg/kg[110] (as it does not seem appropriate to set a stricter limit to regulate waste management than to enable the placing on the market as a product). To take this into account, a provision should be included in the measure to alternatively set the limit value to the value for PBDEs in Annex I at that time, if this is higher than the value of 200 mg/kg proposed for Annex IV.

As regards the **Annex V limit**, it is proposed to follow the recommendation in Ramboll (2019) to integrate decaBDE into the PBDE group value in Annex V of the POPs Regulation which is already established to 10,000 mg/kg. As indicated in section 4.3, no reliable applicable health-based reference value could be determined for decaBDE. Given that an agreed Annex V value already exists for the sum of the other PBDEs of higher toxicological concern, and considering that a (rough) estimate of a possible health-based Annex V value based on a typical concentration of decaBDE in sediments would largely exceed the current value, it is proposed to **maintain the limit for the sum of PBDEs at 10,000 mg/kg,** integrating decaBDE into the existing sum value.

As explained in section 5.3.3 no impacts, and therefore no costs, are expected from changes proposed to Annex V. This is because such limits are very rarely applied and, in practice, would only result in some waste being (potentially) directed for disposal to underground storage in a hazardous waste facility rather than being disposed in a hazardous waste landfill. In the specific case of WEEE/ELV plastics containing PBDEs exceeding the Annex IV limits, these are currently already largely sent to incineration facilities and the Annex V value is not applied.

6.2. Hexabromocyclododecane (HBCDD)

6.2.1. What is it and why is it a problem?

Hexabromocyclododecane[111] (HBCDD) entered the world market in the late 1960s and since then was **used as a flame retardant in insulation boards in the construction sector**. The main use of HBCDD in the EU (90 %) was in **expanded and extruded polystyrene** (EPS and XPS) used in this type of insulation. Approximately 6% of

[109] Such envisaged lowering of the Annex IV limit would also be supported by a possible future lowering of the value in Annex I , which relates to the maximum amount, as a trace contaminant, in products placed on the market. Under the POP Regulation the values in Annex I are amended via delegated acts.

[110] This limit is also set to be reviewed via a delegated act.

[111] The entry covers hexabromocyclododecane, 1,2,5,6,9,10-hexabromocyclododecane and its main diastereoisomers: alpha-hexabromocyclododecane, beta-hexabromocyclododecane and gamma-hexabromocyclododecane.

HBCDD was used in **EPS packaging** and about 2% of the total consumption of HBCDD was in high impact polystyrene (HIPS), a plastic used in electronic products and articles. Another 2% was used in textile coatings. Ramboll (2019) estimated that between **1988 and 2017 almost 222,000 t of HBCDD have been used in the EU in the different applications** of which 193,000 t still had to become waste in 2017 (i.e. were still in service life).

HBCDD was listed in 2013 under Annex A of the Stockholm Convention, where parties must take measures to **eliminate** their production and use (from 2014). The substance is listed in **Annex IV of the POPs Regulation since March 2016** with a concentration limit of **1,000 mg/kg**. The Annex IV value for HBCDD was subject to be reviewed by the Commission by 20 April 2019[112].

The consumption/demand of HBCDD in EPS/XPS outside the construction industry stopped in 2014. In the EU, HBCDD was used in EPS and XPS in construction until 2017 in **typical functional concentrations of 0.7 and 1.5%,** respectively. Today there is no more production, trade or use of HBCDD in the EU. Unintentional **traces of the substance below 100 mg/kg are tolerated** under Annex I of the POPs Regulation, including HBCDD present as a legacy additive in secondary raw materials.

HBCDD has a strong potential to **bioaccumulate and biomagnify**. It is **persistent** in the environment and has a potential for long-range environmental transport. It is **very toxic to aquatic organisms**. Information on the human toxicity of HBCDD is to a great extent lacking but vulnerable groups could be at risk, particularly due to the observed effects on development and on the neuroendocrine system.

6.2.2. Baseline

The most relevant waste streams due to historic use, imports or cross-contamination are: (1) EPS in construction, (2) XPS in construction and (3) EPS in packaging. HBCDD in waste streams containing HIPS from the electronics sector is still relevant at low levels but will decrease from the beginning of the 2020s. The relevance of HBCDD in textile waste is also already decreasing.

HBCDD has **not been used in packaging since 2016** (or earlier) and, due to the nature of use of packaging, has short lifetimes. This suggests that most packaging with HBCDD **should have already disappeared** from waste streams. In addition, where it has been recycled, the trace contaminant limit in Annex I of the POPs Regulation (100 mg/kg) should ensure low levels of HBCDD in new products. There are however some concerns due to HBCDD **being detected in consumer products**/packaging, and about potential cross-contamination of packaging EPS/XPS as a result of being collected / mixed with **insulation material** coming from demolition. Furthermore, a small part of the goods imported from Asia into the EU may still contain packaging with HBCDD (Ramboll, 2019). About **390,000 t of EPS/XPS packaging** were generated in the EU in 2017.

Given the expected low average concentrations of HBCDD in WEEE and textile waste, these two waste streams are not considered further and focus is placed on insulation boards used in construction and on packaging.

Based on very limited information RPA(2021) estimates that there could be **approximately 100 recyclers**, most probably SMEs, **dedicated to EPS/XPS packaging**

[112] Neither Annex I nor Annex IV limits for HBCDD were reviewed in 2019 during the POP recast, which was published on 25 June 2019. Target dates for review, which had already elapsed on the date of adoption of the Regulation, were however maintained in the legal text adopted by Council and the European Parliament.

in the EU, although this figure is highly uncertain. The number of recyclers that specifically deal with EPS/XPS insulation panels in the EU is unknown. There are an estimated **1,000 – 4,000 companies recycling construction and demolition waste** in the EU of which the vast majority are micro or small companies. However many of these surely do not recycle insulation panels. According to material flows developed by Ramboll (2019) about **99,000 t and 33,000 t of EPS and XPS insulation waste** were generated in the EU, respectively, in 2017.

EPS/XPS insulation used in construction comes in several forms the most relevant being the so-called "**external thermal insulation composite systems**" (ETICS) and flat roof and floor insulation. The former contain about 10% of insulation foam, which is **tightly adhered to the mineral material** (bricks, concrete, etc.), the latter are relatively easy to disassemble and separate. The issue at hand is that for proper treatment the insulation material has to be segregated and separately collected. This is very often not the case. In the case of ETICS the insulation is tightly bound to the mineral material, making it very difficult to separate and all generally ends up crushed and mixed with mineral demolition waste. This material will be usually either **recycled as aggregate**[113] or disposed of in **non-hazardous or inert waste landfills**.

There are **both field and analytical methods that can be used to measure and detect HBCDD** in materials, although these are **not specific for waste** and some are not validated below the current Annex IV value. As discussed for PBDEs, there is a field method using XRF hand-held equipment that can detect bromine (which is used as a proxy given bromine is present in HBCDD). This method is however **not specific** and, although currently detecting bromine is an almost certain indication of the presence of HBCDD in insulation, the **recent substitution** of this substance by a **polymeric brominated compound**, suggests that in the future this will no longer be conclusive. A somewhat **more complex field** method is available, which requires prior extraction and XRF detection of bromine, which allows distinguishing between the two additives. It can quantify HBCDD above 50 mg/kg but the method seems to have only been tested at concentrations above 6,500 mg/kg (which is the lower end of the functional concentration in EPS). Finally there is a laboratory method[114] for electrotechnical equipment the development of which is currently being finalised. This method is expected to be able to **quantify HBCDD above 150 mg/kg**, but it seems to only have been tested to measure concentrations above 1,000 mg/kg. Other methods are available in the scientific literature[115].

Given the past almost universal use of HBCDD in EPS/XPS insulation material, some stakeholders representing former producers and users of HBCDD in the polystyrene insulation foam sector[116] argue that there is no point in analysing or attempting to sort **EPS/XPS demolition waste** given that it **will always exceed the current limit**. However, other sources indicate that HBCDD-containing insulation material was 0%

---

[113] Contacts maintained with the European Aggregates Association (EUPG) suggest however that, due to strict acceptance criteria on the input material, and requirements on the resulting product imposed by the applicable European Standards (eg on maximum amounts of lightweight contaminants in the aggregate), the presence of HBCDD in recovered aggregates is very unlikely.

[114] IEC 62321-9. Envisaged publication date June 2021.

[115] Votja et al, 2017. www.researchgate.net/profile/Lisa_Melymuk/publication/310438153_Screening_for_halogenated_flame_retardants_in_European_consumer_products_building_materials_and_wastes/links/59dde2510f7e9b53c1b22734/Screening-for-halogenated-flame-retardants-in-European-consumer-products-building-materials-and-wastes.pdf

[116] See http://pops-and-waste.bipro.de/wp-content/uploads/2018/04/VCI_HBCD-IG-EUMEPS_Opinion_20180403.pdf

until the end of the 1970s, increased to 75% in the early 1980s and rose steadily to 95% in 2002-2014, but never reached 100% (Conversio, 2020). The HBCD Industry Group noted that in 2018 approximately 80kt (~57%) of European EPS/XPS demolition waste contained HBCDD and Ramboll (2019), quoting Giraf (2018), concluded that **70% of EPS/XPS from C&D waste contained HBCDD** in concentrations above 1,000 mg/kg.

The treatment of EPS/XPS waste varies widely between EU countries. Conversio (2020)[117] estimates the following distributions:

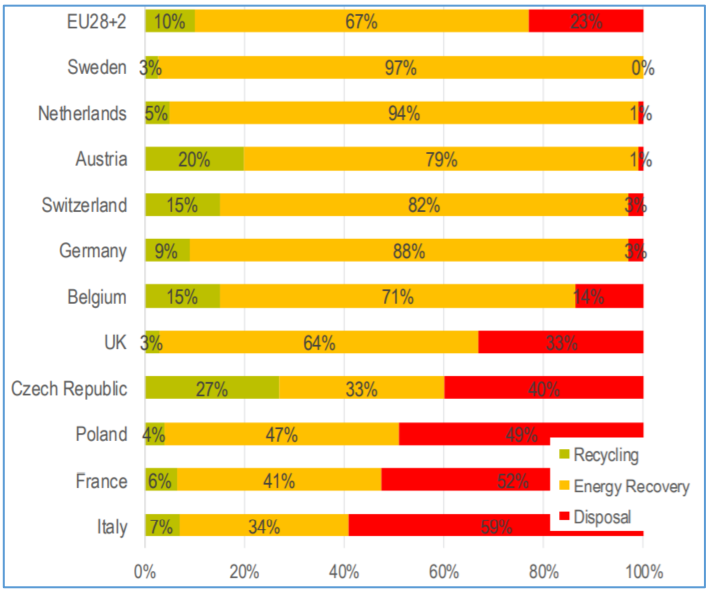

Figure 4: Distribution of EPS/XPS waste treatment between EU countries.

On average, according to figures quoted in RPA(2021) **78% of this waste is incinerated, 21% landfilled and 1% recycled (mechanically)**. If post-industrial EPS/XPS is taken into account the incineration figure decreases and landfill increases.

As regards EPS/XPS **packaging, recycling, landfill and incineration are evenly distributed**. Currently EPS/XPS obtained from packaging generally has very low concentrations of HBCDD which only increase if the material is contaminated due to mixing with demolition EPS. Some introduction of HBCDD into the EU in **imported packaging** is also possible (although not allowed).

A recycling plant for compacted HBCDD-EPS and XPS that uses the CreaSolv® decontamination process is under construction in the Netherlands by the consortium **PolyStyreneLoop.** According to them, 1 tonne of reusable polystyrene (with HBCDD content <UTC of 100 mg/kg) can be obtained from every 1.1 tonnes of waste polystyrene. In the process, HBCDD is separated and bromine is recovered by incineration of HBCDD for reuse by the bromine industry[118]. It is envisaged that in its third year of operation this demonstration plant will be able to process 3,000 t/year. This is clearly a small part of EPS/XPS insulation waste produced but may become a promising alternative to recycle the increasing amounts of this waste that will continue to be generated well **up to the year 2070** (peaking in the 2050s). A study carried out by

[117] Conversio (2020): Waste generation, waste streams and recycling potentials of HBCD-containing EPS/XPS waste in Europe and forecast model up to 2050.

[118] PolystyreneLoop (2020) https://polystyreneloop.eu/technology/; Unilever (2017) Available at https://www.unilever.com/news/news-and-features/Feature-article/2017/CreaSolv-a-breakthrough-waste-recycling-technology-that-we-want-to-share.html

Conversio (2020) shows that **approximately 30% of the EPS/XPS waste containing HBCDD has a potential to be recycled by PolyStyrene Loop**.

6.2.3. Impacts of the policy options

Three options for an Annex IV value are considered in this impact assessment:

1,000 mg/kg (Option 1) – current baseline. Value in Annex IV.

500 mg/kg (Option 2) – Intermediate value between the baseline and the current UTC value, corresponding to mid-range resulting from Ramboll (2019) assessment.

100 mg/kg (Option 3) – Current UTC value in Annex 1. Lower end of the range considered by Ramboll (2019) applying the "methodology" described in Annex IV of this report. This value is also advocated by some NGOs (eg. IPEN).

Based on available information and comparison with the current situation, it is expected that Options 2 or 3 would not result in a significant diversion of waste from recycling to disposal or there is insufficient information to assess whether waste diversion would occur:

- **EPS/XPS insulation panels** have functional concentrations above Option 1 and the vast majority of end-of-life EPS/XPS insulation panels currently contain HBCDD – thus **no change is expected under any of the options**. The situation is expected to **change in the future** when non-HBCDD EPS/XPS insulation panels (containing alternative polymeric flame retardant) increasingly become waste. Mixing of HBCDD-containing and non-containing insulation panels cannot be ruled out in the future (although should be avoided). In such instances, reducing the Annex IV value to Option 2 (500 mg/kg) and furthermore to 3 (100 mg/kg) **might have an impact,** in terms of diversion of material from mechanical recycling to incineration, which the supporting studies have not been able to estimate.
- Almost all **EPS/XPS packaging that contains HBCDD** is expected to already have become waste. Current average concentrations have been **estimated to be very low**, suggesting **no impact on final treatment outcomes** from Options 2 or 3. However, cross-contamination between EPS/XPS packaging and EPS/XPS demolition waste can cause the average concentrations to increase. Furthermore, it cannot be ruled out that some imported packaging may contain HBCDD.

<u>EPS/XPS insulation panels in mixed demolition waste</u>

Although there is no information available on the concentration of HBCDD in mixed demolition waste, it cannot be ruled out that Options 2 (500 m/kg) or 3 (100 mg/kg) would have an impact on **mixed C&D waste that contains fragments of EPS/XPS insulation panels** that have not been segregated into a separate waste stream[119]. This fraction is expected to be landfilled (or processed for recycling into aggregate).

[119] Schlummer et al (2017) report that "*PS is mostly not separated from mixed demolition waste and not subjected to PS recycling*". https://www.hilarispublisher.com/open-access/recycling-of-flame-retarded-waste-polystyrene-foams-eps-and-xps-to-psgranules-free-of-hexabromocyclododecane-hbcdd-2475-7675-1000131.pdf

Available information suggests that, in order to exceed Option 1, insulation panels would have to account for approximately 10% of the weight of the mixed mineral C&D waste fraction. This seems highly unlikely.

However, it is hypothesised that under Options 2 and 3, EPS/XPS contamination would need to account for **only 5% and 1% by weight** (respectively) **of the mixed fraction** for the Annex IV limit value to be exceeded. It is therefore more likely that waste would be diverted from being disposed of in a non-hazardous landfill to incineration or disposal in a hazardous waste landfill (or from recycling into aggregates) under Option 2 (500 mg/kg), and especially Option 3 (100 mg/kg), than under Option 1 (1,000 mg/kg). Given the comparably much lower density of EPS/XPS as compared with, e.g. concrete, the likelihood of exceeding 5% by weight seems however small (or indicative of poor sorting).

Due to the size of this waste stream[120], it is expected that there would be **insufficient capacities to incinerate the diverted waste**. It is noted that other options such as disposal in a hazardous landfill or underground storage can be authorised for several categories of C&D waste up to the Annex V value, in accordance with Part 2 Annex V of the POPs Regulation. There is a **risk of high economic impact** due to the high costs of depositing waste in a hazardous waste landfill or underground hazardous waste storage facilities. There is currently not enough information to estimate such impacts with certainty.

Several **industrial stakeholders** have indicated they expect that lowering the Annex IV values to either Options 2 or 3 would be **negative for demolition companies and recyclers** as this would increase the testing costs[121] for demolition companies dealing with EPS/XPS insulation waste and, in the future for the PolystyreneLoop consortium itself. Although this cannot be ruled out, the **rationale for this is not clear** given that currently the vast majority of EPS/XPS insulation waste already largely exceeds the baseline limit value. On the other hand, the majority of packaging waste has concentrations largely below the lowest of the options considered (and therefore no changes are expected).

The need for testing, both now and in the future may however arise if clean and contaminated insulation waste, or insulation and packaging waste, become mixed during waste collection and treatment. Approaches to minimise this risk exist, such as **improved sorting during demolition**[122] and **maintaining waste streams separated** during collection and treatment in accordance with Article 11(1) of the Waste Framework Directive.

It has not been possible to estimate these testing costs. By way of reference, field analytical techniques for bromine / HBCDD are reported to have a cost per sample of 10-20 € and require an initial investment in portable XRF equipment of the order of **30,000 € per company**[123]. If samples have to be sent for analysis to a **laboratory** the costs are estimated to range from 200 – 300€ per sample and require a few days for the result to be

[120] Eurostat data for 2018: non-hazardous mineral CDW 320.3 Mt, hazardous C&D waste 9.1 Mt.

[121] Testing to determine whether waste EPS/XPS contains HBCDD and whether it exceeds the Annex IV values. Further details on sampling and testing of HBCDD in plastic waste are provided in chapters 10 and 11 and in Annex 1 of RPA(2021).

[122] Commission Construction & Demolition Waste Management Protocol. https://ec.europa.eu/growth/content/eu-construction-and-demolition-waste-protocol-0_en

[123] Or potentially per demolition / treatment site.

delivered. Some of these testing costs could be avoided if in future new insulation materials would be marked or labelled as “HBCDD-free”.

Given some EPS/XPS still remains in the **mixed mineral demolition waste** that is landfilled or recycled, **impacts from Option 2 or Option 3 might occur**. There is insufficient information to quantify the extent of this diversion but two hypothetical scenarios can be formulated:

- 1% of all mixed non-hazardous C&D waste (3.2 million tonnes per year) is **diverted from a non-hazardous to a hazardous landfill** under Option 3 (100 mg/kg);
- 0.2% (640,000 t / year) is diverted under Option 2 (500 mg/kg).

According to EUROSTAT, 27.15 Mt of hazardous waste were landfilled in the EU27 in 2018. The potential amount of waste sent to hazardous waste landfill under Option 2 represents 2.36% of this amount and considered within what could reasonably be absorbed by current landfill capacity (max increase estimated to be 5%). That would be largely exceeded by Option 3. The additional costs of landfilling in a hazardous waste landfill would be of 635 M€ and **135 M€**, respectively. This estimation is however **highly uncertain**. Producers and recyclers of mixed C&D waste would potentially also potentially incur in high testing costs for HBCDD in order to check compliance with the new limit value.

Finally, as in the case of PBDEs in WEEE/ELV plastic waste, it **cannot be ruled** out that differing national / regional implementations of the waste legislation could result in that waste exceeding Annex IV limits would be **classified as hazardous waste**. It should be noted however that according to the limits set in Annex III of the Waste Framework Directive, waste containing HBCDD should only be classified as hazardous waste above a concentration of 2,500 mg/kg[124] and therefore, **should be unaffected** by all options under discussion. These possible effects cannot currently be quantified and, if they exist, will differ widely between Member States and even between regions in Member States.

EPS/XPS Packaging

The information available suggests that the current concentrations of HBCDD in packaging waste are likely to be **relatively low** but some end-of-life products may contain significant HBCDD concentrations. Whether companies involved in the recycling of EPS packaging would be impacted **depends on whether further testing would be required**. Given that testing of the final recycled material that is placed on the market is already required to meet the UTC of 100 mg/kg it is not envisaged such testing would result in significant additional obligations.

CO_2 emissions

Building on estimates by BIR (2020)[125] and Deloitte (2017)[126] additional CO_2-eq emissions are expected to arise as a result of potential diversion of EPS/XPS packaging from recycling or landfill to incineration. Approximately 50% of the EPS/XPS packaging

[124] Resulting from limits applicable to waste containing substances classified for their acute and chronic toxicity to aquatic organisms.
[125] BIR (2020): Recycling Plastics 2020, available at https://www.bir.org/publications/facts-figures/download/737/1000000832/36
[126] Deloitte, 2017, “Resource Efficient Use of Mixed Wastes Improving management of construction and demolition waste”, available at: https://ec.europa.eu/environment/waste/studies/pdf/CDW_Final_Report.pdf

waste that would have to be additionally incinerated would be diverted from recycling and approximately 50% would be diverted from landfill. The same division is assumed for C&D waste containing EPS/XPS insulation panels. **For every tonne of EPS/XPS recycled 20.9 t CO_2e are offset**. If the material is incinerated an additional 0.9 t of direct CO_2 emissions per tonne of the material are generated.

Given the very limited quantitative information available, it is not possible to carryout reliable estimations of waste diverted from one treatment to another under Options 2 or 3. Consequently, it is also impossible to estimate benefits to human health or the environment in a quantitative manner. Any increase in the amount of HBCDD diverted to destructive treatment (normally incineration) will result in a **reduction of the overall stock of HBCDD in waste** and consequently a reduction in the risk of HBCDD being emitted to the environment and impacting the health of humans (via the environment) or of ecosystems.

6.2.4. Conclusion on preferred policy option

It is expected that Option 2 (500 m/kg) and Option 3 (100 mg/kg) would have only limited impact on the final treatment of HBCDD-containing waste and on the operators handling it, with the exception of **mixed mineral C&D waste** with HBCDD-containing EPS/XPS present as an impurity, where **these effects cannot be ruled-out**.

The key waste stream (separated EPS/XPS insulation in C&D waste) is already effectively directed towards incineration (or, perhaps in the future, to recycling) by the current Annex IV limit of 1,000 mg/kg. This is because HBCDD-containing EPS/XPS insulation panels already now generally contain more than 1,000 mg/kg HBCDD. In the future however, some 25 – 50 years from now, there will be a **mixed generation of insulation panel demolition waste containing either HBCDD or the (alternative) polymeric flame retardant**. In such a situation, having lower annex IV values may become an incentive to ensure more effective segregation and sorting of contaminated panel waste for elimination (or decontamination and recycling if suitable technologies are then in place).

Given that in the short/medium term there seem to be limited benefits in lowering the HBCDD values in Annex IV and that considerable uncertainties remain about the economic impacts on recycling and disposal of mixed demolition waste, which could potentially be very substantial, some **caution seems warranted** as regards proposed preferred policy option.

Therefore, it is proposed that **policy Option 2,** which has **a lower risk of adverse direct economic impacts, is followed.** This limit could be considered for future reassessment once more information is available on the presence, amounts and treatment of EPS/XPS insulation material bound to demolition waste. In addition such a delay would allow the further development of both improved field and laboratory analytical methods and in particular, their validation to the desired, lower analytical limits.

This proposal is consistent with the application of the methodology described in Annex IV of this report and further illustrated in section 6.6.2 of Annex VI. The upper limitation criterion is defined by the estimated health based criterion (1,000 mg/kg) which, following its rounding down, coincides with the current Annex IV limit value. The lower limitation criterion, based on disposal capacity to hazardous waste landfill (DR1 in the limitation criteria diagram Annex VI) and potentially also on economic concerns associated to the management of mixed demolition waste is of 500 mg/kg. Based on the methodology described, and following the application of target function II, the value proposed is the highest of the lower limitation criteria.

An additional argument in support or adopting a cautious approach and not lowering the value in Annex IV to the lower Option 3 is that mineral **construction & demolition waste is the largest waste stream in the EU** and is one of the **priorities for action** both in the CEAP as well as in the Waste Framework Directive. In the latter, the introduction of material-stream specific recycling targets for C&D waste has to be considered by the Commission by the end of 2024. Introducing lower Annex IV limits that **may impact the waste management** of large amounts of construction and demolition waste, without having sufficient information on the impact, or on how the problem could be addressed (if it really exists), is considered not to be justified in view of the, a priori, very limited benefits to be obtained.

Further information on this matter will become available through an **on-going project** being carried out for DG Environment by the **JRC** which specifically investigates the feasibility of developing recycling targets for specific streams of C&D waste, including insulation waste.

Finally, it should be stressed that, particularly in the case of this substance, the impact of changing values in Annex IV on the **quality of recycled materials re-entering the market** is **questionable**, given this is already determined by the Annex I value, which is set at 100 mg/kg (equivalent to the Option 3 value).

There is **no reason to review the Annex V value for HBCDD currently established at 1,000 mg/kg.** With the current value most HBCDD-containing insulation waste exceeding the Annex IV limit, would also exceed the Annex V limit. In the event of a national derogation from being subjected to a destructive treatment this waste could only be allowed to be disposed in a permanent underground storage installation for hazardous waste.

6.3. Dioxins and furans (PCDD/Fs)

6.3.1. What are they and why are they a problem?

Polychlorinated dibenzo-p-dioxins (PCDDs, dioxins) and **polychlorinated dibenzofurans (PCDFs, furans)** are two families of substances that consist of 75 and 135 members (congeners) respectively. They differ widely in chlorine content and toxicity. 13 dioxins and 4 furans are included in Annexes III, IV and V of the POPs Regulation. A full list of the substances covered can be found in the relevant chapter in RPA(2021).

PCDDs and PCDFs are formed as by-products in combustion processes in incinerators (especially from burning of waste) and other installations where organic material is burnt (including smelters). They are also produced unintentionally in the manufacture of some pesticides and other organic substances that contain chlorine. These substances are therefore **not produced intentionally** and are **not placed on the market or used for any purpose** (other than as analytical standards). Consequently, they are not listed in Annex I of the POPs Regulation.

However, they can be found in the ashes of combustion processes and, despite strict controls, some amounts are released to the atmosphere via emissions from stacks (air pollution). Dioxins and furans are highly toxic and are also **persistent and bioaccumulative.** They tend to concentrate in fatty tissues and **enter the food chain**, for instance, through plants grown in contaminated soil and via animals feeding on them. Soil can be contaminated through the **deposition of material released to the air** or by the **intentional or accidental introduction of ashes** or other dioxin-containing waste into soil.

Dioxins and furans are subject to monitoring of emissions and release reduction provisions under the Stockholm Convention and the EU POPs Regulation. They are highly regulated substances in the EU with limits existing in water, foodstuffs and cosmetic products, among others. From the toxicological point of view dioxins and furans **are known to cause cancer in humans, produce reproductive and developmental disorders and affect immunity**, among other effects. They are **also highly toxic for aquatic and terrestrial organisms**.

6.3.2. Baseline

An exhaustive compilation of information on wastes that can contain dioxins and furans is included in RPA(2021) and is summarised in Annex VI of this report, together with their typical concentrations. In terms of tonnages produced in the EU the most important wastes are **construction and demolition mineral waste, agricultural compost and digestate and coal power plant fly ashes**. All of them are generated in amounts exceeding 50 Mt/year. Other activities generating ashes or slags in the millions of tons per year include **municipal, healthcare and hazardous waste incineration, biomass-based power production,** steel production and copper, zinc, iron and lead smelting. **Sewage sludge** from municipal wastewater treatment plants is also know to contain measurable concentrations of PCDD/Fs.

A detailed review of the current waste management baseline for different waste streams relevant to this assessment is provided in RPA(2021). Vary large waste streams such as coal-fired power plant ashes (over 64 Mt/year generated) and mineral construction and demolition waste are to a great extent used in construction and geotechnical applications, although large amounts are also landfilled. About **25 Mt of bottom ashes from municipal solid waste incineration** (MSWI) are generated each year in the EU of which some **15 Mt are used in construction** and 10 Mt are disposed of in non-hazardous waste landfills. About **2.5 Mt of fly ashes** from the same source are also generated in the EU of which about 2 Mt are sent to hazardous waste landfills and some **500,000 t are used in construction** (mostly in the Netherlands and Belgium).

A fraction of bottom ashes from biomass power production (10%), of fly-ash from coal-fired power plants (0.2%) and of **ashes from domestic burning** (20%) are also used for soil improvement purposes in agriculture. In total this amounts to a maximum of 1 Mt/year in the EU.

In some countries such as France, fly ashes from MSWI are classified as hazardous waste by default but can be disposed of in non-hazardous landfills. In contrast, in the Netherlands and Belgium fly ash is used extensively as a raw material for composite asphalt fillers subject to approval and testing requirements[127]. **Bottom ashes from MSWI** are far more **extensively used in construction** and geotechnical applications, with large amounts of ashes generated being recycled into these uses in **Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Poland, Portugal and Spain**.

[127] BRL 9320 of 24/04/2009. http://www.kiwa.nl/upload/BRL/9320_2009.pdf

Sensitive standardised laboratory-based analytical methods exists to analyse PCDD/Fs in solid waste at all the concentrations considered as policy options in this impact assessment. In addition there are a number of bioassay-based screening tests for these substances. None of them are however suitable for informing any rapid detection and sorting system that could be put in place at a production or treatment site.

One important consideration in relation to waste contaminated with PCDD/F is that, contrary to the rest of substances considered in this assessment, exceedance of the Annex IV value in the POPs regulation will **immediately classify the waste as hazardous waste under EU legislation[128]**, resulting in important **limitations to the shipment of the concerned waste and to its applications**. Such classification also results in a substantial increase in waste management costs.

6.3.3. Impacts of the policy options

The different options considered result from options for Annex IV limits for PCDD/Fs originally assessed in BiPRO (2005) and those reviewed in Ramboll (2019). According to the latter and based upon economic considerations related to the use of MSWI fly-ash as a filler in asphalt and other construction uses, a limit of between 0.005 – 0.010 mg/kg was recommended in that study. In addition, the former study also considered the option to set a limit of 0.001 mg/kg based on human health concerns.

The NGOs IPEN and Arnika, as well as others, have advocated for a lower general limit of 0.001 mg/kg (with the main purpose of limiting movements of such wastes) and a lower specific limit of 0.00005 mg/kg for the application of untreated (unsolidified) waste on land surfaces. The latter results from estimations, developed by the referred organisations, of transfer of PCDD/Fs from contaminated soil to the human food chain, in particular through chicken's eggs. In order to take all these considerations into account the following options have been considered in this impact assessment:

Option	**Dioxins & furans (mg TEQ/kg)**
Option 1 (baseline)	0.015
Option 2	0.010
Option 3	0.005
Option 3 (+land)	As above (0.005), as well as a specific limit of 0.001 mg/kg for the application of untreated waste on land surfaces
Option 4[129]	0.001
Option 4 (+land)	As above (0.001), as well as a specific limit of 0.00005 mg/kg for the application of untreated waste on land surfaces

Table 5 – Policy options for dioxins & furans (PCDD/Fs)

Figure 5 below shows **typical and maximum concentration ranges** of PCDD/Fs in different waste streams. In the absence of detailed data on the distribution of concentrations in waste, RPA(2021) has made some assumptions [(further detailed in RPA(2021)] regarding the amount of waste that, under each of the policy options, would

[128] The assessment of specific waste streams must be made in conjunction with the classifications for the waste codes listed in the "European List of Waste" in Decision 2000/532/CE (as amended).

[129] Values of 0.001 mg/kg and 0.00005 mg/kg have been assessed to consider concerns expressed by some NGOs regarding the specific scenario of application on land surfaces

be diverted from recycling and/or non-hazardous waste landfilling to hazardous waste landfill or underground storage[130].

Under **Option 2** the only waste impacted would be **soot and ashes from domestic burning** of wood and coal. It is estimated that between 36,000-72,000 t would no longer be allowed to be used in agriculture and between 181,000-361,000 t would be diverted to hazardous landfill with additional costs estimated in **40 – 79,5 M€**.

Under **Option 3** the amounts of soot and ashes from domestic burning no longer allowed in agriculture and of total material directed to hazardous waste landfill would increase to 36,000-145,000 t and 181,000-723,000 t, respectively. Estimated waste management costs are of **40 – 159 M€** per year. Under such as option **municipalities would have to include this type of waste in their hazardous household waste separate collection schemes** (which have to be implemented in the EU by December 2024). According to BiPRO(2005)[131] domestic burning is the largest (75%) source of PCDD/F emissions to the air, although it only represented about 1% of emissions to waste.

Also under **Option 3** significant amounts of **fly ashes generated from power production using biomass** would **no longer be used in agriculture or construction** (8,000 – 33,000 t) and large amounts currently sent to non-hazardous waste landfills would have to be managed in hazardous waste landfills or sent to underground storage (27,000 – 110,000 t). The estimates waste management costs for these biomass ashes is estimated to amount to **6 – 24,8 M€.** Overall additional waste management costs arising from Option 3 for both waste streams amounts to 46 **– 184 M€** per year[132]**.**

Under Option 3+land and Option 4 up to **128,000 t of MSWI fly-ashes would no longer allowed to be used in construction** and would be diverted to non-hazardous waste landfills, in the case of Option 3+, or to hazardous waste landfills, in the case of Option 4. The use of fly ashes in construction is mostly limited to Belgium and the Netherlands. **There is no evidence of agricultural use of MSWI ashes in the EU** but, as indicated above and reported in RPA(2021) this is estimated to happen for a fraction of ashes from domestic burning and of biomass ashes[133]. Overall waste management (landfill) costs of Option 3+ would amount to **52 – 224 M€** and those of Option 4 to **52 - 263 M€**. Given that according to Eurostat a total of **27.15 Mt of hazardous waste were landfilled in the EU27 in 2018**, even if the top range estimate under option 4 was to be all sent to **hazardous waste landfill**, this would result in about 1.2 Mt waste / year which is less than 5% of yearly disposal of waste in hazardous waste landfills. It seems plausible that this additional amount **could be absorbed** by the current hazardous waste landfill capacity.

---

[130] Under the assumption that, subject to provisions in Article 7(4)(b) of the POPs Regulation, Member States would consider allowing such disposal instead of incineration or other destructive treatment, as the environmentally preferable option.

[131] https://ec.europa.eu/environment/waste/studies/pdf/pops_waste_full_report.pdf

[132] Base estimated cost of disposal in hazardous waste landfill or underground storage for ashes of 260 €/t. Disposal costs to non-hazardous waste landfill estimated 50 €/t.

[133] Extensive information is provided in chapter 7 of RPA(2021).

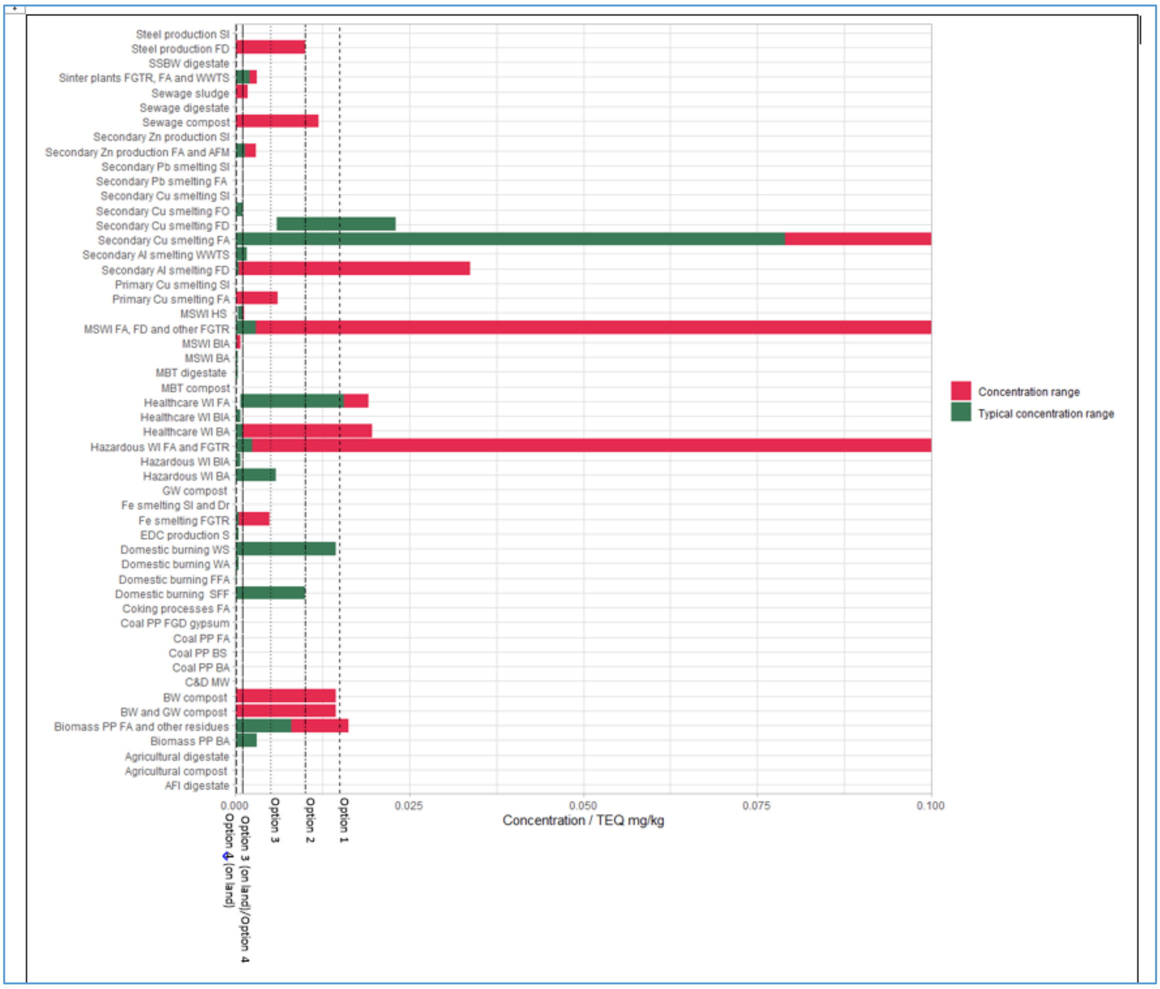

Figure 5 – Maximum and typical concentration ranges of PCDD/Fs in relevant wastes

Finally, under the strictest of options considered, which would include a specific supplementary limit of 0.00005 mg/kg for recovery and disposal operations involving application of (untreated) waste to land, several high volume waste streams would be affected. In addition to all other impacts described under the other options, **Option 4+land** would result in **up to 60 Mt agricultural digestate, up to 116 Mt C&D waste and up to 7.4 Mt MSWI bottom ash not being recycled every year** into materials or used in agriculture, in construction materials or in geotechnical applications. They would be diverted to non-hazardous waste landfills.

Other wastes such as **coal power production fly ash** and coking ash would also be affected, requiring increased testing (given greater likelihood of exceeding limits) and some increased diversion to landfill. Overall additional waste management costs (landfilling) estimated for **Option 4+** range from **1,897 – 9,484 M€ per year, to be absorbed by the different producers of the waste**, including public authorities. The latter represents between **37 - 184 Mt of waste /year** that would mostly go to non-hazardous waste landfills. Given that according to Eurostat, in 2018 the EU-27 Member States landfilled[134] 806 Mt of non-hazardous waste, absorbing this waste, in a worst case

[134] Operations D1, D5 and D12.

diversion estimate[135], would represent almost a **23% increase in landfill / year**. **It is likely this amount would cause serious capacity problems to landfill operators**.

Finally, although in general PCDD/F concentrations in sludge from municipal waste water treatment plants seem to be lower than the Option 4+land limit **it cannot be ruled out that in some cases this limit would be exceeded**. It is uncertain to what extent this would result in some sludge used in agriculture being diverted to incineration or landfilling. Certainly additional testing costs would be likely.

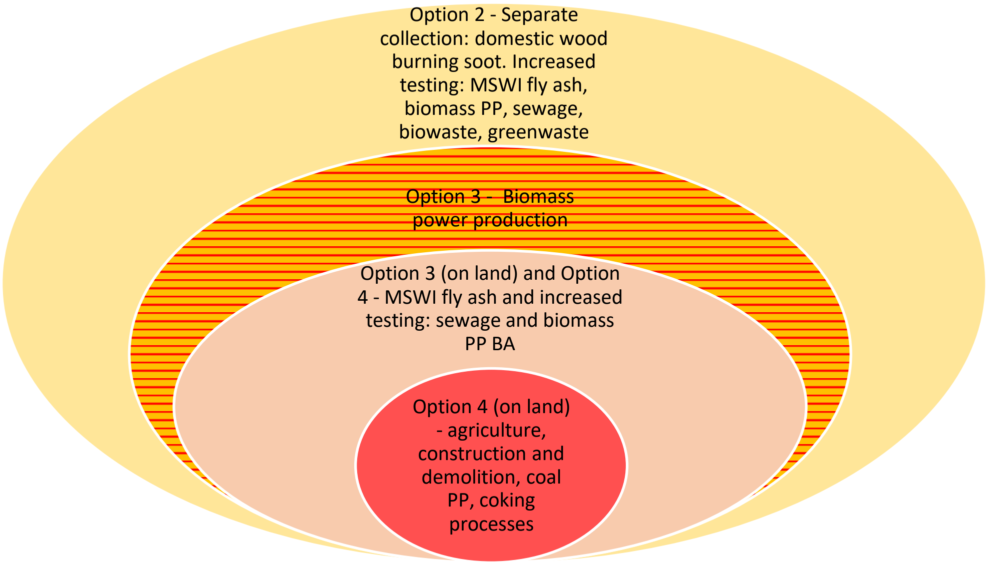

Figure 6: Impacts of different policy options for PCDD/Fs are shown in a cumulative manner, indicating which waste streams are impacted under the different options. .

RPA(2021) has estimated **additional costs to users of materials coming from the different waste streams** that would have to pay extra for **substitute primary material** (be it aggregate, concrete, lime, etc.). Total estimated **additional yearly substitution costs** to be borne by the different users of waste material (especially ashes) are: Option 2 432 – 864 k€; Option 3 0,5 – 2,1 M€; Option 3+land 0.6 – 3.1 M€; Option 4 0.6 – 3.1 M€; **Option 4+land 380 – 2,308 M€.**

Options 2 and 3 are not expected to have significant adverse impacts on employment, however **Option 3+land** and **Option 4** are expected to impact construction companies using MSWI fly ash as composite asphalt filler in **Belgium and the Netherlands**, potentially affecting employment. No figures could be estimated for the potential loss of employment or for the number of employees affected.

All options impact public authorities, especially due to the need to address the **separate collection as hazardous ashes from domestic burning of wood and coal from households**. It is challenging to estimate the additional cost to public authorities of implementing / adding this waste stream to the existing collection schemes, given the

---

135 See table 7-14 in RPA(2021) for assumptions of waste diversion under the different options. The methodology for each of the options is as follows where the typical waste PCDD/F concentrations are above the proposed limits: Option 1: baseline; Option 2: 5-10% reduction in non-hazardous landfill and applications on land; Option 3: 5-20% reduction in non-hazardous landfill and applications on land; Option 3 (land): 5-25% reduction in applications on land; Option 4: 5-25% reduction in non-hazardous landfill and applications on land; Option 4 (land): 10-50% reduction in applications on land.

variety of systems and combinations of collection systems in place[136] and their possible combinations. A recent study by EY[137] reports costs for the collection of household hazardous waste streams, based on good practice examples, in different EU countries.

According to this report, the separate collection of hazardous household waste in Odense (Denmark) has a cost of **3.3 € / inhabitant**. This cost would in most cases be borne by municipalities and, ultimately, by tax-payers, in line with the polluter pays principle enshrined in the TFEU and the Waste Framework Directive Article 14. Additional landfill disposal costs due to the management of these ashes are provided above. For all other options public authorities may need to **incur higher costs associated to monitoring / enforcement**, but no cost estimate can be provided.

According to preliminary discussion held with Member States, the **separate collection** of domestic burning ashes as hazardous waste, or otherwise, **does not seem to take place** (or happens only very rarely). **Concerns** have been expressed about the **proportionality and practicality** of such a measure, as well as about the possibilities to enforce it. In most Member States these ashes are either deposited together with residual waste (and subsequently incinerated in a MSW incinerator or landfilled in a MSW landfill) or, quite frequently, **disposed of in gardens / vegetable gardens**.

The extent of domestic fuel burning, disposal practices, the nature of the fuel (wood, coal) and the type of appliances to burn the fuel (from open fireplaces to modern pellet boilers) vary widely among Member States and regions, resulting in a highly granular and diverse situation where, potentially, **only a fraction of domestic burning ashes** will exceed the limit value proposed.

In addition, **doubts have been raised** about whether the exceedance of the Annex IV limit values in domestic biomass burning ashes, and for biomass ashes from biomass power plants, would lead to classification of such waste as hazardous. The underlying reasoning in that there are **no applicable hazardous waste codes** in the European List of Waste[138]. Regardless of this, the Commission considers a **priority to address, and limit, the application of biomass ashes** exceeding the proposed limit value for PCDD/Fs**, in vegetable gardens and other agricultural applications** that can lead to human exposure to dioxins via the food chain.

In terms of **benefits to human health and to the environment**, RPA (2021) has estimated the overall reductions in PCDD/F emissions to the environment (especially to land) resulting from the different policy options. **All policy options other than Option 4+land result in relatively modest reductions in emissions of PCDD/Fs from waste** ranging from dozens to a few hundred grams (expressed as toxicity-equivalents to the reference dioxin TCDD). Option 4+ would result in a more substantial reduction of between 2 - 10 kg per year (central estimate 6 kg).

Finally, diverting material (such as fly or bottom ashes or C&D waste) from recycling to disposal results in these materials having to be substituted by primary material. The estimated adverse effect in terms of negative CO_2e balance was calculated by RPA

---

[136] Door-to-door collection, street containers or "bring systems", mobile collection points, civic amenity sites.

[137] https://op.europa.eu/en/publication-detail/-/publication/bb444830-94bf-11ea-aac4-01aa75ed71a1/language-en/format-PDF/source-133422972

[138] This matter can be controversially discussed in light of the third bullet point of point 2 of section "Assessment and Classification" of the Annex of Decision 2000/532/EC, which states that for the POP substances listed therein (including PCDD/Fs and PCBs) exceeding the value in Annex IV in Regulation (EU) 2019/1021 results in the waste being hazardous waste. Furthermore, Article 7(2) of Directive 2008/98/EC (Waste Framework Directive) allows Member States to "*consider waste as hazardous waste, even though it does not appear as such in the list of waste.*"

(2021). For Options 2 to 4 the overall impact in terms of additional CO_2 emissions generated (not avoided) ranges from a few thousand to about 120,000 t/year. Due to the comparatively much larger tonnages of waste involved, only Option **4+land would result in significant adverse impacts**, leading to CO_2 emissions of between **18 and 91 Mt/year.**

6.3.4. Conclusion on preferred policy option

In view of the above it seems apparent that all options result in impacts due to diversion of different waste streams from recycling to disposal. In this assessment it is assumed that landfilling will be the dominant final disposal option, given most wastes concerned are listed in part 2 of Annex V of the POPs Regulation and could, subject to Member State authorisation[139], be disposed in a hazardous waste landfill or permanent underground storage facility.

The setting of **treatment-specific limits under Annex IV**, as proposed by stakeholders such as IPEN/Arnika and other NGOs is **not envisaged** under the POPs Regulation. A detailed discussion regarding the approach to set Annex IV limit values for PCDD/Fs, and how different waste treatments are taken into account, is provided in section 4.3 of Annex IV of this impact assessment. In summary**, two health based values** (R) have been considered for PCDD/Fs, one relevant to spreading of untreated waste on land (relevant particularly to agricultural use of sewage sludge and ashes) and another for other uses, which largely refers to disposal in non-hazardous waste landfills (and some uses of solidified ashes in construction).

The use of one health-based value or another has implications on the outcome of applying the methodology described in section 4.2 of Annex IV to this report. The choice of the stricter value, relevant only to land-spreading applications, would result in the **impossibility of safely disposing large amounts of waste in non-hazardous waste landfills**, where the resulting risks are lower and the level of containment higher than that which results from direct application of the waste on soil.

As further explained under the referred section 4.3 of Annex IV of this report, the policy choice has been made not to base the proposal for the limit value for PCDDs in the waste annexes of the POPs Regulation, on a land application health-based value (R1). This is justified on the basis that it would cause a disproportionate impact on other waste disposal options (which would be regulated by the same Annex IV value) and is also supported by the argument that such applications are better addressed by existing Regulations at EU and Member State level. These arguments are further described below:

- The limit in Annex IV covers **spreading on land of sewage sludge**, as well as all other non-destructive treatment options. Spreading of sludge on land for agricultural purposes is specifically regulated by the Sewage Sludge Directive (currently under review). Setting a limit for PCDD/Fs specific for this waste disposal operation can be better considered and established in that Directive.

- The Commission envisages to adopt, by the summer of 2021, a Commission Delegated Regulation amending Annexes II, III and IV to Regulation (EU) 2019/1009 for the purpose of adding **thermal oxidation materials** and derivates

[139] Assuming it is possible to demonstrate that destruction or irreversible transformation of the POP Substance in waste is not possible or does not represent the environmentally preferable option (see Article 7(4)(b) of the POP Regulation).

as a component material category in **EU fertilising products**. Therein a strict limit of 20 ng WHO toxicity equivalents of PCDD/F /kg dry matter (equal to 0.00002 mg TEQ/kg) is set. This value is slightly below that proposed by IPEN and defined for **Option 4+land** (0.00005 mg/kg) and **will apply to ashes and slags used as constituents of CE fertilising products**. Those Member States and regions authorising the spreading on land of (certain) **waste ashes** for agricultural purposes, which still do not have national measures for this purpose, will in the future have as a reference the value determined for CE-marked fertilising products.

- There is **no evidence** that fly-ashes from municipal solid waste incineration are **used in agriculture in Europe**. The use of fly ashes in construction (e.g. as asphalt binder), which are ultimately applied on land, seems to be limited to two Member States in the EU (Belgium and the Netherlands) and regulated specifically under national legislation.

Consequently, as shown in the limitation criteria figure VI-7 in section 6.6.3. of Annex VI of this report, the proposed value results from applying the precautionary criterion on health based limit value R2 (which coincides with current limit value in Annex IV) and lowering to the highest of the upper limitation criteria which, in this case is limited to a certain extent by disposal capacity (if considered together with other waste streams, see section 8.2) and more importantly by economic feasibility criteria, as estimated in the assessment made by the Commission.

Option 4+land, which is the only option that would bring about an important reduction in the amount of PCDD/Fs released to land, **has been dismissed due to the disproportionately high economic impacts** which could affect up to **180 Mt** of waste /year, including compost and digestate, bottom ashes from municipal waste incineration and construction and demolition waste. Disposal of such large amounts of waste also cause concern in terms of **available landfill capacity**.

Option 4, setting a limit of 0.001 mg/kg is not considered appropriate due to **its impact on the use of fly-ashes in construction** in two EU MS, increased diversion to hazardous waste landfill and the higher economic impact on municipal waste incinerators. It is expected these will have a higher likelihood of not being able to meet this limit, resulting in higher waste management costs and testing costs for only a small benefit in terms of avoided PCDD/F emissions. Furthermore, as said above such uses are nationally regulated, supported by leaching tests and risk-based limits.

Option 3 (0.005 mg TEQ/kg) is the preferred policy option for the Annex IV limit value that has a potential impact on two important sources of dioxin-containing waste: **ashes from domestic burning** of wood and coal and **fly ashes from biomass power plants** which currently are often disposed of in non-hazardous waste landfills or find their way into agricultural use. This value is broadly in line with the limit of 0.003 mg TEQ /kg established by **South Korea**[140] and **Japan**[141] (applicable only to certain wastes).

It should be noted that the analysis by RPA (2021) **groups ashes and soot** from domestic burning and estimates that 5 – 20% of these would be impacted under Option 3 (0.005

[140] National Implementation Plan under the Stockholm Convention of South Korea (2009). Limit applicable to certain industrial wastes: dust, waste catalyst, sludge, waste absorbers, waste acid, waste alkali.

[141] National Implementation Plan under the Stockholm Convention of Japan (2016). Limit applicable to waste from incinerators, electric furnaces for steelmaking and to Roasting furnaces, melting furnaces and drying furnaces for aluminium alloys.

mg TEQ/Kg) based on the reported upper range of the typical dioxin concentration being about 0.01 mg TEQ/kg. This conclusion is however based on the top-range values estimated for **soot**, which only represents 0.8% of the total waste material. Mixed ashes from coal and biomass burning typically have concentrations at least about 100 fold lower (and representing 99% of the material). On the other hand, the burning of contaminated waste wood or in open fireplaces / boilers with poor combustion conditions results in higher values, also for mixed ashes.

Considering all the above, for the purpose of this impact assessment, the lower range impact estimate (5% of material exceeding limit value) is considered to provide a more realistic estimate of the amount of domestic burning ashes / soot affected.

Costs and impacts are not negligible but these a highly spread over many actors (municipalities, waste operators) and could be seen as proportionate. In addition, the measure is considered to be technically achievable with current best available technology (e.g. for MSW incinerators). As regards ashes from biomass production it should be noted that that **generation of this ash is likely to more than double by 2030** as countries transition from coal power production under the European Green Deal policy agenda. This is likely to further increase hazardous landfill and underground storage costs. Costs associated to Options 3+ and 4 have been assessed by the Commission as disproportionate and affecting multiple waste streams (in particular Option 4).

No review of the existing **Annex V** limit value for PCDD/Fs is proposed as there is no indication that the values currently established are not appropriate. See also further explanations on the very limited relevance of these limit values provided in section 5.3.3 of this impact assessment.

6.4. Dioxin-like PCBs

6.4.1. What are they and why are they a problem?

Similarly to dioxins and furans, polychlorinated biphenyls (PCBs) are a family of substances comprising 209 different members (congeners). A dozen of the 209 PCB congeners are considered "dioxin-like" PCBs (dl-PCBs)[142] because their mechanism of toxic action is common to that of the reference dioxin (2,3,7,8-TCDD). WHO has assigned to each of these compounds a **toxic equivalency factor (TEF)** which indicates **their relative toxicity compared to a reference dioxin**. The remaining 197 congeners are referred to as non-dioxin-like PCBs (ndl-PCBs).

PCBs have in the past found **wide industrial use** as heat exchange fluids, in **electrical transformers and capacitors**, and as additives in paint, carbonless copy paper, and plastics. Production of PCBs began in the 1920s but only reached substantial volumes after 1945, reaching its peak in the 1960s and 1970s. Due to environmental and human health concerns **production of PCBs ceased in most countries in the late 1970s or early 1980s**.

PCBs are **highly regulated, currently banned, chemicals**. They are listed in Annexes A and C of the Stockholm convention as well as in Annexes I, III, IV and V of the EU

[142] The 12 dl-PCBs are: PCB-77, PCB-81, PCB-105, PCB-114, PCB-118, PCB-123, PCB-126, PCB-156, PCB-157, PCB-167, PCB-169 and PCB-189.

POPs Regulation, with a **limit of 50 mg/kg** (in both annexes I and IV) for total PCBs[143]. Directive 96/59/EC on the disposal of PCBs and PCTs, as well as its predecessor Directive 76/403/EEC have addressed the issue of safe disposal of PCBs and waste contaminated with PCBs. They also deal with the **disposal or decontamination of equipment containing PCBs**, such as electrical transformers and capacitors. Under the recast POP Regulation, new provisions were introduced in Annex I to ensure the removal of remaining equipment containing small volumes (over 50 ml) of PCBs no later than by **31 December 2025**.

PCBs are **toxic to fish**, killing them at higher doses and causing spawning failures at lower doses. Research also links PCBs to **reproductive failure and suppression of the immune system** in various wild animals, such as seals and mink. Exposure of **humans** to PCBs is known to cause pigmentation of nails and mucous membranes and swelling of the eyelids, along with fatigue, nausea, and vomiting. Due to the persistence of PCBs in their mothers' bodies, children born up to seven years after high exposures to PCBs show **developmental delays and behavioural problems**. PCBs also suppress the human **immune system** and are listed as **probable human carcinogens**. The latter is particularly relevant for dl-PCBs given that due to their common toxicological mode of action with dioxins the concern associated to cancer are greatest.

The reason for addressing dl-PCBs under this assessment are the concerns derived from a study of the Swedish Environmental Protection Agency[144], and also voiced by NGOs such as IPEN. In these it is claimed that not addressing the specific toxicity concerns due to dl-PCBs **underestimates the risks caused by the transfer of pollutants from waste to soils and subsequently into the food chain** (eg into vegetables, poultry eggs, etc). Similarly to earlier discussions on dioxins, this is particularly relevant in relation to the application of waste to soil (be it intentional or accidental). Two options to assess this concern are considered here.

6.4.2. Baseline

The current baseline is defined by the current situation where PCBs are already highly regulated as a group but where no **specific consideration is in place to address concerns due carcinogenic, dioxin-like PCBs**. The study in support of this impact assessment includes an **expert assessment** regarding the soundness of addressing dl-PCBs using the toxicity equivalence factors derived in 2005 by the WHO. It also assesses whether it makes sense, from the scientific point of view, to group them together with PCDD/Fs, given they act in a similar way. An **expert assessment** has been done of the robustness and level of scientific reliability of the existing TEF values for these substances. An assessment was also done of the extent to which grouping dl-PCBs and PCDDs, based on their TEF values, is already in place under different EU and international legal provisions.

The conclusion reached by RPA(2021) is that although values derived by the WHO in 2005 for dl-PCBs have **some limitations** from the scientific point of view, and could

[143] The POP regulation draws on the same analytical methodology and definition of "PCBs" as Directive 96/59/EC which also includes polychlorinated terphenyls (PCTs), monomethyl-tetrachlorodiphenyl methane, monomethyl-dichloro-diphenyl methane and monomethyldibromo- diphenyl methane.

[144] Low POP Content Limit of PCDD/F in Waste, Evaluation of human health risks, Report 6418, March 2011. https://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-6418-1.pdf?pid=3726

benefit from an in depth re-assessment, they are **sufficiently robust to be used together with those for PCDD/Fs**.

This is confirmed by that fact that **decisions to follow this approach have already been taken** in the EU in the context of **foodstuffs**[145], of **water quality**[146] and in the field of **emissions to the air** from waste incineration installations[147] under the Industrial Emissions Directive. Similarly, joint values have also been derived, based on this principle, in the context of water quality in **Australia**. Such aggregated reference values are also used for the purpose of **risk assessment** by acknowledged organisations such as the US Environmental Protection Agency, the US Agency for Toxic Substances and Disease Registry, the World Health Organisation or the Dutch National Institute of Public Health and the Environment of the Netherlands (RIVM).

RPA(2021) has reviewed information on PCB concentrations in waste. Information available generally refers to total PCBs and there is very limited specific information on concentrations of dl-PCBs in any waste streams. The most relevant waste streams identified in terms of their possible PCB content are **large and small WEEE and shredded ELVs** where PCBs can be found, normally at concentrations below 50 mg/kg, for instance in some capacitors. Although in principle these components should be removed, relevant concentrations of PCBs, including dl-PCBs have been found in the vicinity of some shredders in Belgium, resulting probably from deposition of atmospheric emissions released from these installations. Other relevant wastes include certain **demolition waste fractions** (eg sealants), which are generally separated to the extent possible during demolition and **waste oils** which are **systematically controlled for PCBs** under the existing limit (and often lower for the purpose of recycling into base oils). **Incineration ashes, compost and sewage sludge** are also know to contain generally small but measurable concentrations of PCBs.

Analytical methods for PCBs exist and are extensively used to measure PCBs down to well below the required current limit of 50 mg/kg. Existing laboratory methods for PCBs are relatively inexpensive (about 90 €/sample) and are usually based on **analysing a limited set of representative PCB congeners**. The issue with setting a specific dl-PCB limit, potentially aggregated with the limit for PCDD/Fs, is that individual PCBs have to be **analysed separately** and that this limit is **much lower than the currently applicable one** for total PCBs (see PCDD/F section with options between 0.015 – 0.001 mg/kg under consideration). Therefore, the limits under consideration relevant to dl-PCBs are several thousand times lower[148] than those currently applied to total PCBs. This does not mean that specific analyses for dl-PCBs cannot be done. It is **possible using the method currently applied for PCDD/Fs** which also **allows to quantify individual dl-PCBs**. This is however costlier (about 410€/ sample) and requires more expensive and specialised analytical equipment to attain the desired sensitivity and specificity.

6.4.3. Impacts of the policy options

Following from the conclusion that it makes technical and scientific sense to specifically address dioxin-like PCBs, the options under consideration refer rather to whether, based

[145] Commission Regulation (EU) 1259/2011 sets joint limit for PCDD/Fs and 12 dl-PCBs.

[146] Directive 2013/39/EU sets joint environmental quality standards or PCDD/Fs and 12 dl-PCBs.

[147] Commission Implementing Decision (EU) 2019/2010 establishes joint limit for PCDD/Fs and dl-PCBs under BAT 30.

[148] Although it should be noted that limits for PCDD/Fs are expressed in terms of "toxic equivalents" (TEQs) whereas total PCB limits in annex IV are expressed in mass.

on other impact considerations, this is appropriate or not (**Option 1 – baseline implies no action**) and how to do it. If the decision is that addressing dl-PCBs is appropriate and justified the options about how to proceed are: 1) to do so by introducing **a new, stand-alone specific Annex IV limit for the sum of dl-PCBs (Option 2)** or 2) by **including dl-PCBs into the existing Annex IV group limit for PCDD/Fs (Option 3)**.

Given there is very limited analytical information available on the concentration of dl-PCBs in waste, for most waste streams it is not possible to reliably estimate the amounts of waste that would be diverted to different treatments due to the limit value chosen. Considering this scarcity of specific information (which would be needed to set a stand-alone limit) and considering that it was concluded that scientifically it makes sense to group together dl-PCBs with PCDD/Fs, the **analysis of options is heavily focused on Option 3**. Consequently, this section must be considered together with section 6.3, addressing the limit value for dioxins and furans (PCDD/Fs) and the options for limit values considered therein.

The very limited information available coming from one study on the presence of PCBs in small WEEE points to the dl-PCB content representing 18% of the measured seven indicator PCB congeners. However. this conclusion is highly uncertain given only one dl-PCB congener was analysed. Despite these uncertainties and given the very low toxicity of the specific dl-PCB that was analysed (in comparison with the reference dioxin), **the concentration of dl-PCB, expressed as toxic equivalents is very low** (0.0000027 mg TEQ/kg). Given that elements containing PCBs **should be removed in the treatment WEEE[149] and ELV**, and in view of this result, one could hypothesise that introducing dl-PCB limits for these two waste streams may not result in particularly relevant impacts. This conclusion is however **highly uncertain** due to limited information.

As regards **waste oils** there is also very limited information on the presence of dl-PCBs in collected waste oils[150]. Information provided by GEIR, the waste oil recyclers industry association, based on two studies of 2009, suggests that concentrations of dl-PCBs in waste oils are below 0.001 mg TEQ/kg, with only one out of 20 samples analysed slightly exceeding this value (and others being often an order of magnitude of more below). GEIR has indicated that in their view existing controls on PCBs in waste oils are enough to guarantee safe management and therefore **do not consider a specific limit for dl-PCBs necessary**. In their view a requirement to systematically analyse dl-PCBs in every truck load of oil delivered to a re-refining installation would not be possible to fulfil or practical. According to GEIR, this is limited by their current in-house analytical means that would require investment in new equipment, ranging from 50,000 – 110,000 €. This association has further indicated that even if such investment were to be made, having to engage in routine analysis of dl-PCBs in every load of waste they receive would lead to very important logistic problems. This is explained by the delay in clearing a truck load for treatment that would be extended from the current few hours to one or two days, if high-sensitivity analysis for dl-PCBs has to be carried out. Therefore GEIR claims that any measure that would lead to the **need of systemic analysis of dl-PCBs would have a very high economic impact and bring about a strong disruption in the recycling of waste oils into base oils**.

[149] According to the WEEE Directive, 'removal' means manual, mechanical, chemical or metallurgic handling with the result that hazardous substances, mixtures and components are contained in an identifiable stream or are an identifiable part of a stream within the treatment process. A substance, mixture or component is identifiable if it can be monitored to verify environmentally safe treatment.

[150] About 1.7 Mt waste oils are collected every year in the EU of which 680,000 t are regenerated into base oils.

Ashes from municipal waste incineration are in a similar situation. The limited information in studies quoted in RPA(2021) indicate that **dl-PCBs represent between 1 – 10% of the total toxicity (in terms of TEQ) of PCDD/Fs and dl-PCBs**. Results from a very recent study by the NGO Arnika on concentrations in sediments, taken close to a waste treatment facility (treating incineration ashes) in the Czech Republic, showed that dl-PCBs contributed to **15 – 30% of all dioxin-like toxicity**. Considering that different PCB congeners degrade and become distributed in the environment in different ways, these results **may not be representative of concentrations in the waste itself**.

Similarly to what happens with dioxins, bottom ashes will generally have lower overall concentrations of both PCDD/Fs and dl-PCBs than fly-ashes. Conclusions of a recent JRC report[151] investigating the use of thermal oxidation products from a number of industrial processes, as components for fertilisers, indicate that generally, for this type of waste, there is a **good correlation between the concentrations of PCDD/Fs and of dl-PCBs**.

An assessment of the likelihood of additional diversion of waste to landfill, for each of the options discussed under section 6.3 (PCDD/Fs) has been made under the assumption that dl-PCBs would be included in the limit for PCDD/Fs. For the purpose of Table 6 below the options considered for the PCDD/F values are referred to as D1 to D4.

Likelihood of diversion to landfill as a result of Option 3 (inclusion of dl-PCBs into the TEQ for PCDD/Fs)						
Waste stream	**TEQ limit for the total of PCDD/F+dl-PCBs**					
	Option D1 (0.015 mg TEQ/kg)	**Option D2 (0.01 mg TEQ/kg)**	**Option D3 (0.005 mg TEQ/kg)**	**Option D3+land (D3+0.001 mg TEQ/kg on land)**	**Option D4 (0.001 mg TEQ/kg)**	**Option D4+land (D4+0.00005 mg TEQ/kg on land)**
WEEE	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Paper	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Waste oils	Unlikely	Unlikely	Unlikely	Unlikely	**Possible for some waste**	**Possible for some waste**
ELVs	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
CDW	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Incineration bottom ash	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	**Yes**
Incineration fly ash	Unlikely	Unlikely	Unlikely	**Yes**	**Yes**	**Yes**
Sewage sludge	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely

Table 6: Likelihood of diversion to landfill as a result of Option 3 (inclusion of dl-PCBs into the TEQ for PCDD/Fs)

Additional estimations made in RPA(2021) suggest that an **additional 10% of bottom ashes would be diverted to landfill** in the case of **Option D4+land**. An extra **2% fly ashes** would also be diverted to landfill under **Option D3+land**. In the case of **waste oils** additional testing costs, due to the need for specific monitoring are considered likely, however **no diversion of waste oils from recycling is likely to occur if options D1-D3 are retained**. Significant additional costs for users of raw materials (due to substitution

[151] https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/technical-proposals-selected-new-fertilising-materials-under-fertilising-products-regulation

costs of primary material) would be incurred in the case of Option D4+land which builds onto the very large costs estimated in the section 6.3.

6.4.4. Conclusion on preferred policy option

Taking into account that PCDD/Fs and dl-PCBs **share a common toxicological mode of action** and **both are associated to cancer in humans** it is appropriate to address dioxin-like PCBs separately from the existing limit that covers all PCBs. The **limit for total PCB in Annex IV would however be maintained** as it is a well-established value, present in several other legislative instruments, which still serves its purpose as regards PCBs as a whole group.

Specifically addressing **dl-PCBs via inclusion in the limit value for PCDD/Fs** (which would from then on be a limit for the sum of PCDD/Fs and dl-PCBs) is considered to be **scientifically sound and is aligned with similar approaches** to dl-PCBs under other EU legislation and internationally. Therefore, **Option 3 constitutes the preferred policy option**.

Defining a stand-alone limit (Option 2) would be difficult due to the very limited information on concentrations of dl-PCBs in waste and, in terms of simplification and regulatory economy, **would not seem justified**, given a limit for substances with common effects, already exists (for PCDD/Fs).

Finally this option must be seen together with the **specific limit in Annex IV, proposed for PCDD/Fs** under section 6.3 above, given the inclusion of dl-PCBs in the group limit value for PCDD/Fs **will marginally increase the risk of exceeding limits** for certain waste streams, depending on the option chosen. From the analysis carried out, and taking into account the **many uncertainties that exist** due to limited availability of data, it can be estimated that the preferred policy Option 3 for PCDD/Fs **can accommodate inclusion of dl-PCBs without major adverse environmental, economic or social impacts** associated to any of the waste streams assessed.

In summary, and in view of the analysis made in sections 6.3 and 6.4 the resulting preferred policy option is to **set a joint limit for PCDD/Fs and dl-PCBs to be established at 0.005 mg TEQ /kg** (see section 6.6.3. in Annex VI of this report for limitation criteria diagram for PCDD/Fs that applies also to the sum of PCDD/Fs and dl-PCBs).

It is proposed that the existing limit for PCDD/Fs in **Annex V**, already established in **5 mg TEQ/kg,** is maintained but that the text associated to it is **modified** so that it will, as in Annex IV, apply to the **sum of PCDD/Fs and dl-PCBs**. As explained in previous sections no impacts are expected from changes made to Annex V values.

6.5. Short-chain chlorinated paraffins (SCCPs)

6.5.1. What are they and why are they a problem?

Short-chained chlorinated paraffins (SCCPs) are a group of synthetic compounds that have been mainly used in **metal working fluids, sealants, as flame retardants in rubbers and textiles, in leather processing and in paints and coatings**. SCCPs belong to a larger family of substances known as chlorinated paraffins.

SCCPs are currently listed in Annexes I, IV and V of the POPs Regulation. All substances which meet the definition of SCCPs and other chlorinated paraffins (which might however also cover SCCPs) are listed in the report by RPA(2021). They have been listed as “substances of very high concern” in the REACH “candidate list” since 2008.

The use of SCCPs has been **limited in the EU since 2004** under the pre-REACH Directive that imposed restrictions on the marketing and use of certain dangerous substances and preparations[152]. These limitations were subsequently taken up and expanded, initially under REACH and finally under the POPs Regulation from the year 2012. At latest **from 2012 there are no intentional uses of SCCPs in the EU** with the exception of its allowed presence as an impurity in other substances and mixtures (1%) and in articles (0.15%). The reason for this exception for impurities, defined in Annex I of the POPs Regulation, is that SCCPs are present as impurities is the so-called MCCPs (middle-chain chlorinated paraffins), the use of which is not restricted, and have largely substituted SCCPs. In addition, **conveyor belts in the mining industry and dam sealants** containing SCCPs already in use before or on 4 December 2015[153] could still be used (until the end of their service life).

SCCPs are **persistent, bioaccumulative, and toxic, particularly to aquatic organisms**. They have been measured in Arctic organisms at levels comparable to other known POPs, indicating widespread contamination. Upon repeated exposure SCCPs can cause skin and eye irritation in humans. They may also **affect the liver, the thyroid hormone system and the kidneys** which in the long-term can lead to cancer in these organs. **In the EU SCCPs are classified as suspected of causing cancer and are listed as endocrine disruptors** according to the former preliminary criteria for prioritisation of potential endocrine disrupting substances (and also under the Water Framework Directive).

6.5.2. Baseline

In 1994, more than 13,000 tonnes of SCCPs were used in EU15 Member States. Following restrictions on their use in leather processing and in metal working fluids, the amounts used in the EU declined to 530 tons in 2009, distributed into **sealants** (19%), in **paints and coatings** (31%), as flame retardants in **rubbers** (6%) and as flame retardants in **textiles**. Their use from 2012 is banned.

As indicated above, SCCPs are present as impurities in MCCPs and in products containing them. A recent evaluation of MCCPs, done by the UK in the framework of REACH, indicates that concentrations of **SCCPs in MCCPs range from 0.1 – 1%,** with other sources indicating this is often closer to 0.1%.

Due to the phase-out of SCCPs some historical uses in short-lived articles or applications, such as textiles or leather or in metal degreasing, resulted in waste streams that are no longer generated (and all past waste will already have been disposed of). SCCPs used in certain articles such as sealants, rubber and textiles will still be present and be relevant when these materials become waste.

The following waste streams that may contain SCCPs have been identified as still being relevant:

---

[152] Directive 76/769/EEC

[153] As determined in the restriction established for SCCPs in entry 42 of Annex VII to Regulation 1907/2006 (REACH).

- **Rubber waste** from end-of-life **conveyor belts** used for underground mining, hoses and gaskets. [**4,130 t** rubber waste estimated generated in the EU in 2020, containing **413 t SCCPs**]
- **Sealants and adhesives in demolition waste**. [**486t of SCCPs** estimated to be generated in **2,430 t** of demolition waste in the EU in 2020. Often mixed with mineral demolition waste]**.**
- Rubber, plastic and textile **waste from consumer products** (including i**mports**). [No information available about quantities of such products, which will likely be disposed with municipal waste. 119 RAPEX[154] notifications of SCCPs in consumer products were received between 2013-2018]

The most important waste stream identified is rubber from conveyor belts used in mining. This equipment has an estimated average service life of 12.5 years and it has been calculated that 4,130 t of rubber waste containing SCCPs is generated every year. Based on Eurostat data it is estimated that **50,000 t of conveyor belt rubber were disposed of in 2020**, which means that **SCCPs containing rubber represents 8.2%** of the total.

It is estimated that currently **50% of mining conveyor belt waste rubber is incinerated (25,000 t) and 50% is recycled (25,000 t).** Based on modelling performed by RPA(2021) it is expected that **78% and 98%** of rubber containing SCCPs from conveyor belts still in use in 2020 **will have been disposed of by 2025 and by 2030**, respectively.

Other related rubber articles containing SCCPs such as **gaskets and hoses** have shorter service lives (average 7.5 years) and it is assumed that most of them will have already become waste.

The largest separately collected rubber waste stream in the EU is end-of-life tyres (ELTs) which are either recycled into a number of rubber products (rubber tiles, moulded products, rubber asphalt, infill material for sports fields) or sent to energy recovery (incineration). Some **3.6 Mt of tyres are generated in the EU every year**. In addition another **2.8 Mt of other rubber waste** is generated, including 50,500 t of conveyor belt waste.

According to consultations made with specialised waste managers, tyres have dedicated and very specific collection schemes and generally great care is taken not to mix tyre waste with other general rubber goods. Therefore **contamination of the ELT recycled stream (which has no SCCPs), with rubber from other sources contaminated with SCCPs is unlikely**. The extent to which conveyor belt rubber becomes mixed with other general rubber goods during collection and treatment is unknown. Under the assumption that all conveyor belt rubber waste is collected together and processed into recycled rubber, the average SCCP concentration therein would be 8,200 mg/kg.

The amount of SCCP in **sealants and adhesives waste** disposed of in the EU27 was estimated to be **486 tonnes in 2020**, which corresponds to around **2,430 tonnes of sealants and adhesives waste containing SCCPs**. In terms of waste management the study in support of this impact assessment has assumed that 1/3 of this waste can be collected separately and treated as hazardous waste. The remaining **2/3 is assumed to remain bound to mineral demolition waste** (bricks, concrete, etc.) and cannot be

[154] RAPEX is the previously used name given to the rapid alert system for dangerous non-food products established by the Commission, currently known as "Safety Gate". https://ec.europa.eu/consumers/consumers_safety/safety_products/rapex/alerts/repository/content/pages/rapex/index_en.htm

separated. It is uncertain whether this fraction of demolition waste would be managed together with other hazardous C&D waste or if it would be mixed and dealt with together with non-hazardous C&D waste. In the first case the **average SCCP concentration** in the mixed waste is estimated to be **35 mg/kg and in the second case 1 mg/kg**, far below any of the options considered in the impact assessment. Demolition waste containing SCCPs, even if only at low concentrations, is expected to be generated well into the **decade of 2060**.

SCCPs have been detected via market surveillance activities in some consumer products introduced into the EU market. This includes a number of **articles containing PVC or EVA foam**. This includes power cables, bath toys, bathtub pillows and yoga mats. Between 2013 and 2018 a total of **119 Safety Gate** (previously RAPEX) **notifications** were received for articles exceeding the current limit for SCCPs in Annex I of the POPs Regulation (1,500 mg/kg). It is not possible to determine how much waste containing SCCPs is generated from these imported articles. It is assumed that such waste **will be disposed of as municipal solid waste** and will be either **landfilled or incinerated**.

Analysing SCCPs in waste is **not easy but it is possible**. There are no harmonised laboratory analytical methods which are specific for waste, however **methods with sufficient sensitivity exist for other types of sample**s (such as sediment, sewage sludge or leather) that can be adapted to waste. The cost per analysis, including sample preparation, ranges from **190 – 380 € per sample**. There are no readily available field methods to support sorting of SCCP waste on the field or at the recycling plant. Hand-held XRF analysers can be used to detect chlorine within a few seconds but these results **are not specific** and it is not possible to distinguish, for example, rubber containing SCCPs from that containing MCCPs (which are permitted additives and also contain chlorine). Therefore, the only currently possible approach to **sorting is based on manual separation of wastes based on visual inspection** of the waste items, potentially supported by information about their **origin and date of manufacture** (useful for instance for the sorting of conveyor belts manufactured before 2012).

6.5.3. Impacts of the policy options

The different policy options for a (revised) Annex IV limit for SCCPs are:

Option 1: 10,000 mg/kg – current baseline. Same value as the unintentional trace contaminant limit allowed under Annex I for SCCPs in substances and mixtures placed on the market.

Option 2: 1,500 mg/kg – Current UTC limit under Annex I for SCCPs in articles placed on the market. This value was proposed by Ramboll (2019) applying the methodology described in Annex IV of this IA report.

Option 3: 420 mg/kg – Lower limit considered by Ramboll (2019) based on a theoretical concentration of SCCP in a scenario whereby SCCP-containing conveyor belt rubber waste would become mixed with all other rubber waste.

As discussed in the section above, conveyor belt rubber is the key waste stream in which SCCPs were intentionally present and that could be impacted by the policy options under consideration. The analysis of impacts below focuses on them.

Limited information is available on the presence of SCCPs as an impurity in MCCPs. However, the available information suggests that SCCPs account for less than 1% of the paraffins present in MCCPs (but often as low as 0.1%). The Danish EPA notes that in mining applications MCCPs were typically used in concentrations around 2-3% (but as high as 5-10%) – **this suggests an SCCP content around 20 mg/kg to 1,000 mg/kg.** This, together with the existence of the UTC in Annex I of the POPs Regulation (1,500 mg/kg for articles), suggests that SCCPs present in waste as an impurity of MCCPs are unlikely to be affected by Option 2 (1,500 mg/kg). A similar conclusion cannot be easily reached for Option 3 (420 mg/kg).

As regards imported consumer products, under the assumption that market surveillance is effective in ensuring compliance with Annex I of the POPs Regulation, the waste generated by these should not exceed the Option 2 limit. This would not necessarily be the case for the Option 3 limit value. Given these articles are likely to be disposed of with municipal waste it is likely that the concentration in a mixed waste sample will however also be lower than Option 3.

Likelihood of impacts on disposal and recovery methods by waste stream (SCCPs)						
Waste stream	**Option 2 (1,500 mg/kg)**			**Option 3 (420 mg/kg)**		
	Recycling	**Landfilling**	**Incineration**	**Recycling**	**Landfilling**	**Incineration**
Conveyor belts	Possible	No*	Possible	Possible	No*	Possible
Rubber waste – other than conveyor belts	Unlikely	No*	Unlikely	Unlikely	No*	Unlikely
C&D waste	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Waste containing MCCPs	Unlikely	Unlikely	Unlikely	Not clear	Not clear	Not clear
Consumer products	Unlikely	Unlikely	Unlikely	Not clear but not very likely	Not clear but not very likely	Not clear but not very likely
Notes: *Not relevant						

Table 7: Likelihood of impacts on disposal and recovery methods by waste stream (SCCPs)

An estimate was made, with considerable uncertainty, of the amount of **rubber waste from mining conveyor belts** that would be **diverted from recycling to incineration**, under two scenarios. In the first scenario all rubber containing SCCPs is segregated and sent for incineration (e.g. based on information on nature and origin of the conveyor belts). In the second scenario recyclers cannot sort this material out and take a precautionary approach, diverting all mining conveyor belt rubber waste to incineration. This results in:

Impact on final treatment – tonnes of rubber generated from end-of-life conveyor belts used in mining (2021-2035)									
Estimate	**Option 1 (10,000 mg/kg)**			**Option 2 (1,500 mg/kg)**			**Option 3 (420 mg/kg)**		
	Incineration	**Recycling**	**Landfill**	**Incineration**	**Recycling**	**Landfill**	**Incineration**	**Recycling**	**Landfill**
Low estimate	150,000	150,000	0	157,000	143,000	0	158,000	142,000	0
High estimate	150,000	150,000	0	220,000	80,000	0	250,000	50,000	0

Impact on final treatment – tonnes diverted over 2021-2035						
Waste stream	**Option 2 (1,500 mg/kg)**			**Option 3 (420 mg/kg)**		
	Incineration	**Recycling**	**Landfill**	**Incineration**	**Recycling**	**Landfill**
Rubber from conveyor belts – low estimate	+7,000	-7,000	0	+8,000	-8,000	0
Rubber from conveyor belts – high	+70,000	-70,000	0	+100,000	-100,000	0

Impact on final treatment – tonnes of rubber generated from end-of-life conveyor belts used in mining (2021-2035)									
Estimate	**Option 1 (10,000 mg/kg)**			**Option 2 (1,500 mg/kg)**			**Option 3 (420 mg/kg)**		
	Incineration	**Recycling**	**Landfill**	**Incineration**	**Recycling**	**Landfill**	**Incineration**	**Recycling**	**Landfill**
estimate									

Table 8: Impact of policy options on final treatment of rubber from conveyor belts used in mining

The available incineration capacities appear sufficient to accommodate the diversion of the relevant conveyor belt rubber waste currently being recycled for both the high and low estimates.

Based on the above figures the loss in revenue and costs for recyclers dealing with conveyor belts, as well as the increase in revenue for waste managers operating incineration plants, can be estimated.

Under **Option 2** recyclers / waste generators would incur in total additional **waste management costs** of between **1.7 M€ and 16.2 M€** over the period 2021-2035 (under low and high scenarios, average cost of hazardous waste incineration: 260€/tonne). There would be equivalent increases in revenue for operators of hazardous waste incinerators treating this material. Not being able to sell the recyclate that would have previously been generated from the rubber diverted to incineration would also lead to a **loss in revenue for recyclers of 1.3 – 12.4 M€** over the period 2021-2035 (based on 200 €/tonne estimated average market price of rubber recyclate).

Under **Option 3** waste management costs would be of **1.8 – 21.8 M€** over the period 2021 - 2035. There would be equivalent increases in revenue for operators of hazardous waste incinerators. **Loss in revenue** to recyclers due to diversion of material to incineration over this period would be of **1.4 – 16.8 M€**.

The **maximum additional destruction of SCCPs** over the referred period would be of 690 t (Option 2) and 760 t (Option 3) with **maximum annual amounts of 180 t for both options.** The actual amount of SCCPs that would be released from the material, during the service life of the articles that would have been made from this rubber, or its actual environmental or human health impact, could not be quantified, but the effect of destruction will be positive, even if probably to a small extent.

Another impact associated to the diversion from recycling of rubber is that a certain amount of **CO_2e emissions that would have been avoided by the use of the recycled rubber** will not be avoided (and generated due to the use of primary rubber). Based on several sources RPA(2021) reports that for **every tonne of rubber recycled (based on tyre rubber) 969 kg CO_2 are saved.** The diversion figures above result in the following (adverse) impact in terms of GHG emissions: **Option 2: 6,738 – 67,830 t** in total over the period 2021-2035; **Option 3: 7,752 – 96,900 t** over the same period. These emissions are not negligible but relatively limited in comparison with the total GHG generated by households and industry in the EU-27 (4 billion tonnes of CO_2 equivalents in 2018[155]).

In the event that **testing is carried** out (especially under the "low" scenario that assumes testing and sorting of rubber batches), testing costs would be incurred by recyclers. Based on a cost per sample of 190-380€, consultants assumed the need to do at least one test per tonne of waste processed, which would result in **yearly testing costs of €3.8 and 7.6**

155 See https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Greenhouse_gas_emission_statistics_-_air_emissions_accounts#Greenhouse_gas_emissions

million (20,000 tonnes of rubber in end-of-life conveyor belts from mining applications). However, considering the 200 €/t average market price for rubber recyclate (and a 260 €/t incineration cost) such an analytical approach is not considered realistic and considerably lower analytical frequency and total analytical costs, that could not be estimated, are considered likely.

As regards impacts on **users of recycled rubber**, it is estimated that the policy options under consideration will have limited impact on them given recycled rubber coming from mining conveyor belts **is small compared to total amount of rubber recycled.** However, if users of such recycled rubber would have to substitute for primary rubber (estimated average additional cost of 500 €/t), then the total additional costs would range from **€2.3-26 million** over 2021-35.

As noted in Section 4.3.2 of RPA (2021) the available information suggests that, when all rubber waste streams are taken into account, there would be limited impacts on final treatment outcomes. Consequently, limited market and employment effects can be expected.

Economic/social impacts	**Option 2 (1,500 mg/kg)**	**Option 3 (420 mg/kg)**
Trade and investment flows	No/limited impacts expected	No/limited impacts expected
Competitiveness (sectoral) of business	No/limited impacts expected	No/limited impacts expected
Position of SMEs	Testing costs more difficult to absorb for SMEs	Testing costs more difficult to absorb for SMEs
Internal market and competition	No/limited impacts expected	No/limited impacts expected
Innovation and research	No/limited impacts expected	No/limited impacts expected
Specific regions or sectors	No/limited impacts expected*	No/limited impacts expected*
Employment	No/limited impacts expected	No/limited impacts expected
Working conditions	No/limited impacts expected	No/limited impacts expected
Note: *There is an indication of potential differences between local practices of separation of conveyor belts from other rubber waste but no detailed information is available.		

Table 9: Market and employment impacts of annex IV options for SCCPs.

6.5.4. Conclusion on preferred policy option

Policy Options 2 and 3 seem to have **relatively similar impacts,** which are not negligible but relatively small and focused on the sector of rubber recycling. The impacts of Option 3 on waste originating from other articles / materials, especially those that lawfully contain MCCPs (in which SCCPs are an impurity) are far more uncertain and therefore there is a higher risk of unforeseen impacts.

The benefits, in terms of the amount of SCCPs destroyed (and therefore potentially not emitted) are very similar for the two options (over the period 2021-2035).

Considering that due to the presence of impurities of SCCPs in articles containing MCCPs, the Annex I limit in the POPs Regulation permits the placing on the market of articles containing SCCPs up to a concentration of 1,500 mg/kg, it does not seem appropriate to set a stricter limit applicable to waste management.

The preferred policy option for the **Annex IV limit value** is **therefore determined to be Option 2 (1,500 mg/kg)** given it appears to have limited impacts (only on recycling of rubber from conveyor belts) and is unlikely to cause relevant impacts on other waste streams. This conclusion is consistent with the application of the methodology described in Annex IV of this report, whereby in application of the precautionary principle, the current value is reduced from the current limit of 10,000 mg/kg to 1,500 mg/kg which is the highest of the lower limitation criteria, defined by the applicable unintended trace contaminant limit. See limitations criteria diagram in Figure VI-8 of section 6.6.5 of Annex VI of this report.

The review of the **Annex V value** for SCCPs, **currently established at 10,000 mg/kg,** is not proposed, as there is no indication that the current value is not appropriate. Further justification about the very limited relevance of Annex V limit values is provided in section 5.3.3 of this impact assessment.

6.6. Perfluorooctanoic acid (PFOA), its salts and PFOA related compounds

6.6.1. What are they and why are they a problem?

Perfluorooctanoic acid (PFOA), its salts and PFOA-related compounds all belong to a broader family of **organic substances that contain fluorine**[156] **known collectively as PFAS**. Under the Stockholm Convention PFOA-related substances refer to any substances that degrade to PFOA. A detailed list of the identities of the dozens of individual substances in scope is provided in RPA(2021).

This family of perfluorinated compounds have been used in numerous applications. This is due to their high thermal and chemical stability, their surface tension and lubricating properties. An exhaustive list of uses is provided in RPA (2021).

Some of the most relevant uses include: 1) manufacture of polymers used in insulation of power cables and of others such as PTFE (better known as Teflon®) used to produce non-stick coatings, seals, pipes, filters, etc.; 2) as surfactant in the manufacture of semiconductors 3) in certain fire-fighting foams and cleaners; 4) **water-proofing and anti-stain treatment for textiles, including professional clothing, outdoor jackets and carpets**; 5) use in certain paints, inks, adhesives and waxes. The most relevant sectors concerned are **textiles, automotive and electronics.**

PFOA is **highly stable and persistent in the environment and does not undergo any degradation** under relevant environmental conditions. It is known that PFOA may result in a broad range of adverse impacts on terrestrial and aquatic species. This includes effects on hormonal processes, immunological effects and effects on behaviour. A report by the Nordic Council of Ministers[157] published in 2020 provides estimations of **PFAS remediation costs** at European level that range from **€821 million to €170 billion**.

In the European Union, PFOA and AFPO, a salt of PFOA, are both classified as hazardous[158] because they are known to **produce cancer and are toxic for reproduction and for the liver** after repeated exposure. Other known effects include thyroid disease, pregnancy-induced hypertension and elevated cholesterol. **Humans are exposed to PFOA mainly via the environment** (e.g. food and drinking water) and to some extent via house dust.

Annual **health impact-related costs** in Nordic countries due to PFAS exposure are estimated in the previously referred report to be **€52-84 billion**. Although it is not

[156] per- and polyfluoroalkyl substances

[157] The cost of inaction http://norden.diva-portal.org/smash/get/diva2:1295959/FULLTEXT01.pdf and Goldenman et al. 2019 and in 2020 https://www.miljodirektoratet.no/publikasjoner/2020/mars-2020/the-cost-of-inaction/

[158] They are also included in the so-called "candidate list" of substances of very high concern (SVHCs) established under REACH.

possible to determine what fraction of these costs refer specifically to PFOA, its salts and related substances it provides a clear indication of their magnitude.

PFOA, its salts and related compounds were listed in the "elimination" annex of the Stockholm Convention in 2019 and **their use in Europe has been severely limited since July 2020** via a restriction under REACH[159]. In June 2020 these substances were introduced in Annex I of the POP Regulation[160], banning their manufacture, placing on the market and use, **subject to a number of specific exemptions**, some of which run until the year 2025.

PFAS substances in general are as a whole a matter of great concern and political attention. Under its Chemicals Strategy for Sustainability the European Commission has published a **PFAS strategy**[161] and, together with a number of Member States, work is underway to **prepare a broad restriction under REACH limiting the use of all PFAS substances**.

6.6.2. Baseline

A compilation of information about the presence and content of PFOA, its salts and related compounds in numerous articles and products is provided in RPA(2021). This information is **highly variable and has considerable uncertainties associated to it.** It is often difficult to tell whether the information corresponds to PFOA itself, to some of its salts or to other related compounds. Furthermore the analytical results available are **in all cases expressed as PFOA** which is the substance to which PFOA-related substances degrade to.

Although the manufacture, use and placing on the market of PFOA, its salts and PFOA-related compounds is, with limited exceptions, no longer allowed in the EU (including in articles), the **entry of PFOA can still occur via imported articles** due to imperfect market surveillance.

Information about the concentration of PFOA, its salts and related compounds **in waste is extremely scarce** and assumptions have to be made based on what is known about their presence in articles which, ultimately, become waste upon disposal. RPA(2021)[162] provides a detailed overview of concentrations in articles under the assumption that this will be their concentration when they become waste.

The most relevant wastes that can contain PFOA are **waste electrical and electronic equipment** (WEEE), end-of-life **vehicles** (ELVs), **textile waste** including clothing and upholstered furniture and waste from disposal of **carpets** (including fitted carpets). No analytical information on the concentrations of PFOA, its salts or related substances, measured in waste, could be found by the consultants that performed the support study for this impact assessment. Some of these wastes, apart from being separately collected, also end up in **mixed municipal waste**. PFOA and its salts and related compounds have a high mobility and consequently they are **not very much retained in sewage sludge** of municipal treatment plants. A study on sludge from 15 plants in Germany and Spain indicates concentrations of PFOA of 0.0012 mg/kg, which are well below any of the options under consideration.

---

159 The restriction under REACH was deleted by Commission Regulation (EU) 2020/2096 in December 2020, following the inclusion of PFOA, its salts and related substances in Annex I to the POP Regulation in June 2020.

160 Commission Delegated Regulation (EU) 2020/784. 15.06.2020. L 188 I/1

161 SWD(2020) 249 final. https://ec.europa.eu/environment/pdf/chemicals/2020/10/SWD_PFAS.pdf

162 See section 5.2.1 and table 5-3 in RPA(2021).

WEEE and ELV are separately collected and treated in thousands of facilities, mostly SMEs, throughout Europe. However as mentioned in the analysis of PBDEs it is estimated that only about 30 specialised facilities recycle WEEE/ELV plastics. In the case of WEEE and ELV it is estimated that **printed circuit boards as well as cables and insulators can contain PFAS**, its salts and related compounds. Due to their content in valuable metal constituents **printed-circuit boards are dismantled** and **sent to specialised smelters** where metals are recovered and organic constituents, including PFAS are (largely) destroyed at the very high temperatures of the smelter. ELVs also contain PFOA in some plastic components, seals and textiles (e.g. upholstery of seats).

There are **no applicable methods for the rapid identification of materials containing PFOA**, its salts or related compounds and consequently **no approaches to sorting**. Laboratory methods to analyse PFOA in environmental samples **are available** but there do not seem to be specific standardised methods to analyse many of the relevant waste matrices identified. In the background document[163] to its opinion on PFOA the European Chemicals Agency concluded that methods are available that allow to analyse concentrations of PFOA **as low as 0.002 mg/kg**. However, Ramboll (2019) reports that "*most laboratories report a limit of quantification of 1 mg/kg*". Given the very limited experience in the analysis of waste and considering the analytical criterion to be used refers to analytical capacities widely available and not only in limited specialised laboratories, **the value of 1 mg/kg is retained for PFOA** as criterion A for the purpose of applying the methodology.

The limited information available on analytical costs points to laboratories offering an analytical package containing a number of PFAS substances for prices ranging from **350 – 500 € per sample** and that prices of the order of 200 € are possible if only PFOA is analysed.

Currently **very few textiles are separately collected and recycled**. It is estimated that most textiles containing PFOA and other waste containing PFOA are **discarded to municipal waste and are landfilled or incinerated**. Only about 3% of carpets in the EU are recycled.

It is conceivable that some plastics containing PFOA from WEEE and ELV may be recycled. However, exchanges with recyclers indicate a low level of concern about this matter with a clear assumption that most of the PFOA, its salts and related compounds in electronics will be in the **printed circuit boards**, which are **destroyed.** There is no evidence that these substances are systematically controlled in the plastic recyclate.

6.6.3. Impacts of the policy options

Three options are considered for the Annex IV values of the PFOA, its salts and PFOA-related compounds:

- Option 1 is maintaining the current baseline, i.e. not setting a value. This option is not further analysed as by not acting the Commission would be in breach of its obligations under the POPs Regulation;
- Option 2 is setting the Annex IV limit to 50 mg/kg for PFOA and it salts and to 2,000 mg/kg for PFOA-related compounds. These values were proposed by

[163] RAC (2018) Background document to the Opinion on the Annex XV dossier proposing restrictions on Perfluorooctanoic acid (PFOA), PFOA salts and PFOA-related substances https://echa.europa.eu/documents/10162/61e81035-e0c5-44f5-94c5-2f53554255a8

Ramboll (2019) based on the value in Annex IV of the POPs Regulation for the similar substance PFOS. A **factor of 40 is applied to PFOA-related compounds**, as previously determined under REACH[164] and Annex I of the POPs Regulation; and;

- Option 3 refers to a lower limit of 0.025 mg/kg for PFOA and its salts and of 1 mg/kg for PFOA-related compounds. These values correspond to those set as an **unintentional contaminant limit** under the EU POPs Regulation for products placed on the market.

Very few comments and information on the impacts of Options 2 and 3 were provided during the consultation activities. This seems to indicate either low concern regarding these options or reflect a lack of monitoring and control of PFOA in waste. Based on the limited information available about concentrations in individual products RPA(2021) has estimated that impacts are unlikely for Option 2 with **some impacts being possible for textiles and carpets** disposed as waste, in the case of Option 3.

Analytical results for textiles and carpets indicate that sometimes Option 3 values for PFOA would be largely exceeded. This is likely to bring about increased testing costs, which for the whole sector could be as high as the **low millions of euros** (potentially with more serious impact on SMEs[165]) and **some reduction** in the amount of textile material available for recycling.

No **quantitative estimation in terms of tonnages of waste diverted from one treatment to another has been possible**. For carpets, 1.6 Mt of carpet waste was estimated to be generated in the EU in 2018 but only a small amount was recycled. There is a **large uncertainty in this assessment** given that, for the relevant waste streams, even if individual articles may exceed the limit, the average concentration in a representative sample of waste would likely be much lower.

Two waste operators that responded to the consultation (hazardous waste incinerators) expressed little concern that either of the options would bring about any relevant changes. On the contrary, the German Federal Ministry for the Environment expressed some concern that option 3 could **prevent recycling**.

Textile recycling is currently in its infancy in the EU, but textile waste management is a major challenge and **boosting recycling of textiles is one of the objectives identified in the new CEAP and Article 11 of the Waste Framework Directive**. It is unlikely that neither Options 2 or 3 would have major impacts on the availability and price or raw materials, on the market or on employment. Given the current strict limitations on the placing on the market and use PFOA and the relatively **short lifetime of many textile articles** such as clothing it is unlikely that these substance will remain in waste for many years[166]. **Textiles from carpets, from vehicles and furniture, with estimated lifetimes of 10 – 15** years will however still appear in waste, potentially containing variable amounts of PFOA, its salts and related compounds until potentially about **2035**.

---

[164] Commission Regulation (EU) 2017/1000. 14.06.2017. L150, p14.

[165] Given most textile recyclers and waste managers disposing of textile waste (eg demolition companies disposing of carpet waste) are expected to SMEs.

[166] Garments such as all-weather jackets may however remain longer in use.

6.6.4. Conclusion on preferred policy option

The information available to apply the methodology described in Annex IV is very limited and there is **high uncertainty** in defining most of the lower and upper limitation criteria. **No applicable health based reference value could be derived for PFOA**, its salts and related compounds (see Table VI-2 on section 4.3. of Annex IV of this impact assessment). The upper limitation criterion value used is based on the limit value agreed for a similar PFAS substance, PFOS, whereas the relevant lower limitation criteria are based on analytical capabilities and the UTC limit value under Annex I of the POPs Regulation. See figure VI-9 in section 6.6.6 of Annex VI of this report.

The application of the precautionary "target function II" of the methodology would lead to reducing the proposed value from the upper limitation criterion of 50 mg/kg (based on PFOS) to the highest of the lower limitation criteria, estimated in 1 mg/kg, based on a conservative estimation of analytical capacity in waste. Applying the same ratio as in Annex I of the Regulation between PFOA and PFOA related substances, a value of 40 mg/kg is proposed as the limit for PFOA related substances.

There is insufficient information to factor in criteria associated to economic feasibility of treatment capacity. Given the many uncertainties in estimating the types and amounts of waste that would be impacted by an annex IV limit based on Option 3 and considering that it is likely that textile recycling, in particular of carpets, could be affected, a cautious approach would be a proposal based on Option 2, with a review in the coming years.

The argument could also be made that it is **unreasonable to propose the limit value in Option 3, that is relevant only to waste management, that is equivalent to the current unintentional trace contaminant limit** in Annex I of the Regulation (which applies to products placed on the market).

On the other hand, the Commission is required under the Waste Framework Directive to consider **setting preparing for reuse and recycling targets for textile waste** by 31 December 2024. These wastes have to be separately collected by Member States by 1 January 2025 and are **a high priority in the CEAP**. Therefore setting stringent Annex IV limits for these substances would seem warranted to promote clean and (almost) PFOA free recycled textiles from the onset. The objectives of the newly published **PFAS Strategy** further support this line of reasoning.

Consequently, although the currently available information does not allow for any quantitative assessment or refinement of the policy options put forward in this impact assessment, an alternative, **intermediate policy option is proposed** based on a qualitative analysis and which results from the application of the methodology (based on limited information), as described above.

Consequently, the preferred policy option **"3 bis"** is proposed as: **1 mg/kg for PFOA and its salts and of 40 mg/kg for PFOA related compounds**. A comparable[167] value (10 mg/kg as sum value for PFOA, its salts and PFOA related compounds, as well as of PFHxS compounds) has been proposed by a number of NGOs responding to the Commission's consultation on the inception impact assessment.

[167] Although not equivalent, this value can be considered of a similar order, given the value proposed is lower than that proposed for PFOA-related substances but higher than that proposed for PFAS and its salts. Furthermore, according to RPA(2021) concentration values reported for PFOA-related substances in articles all correspond to measurements for PFOA itself or for 8:2 FTOH, converted to PFOA, and not the PFOA-related substance; therefore, the limit value for PFOA and its salts would apply (and not the higher value for PFOA-related substances). See section 5.2.1. and table 5.3 of RPA (2021).

This "**Option 3 bis"** for the **Annex IV limit value would reduce the risk of impacts on textile recycling** (given only a limited number of articles seem to exceed the value for PFOA) but would at the same time impose a stringent limit, more restrictive that the one provided by Option 2. Although the use of a single limit value to cover all substances in scope is appealing due its regulatory simplicity, it would deviate from the approach used for PFOA, its salts and PFOA-related compounds in Annex I of the Regulation and from the approach chosen in the original REACH restriction. In these a separate value is defined for PFOA and its salts, different from that for PFOA precursors (PFOA-related compounds).

As regards the **Annex V** limit, it is proposed to align this upper limit for **PFOA, its salts and PFOA-related compounds** to that already established for PFOS[168], a related perfluorinated substance, and set at **50 mg/kg** (equivalent to Option 2). For **PFOA-related compounds a value of 2,000 mg/kg** should be established (based on the same ratio as for Annex IV values). For the reasons explained in section 5.3.3 of this impact assessment no economic, social or environmental impacts are envisaged from the introduction of an Annex V limit value for these substances, given the very limited relevance and scope of application of these values.

6.7. Perfluorohexane sulfonic acid, its salts and related compounds (PFHxS)

6.7.1. What are they and why are they a problem?

These substances belong to the **same broad family of perfluorinated substances** (PFAS) mentioned in section 6.6. The list of substances in scope is provided in RPA (2021).

These substances have **similar properties and uses[169] to those of PFOA**, its salts and PFOA-related compounds and are seen as **"regrettable substitutes" for these**, following the restriction of PFOA first under REACH and subsequently under the Stockholm Convention. Due to these concerns, especially about PFHxS substances used in textiles that could be imported into the EU, Norway presented a REACH restriction dossier **proposing a broad restriction** with some limited exceptions. An opinion by the European Chemicals Agency on the restriction of these substances under REACH was concluded in June 2020 and was transmitted to the Commission.

Similarly to PFOA, PFHxS substances were globally used in a variety of industrial processes in the production of many consumer products such as carpets, waterproofing and stain-resistant fabrics, leather, upholstery, coatings, apparel, non-stick cookware, food packaging, aqueous fire-fighting foams (AFFFs), metal plating, polishing and cleaning agents, semiconductors, coatings, electronics, papermaking sealants and printing inks.

PFHxS, its salts and PFHxS-related compounds **have been proposed for listing under Annex A** (the elimination annex) of the Stockholm Convention and a decision is envisaged to take place in a session of the Conference of the Parties of the Stockholm

[168] As also proposed in Ramboll (2019)

[169] The main difference is that PFHxS was not used as a polymerisation aid. The use in articles is very similar to PFOA. A list of uses can be found in the document UNEP/POPS/POPRC.15/7/Add.1 that can be downloaded from: http://chm.pops.int/Convention/POPsReviewCommittee/Chemicals/tabid/243/Default.aspx

Convention that is due to meet in the summer of 2022[170]. These substances have been included in this impact assessment in preparation for their possible listing.

6.7.2. Baseline

Only limited information is available on the current intentional and unintentional production of PFHxS, its salts and related substances and their use in the production of articles and mixtures. Evidence compiled during the REACH restriction process seems to **indicate that there is no intentional production of PFHxS in Europe** after the bankruptcy of the only European producer in 2018. Some PFHxS may still be produced unintentionally, for instance as an impurity of the related substance PFOS (also prohibited under POP regulation but with one exception). Therefore it seems **likely that use of these substances in the EU, including in textiles is very limited**. Imports of **textiles containing PFHxS-related compounds**, for instance from China, although expected to be low, cannot be excluded.

Prior to 2002, when 3M, the major worldwide producer of these substances, ceased their manufacture, EU imports of articles containing PFHxS, its salts and PFHxS-related substances existed and were divided between uses in carpets (60%), apparel and leather (20%), fabric and upholstery (15%), fire-fighting foams (5%) and coatings (0.4%).

According to the Norwegian restriction proposal for PFHxS, its salts and PFHxS-related substances the **yearly emissions to the environment** of these substances in the EU in the period 2011-2019 was of **about 220 kg**. These are projected to double, in the event of a no-action scenario where the **on-going restriction under REACH** would not be put in place.

6.7.3. Impacts of the policy options

The situation for PFHxS, its salts and PFHxS-related compounds is very similar to that of PFOA and its compounds. The very limited available information on the concentration of PFHxS in the relevant waste streams seem to indicate that exceedance of Option 2 values is very unlikely. In the case of some carpets, some other textiles and remaining PFOS-containing fire-fighting foams, these could exceed Option 3 values.

Consequently, although the likelihood of impacts due to any of the options seems smaller than in the case of PFOA and its compounds, there is high uncertainty about the situation and an approach, identical to that proposed under section 6.6 for PFOA would seem warranted. The only remarkable possible impact, associated to Option 3 and **Option 3bis** which, cannot be quantified in any detail, relates to testing costs to quantify the presence of PFHxS and PFHxS-related compounds in waste. These costs could be addressed together with those incurred for the testing for PFOA given the same analytical methods, covering a whole range of PFAS substances, are applicable.

6.7.4. Conclusion on preferred policy option

For reasons identical to those described in section 6.6.4 a preferred **"Option 3 bis"** is proposed for the **Annex IV limit value**, defined as: **1 mg/kg for PFHxS and its salts and of 40 mg/kg for PFHxS related compounds.**

---

[170] The date for the sessions of SC COP-10 in which these discussions will be held, initially scheduled in July 2021, have been postponed to June 2022 as a result of the negative evolution in many European countries of the COVID-19 pandemic. COVID-19 Communication (brsmeas.org)

As regards the **Annex V** limit, it is proposed to follow the recommendation in Ramboll (2019) to align this upper limit for **PFHxS and its salts** to that already established for PFOS, a related perfluorinated substance, and set to **50 mg/kg** (equivalent to Option 2). For **PFHxS-related compounds a value of 2,000 mg/kg** should be established. As explained in section 6.6.4 for PFOA, no impacts are envisaged from the setting of such a limit in Annex V.

6.8. Pentachlorophenol and its salts and esters (PCP)

6.8.1. What are they and why are they a problem?

Pentachlorophenol was first produced as **wood preservative** as early as the 1930s, but has been used as a **biocide, pesticide, disinfectant, defoliant, anti-sapstain agent, and anti-microbial agent in the treatment of wood** since that time (UNECE, 2010[171]). The ester pentachlorophenyl laurate (PCP-L) has been applied as a biocide and pesticide for textiles, particularly **heavy textiles such as tent canvass**, where it was used to prevent mold and fungus, particularly for military applications.

Restrictions on the use of PCP within the EU **entered into force in 1991** and a ban was placed with respect to the use of PCP as a synthesising or processing agent in industrial processes (including use a wood preservative) under Commission Directive 1999/51/EC. Since 2008 and until its recent deletion in December 2020[172], PCP has been regulated under the REACH Regulation by a restriction limiting the placing on the market of PCP as a constituent substance, in mixtures or in articles above 0.1 % w/w.

While the **use of PCP, its salts and esters has ceased in the EU for over a decade**, the service life of treated timbers can be up to 50 years. This includes primarily utility poles, but also railway sleepers, with goods treated in the 1980s being the most likely to contain PCP. Treated timbers can also emit PCP during their service life. This includes not only direct emissions to the air but also leaching and contamination of rain water that can then reach soil and surface and groundwater.

PCP has a harmonised classification in the EU as **acutely toxic both for human health and for aquatic organisms**. PCP has developmental, immunotoxic and neurotoxic effects in mammals. Human survivors of toxic exposures have been found to suffer from **permanent visual and central nervous system damage**.

PCP and its salts and esters are listed in Part A of Annex I of the POPs Regulation. It was originally listed under this Regulation without an Unintentional Trace Contaminant (UTC) limit value but **a UTC limit value of 5 mg/kg was adopted on 16 December 2020** (which entered into force in January 2021).[173] This is expected to **allow the continuation of recycling of wood chips and facilitate enforcement**.[174]

PCP and its salts and esters **were listed in Annexes IV and V** of the Regulation by Regulation (EU) 2019/636, with a an Annex IV value **of 100 mg/kg** and an Annex V value of 1000 mg/kg. Given Regulation (EC) 850/2004 was repealed by Regulation (EU)

---

[171] UNECE, 2010, 'Exploration of management options for PCP', paper presented to the UNECE task force on POPs.

[172] The listing of PCP in the restrictions Annex of REACH was deleted in December 2020 due to the inclusion of such provision under Annex I of the EU POPs Regulation.

[173] See https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=PI_COM:C(2020)8844

[174] Explanatory Memorandum for the Draft delegated regulation - Ares(2020)4532780.

2019/1021 but at the time PCP could not be introduced in the recast POPs Regulation, it is necessary to amend Annexes IV and V by adding an entry for PCP.

6.8.2. Baseline

There is currently no manufacture or use of PCP, its salts or esters in the EU. Stockpiles of treated timbers and textiles, mainly from the mid-1980s to early 1990s, can be expected to be declining. In Europe, PCP was produced in France, Germany, the Netherlands, Poland, Spain and the United Kingdom. All production of PCP and its salts and esters ceased in the EU between 1992 and 2002.

In Germany, in the early 1980s, approximately 60% of the total volume of PCP was used for wood preservation, 13% in textiles, 6% in mineral oil, 6% in adhesives, 5% in leather and 10% in applications other than paper and pulp, since this use ceased in the 1970s (BIPRO, 2015)[175]. By the end of the 1990s, the use of PCP and Na-PCP in the EU was limited to wood treatment for sapstain control and PCPL use to the treatment of industrial and military textiles. **By 2008, all uses had ceased in all EU countries**

Given that historically the main application of PCP and its salts and esters was as a heavy-duty wood preservative, the main PCP-containing waste stream is expected to be constituted by **utility poles, cross-arms and other timber products for construction**. Outer layers of treated wood could contain PCP in concentration in a range of several thousand mg/kg and UBA (2015) reports detection of PCP in recycling of construction waste. According to this same source, the average concentration of PCP in treated and air-dried wood amounts to approximately 625 mg/kg[176].

Military and industrial textiles treated with pentachlorophenyl laurate have an estimated **product service life of 15-20 years** and may also be considered relevant waste streams as PCP-L treatment of textiles ceased in 2002. Relevant amounts of waste could still be expected in France, Spain and Portugal where application of PCPL was allowed until 2008.

ESWI (2011)[177] estimated that around **500 tonnes of PCP in PCP-treated wood are still in use in the EU in 2020**. However, they also estimated that **by 2032, all PCP-treated wood will have been disposed for incineration** and all PCP destroyed. With regard to treated textile waste it was considered that this type of waste is not suitable for recycling and is likely to end up in municipal solid waste. The amount of PCPL in PCPL-**treated textiles** still in use in 2020 was estimated to be around **2 tonnes and 0 by 2022** (equivalent to 80 t of textile waste). No new information is available to confirm the projections made in 2011.

Nearly all **treated wood is expected to be incinerated**, whereas textiles are likely to enter landfills or be incinerated with or without energy recovery. ESWI (2011) assumes that nearly 100% of PCP wood waste in terms of volume is incinerated, as it can be disposed of neither at landfills for non-hazardous waste (due to the PCP concentration and classification as hazardous waste) nor at landfills for hazardous waste (due to the

---

[175] UBA (2015): Identification of potentially POP-containing Wastes and Recyclates – Derivation of Limit Values. https://www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/texte_35_2015_identification_of_potentially_pop-containing_wastes.pdf

[176] However contamination can range from 150 mg/kg to over 50,000 mg/kg.

[177] ESWI (2011): Study on waste related issues of newly listed POPs and candidate POPs. Available at: https://ec.europa.eu/environment/waste/studies/pdf/POP_Waste_2011.pdf

high total organic carbon content). Importantly, **recycling of old treated wood can be largely discounted**, as this material is normally not usable anymore.

Based on available projections reported in RPA(2021) textile waste streams contaminated with PCP, its salts and related compounds will cease to be relevant in 2022, whereas wood waste will continue to be generated until approximately 2032, by when all is expected to have been incinerated and the PCP contained in it, destroyed.

From the analytical point of view **methods are available to measure PCP, its salts and esters in waste**. Gas chromatography and mass spectroscopy analysis can achieve a detection limit of **0.1 mg/kg** for both wood and textiles waste matrices at an estimated cost of between **100 – 200 € per sample**.

6.8.3. Impacts of the policy options

As indicated above, the current baseline is that **there is no limit in the POP Regulation** for pentachlorophenol, its salts and esters. However, given that **an Annex IV limit of 100 mg/kg had been agreed** with Member States **and adopted in 2019** under Regulation (EU) 2019/636, but could not be introduced into the current Regulation during its recast, only this value is considered as an Option (referred to as **Option 3**).

According to projections done in 2011, about **170,000 t of wood waste contaminated with PCP will be disposed of and incinerated** in the EU in 2021, with amounts declining to below 100,000 t in 2027, below 25,000 t in 2029 and reaching 0 in 2032. As already indicated textile waste is expected to be irrelevant after 2022.

It is estimated all this material is already currently being incinerated and not recycled, and **there is no reason to promote any change in this**. Consequently adoption of the option considered is expected to have no impact on current practices, but will provide legal certainty and ensure that this practice is maintained now and in the future (and will allow the Commission to fulfill its legal obligation of setting a limit in Annex IV).

According to information received from relevant stakeholders, concentrations currently detected as impurities in (otherwise uncontaminated) wood chips that are recycled are consistently lower than Option 3; in fact, they are sufficiently low **to allow compliance with the recently adopted UTC of 5 mg/kg** (which applies to the final wood chips placed on the market as a products – e.g. as constituents of different forms of wood panel board). Therefore, evidence suggests that waste management operators would not incur additional costs associated with compliance or adjustments due to operations already reaching the limit value.

The **incineration of wood and textiles has of course its own impacts**, both in terms of CO_2 and pollutants emissions[178] and of impacts associated with the use of virgin materials instead of recycled materials. Similarly, preference for the use of secondary as opposed to primary wood materials can deliver **significant benefits in terms of global warming impacts** (10% reduction) and land use (Höglmeier et al, 2014).[179] However, Option 3 **does not result in a significant increase of wood or textile wastes diverted from recycling to incineration** and therefore no impact in this sense is expected with

[178] See for example Lin HC (2011): Combustion Emissions Analysis of Wood-Based Waste Processing-Materials. In: Mohamed Khallaf (Eds.), The Impact of Air Pollution on Health, Economy, Environment and Agricultural Sources. September 2011.

[179] Höglmeier et al (2014): Utilization of recovered wood in cascades versus utilization of primary wood—a comparison with life cycle assessment using system expansion, available at https://link.springer.com/article/10.1007/s11367-014-0774-6

regards to the current baseline. **Consequently, overall no negative impacts are expected**.

Although not quantifiable, the re-introduction of an Annex IV limit is expected to result in **human health and environmental benefits from avoided emissions and exposure via the environment**, that result from ensuring continuity of treatment practices which lead to the destruction of remaining wood (and textiles) contaminated with PCP by the year 2032.

6.8.4. Conclusion on preferred policy option

Based on the discussion above and taking into account that a political discussion on the limits agreed and adopted under Regulation (EU) 2019/636 took place only 2 years ago, there would seem to be no substantial reason to deviate from the **Option 3 Annex IV limit** value of 100 mg/kg. This is therefore the value proposed.

Although the limitation criterion diagram, (see Figure VI-11 in section 6.6.8 of Annex VI of this report) for PCP places economic feasibility and waste management capacity criteria at a level of 100 mg/kg proposed (and previously agreed under Regulation (EC) 850/2004) there are indications that the economic and waste management impact of further lowering towards the next lower limitation criterion would be small (given known relevant waste concerned would exceed the proposed value).

Consequently, according to the assessment made, it could be argued that **a lower limit would seem to be possible** (e.g. aligning to a **50 mg/kg limit** that is set in the POPs Regulation for waste contaminated with other POP organochlorine pesticides).

Similarly, the **previously agreed Annex V value of 1,000 mg/kg** results from the translation of the maximum concentration allowed in products under the (previous) REACH restriction which established a maximum limit of 0.1%. This value is lower than the orientation values obtained using the methodology proposed by BiPRO for Annex V values. Consequently no reason is seen to deviate from the value proposed and agreed in the year 2019.

6.9. Dicofol

6.9.1. What is it and why is it a problem?

Dicofol is a **pesticide** that was used in many countries worldwide as **to kill ticks and mites** on a variety of fruits, vegetables, ornamental and field crops. It belongs to the family of organochlorine pesticides and it is related to DDT.

Prolonged or repeated exposure to dicofol can cause skin irritation and hyperstimulation of nerve transmissions along nerve axons in humans. Dicofol is highly toxic to fish, aquatic invertebrates, algae and birds and is associated to eggshell thinning and reduced fertility.

Commercial use began in 1955 and according to UNEP it is estimated that 28,200 t of dicofol was used globally from 2000 - 2012, with **1,745 t used in Europe**. The same source however also reports that in Europe dicofol use was estimated to have decreased from 317 t to 32 t between 2000 and 2009. Dicofol cannot be used as a pesticide in the EU since March 2010 and its production in the EU, which occurred only in Spain, ceased sometime between 2006 and 2008. Prior to this Spain, Italy, Romania and France were the major EU users of this pesticide in agriculture.

Following from a proposal by the EU **the Conference of the Parties** to the Stockholm convention **decided to list Dicofol in Annex A "Elimination" of the Convention in 2019**. In August 2020 Dicofol was listed[180] in Annex I of the POP Regulation with no specific exemptions and no unintended trace contaminant limit.

6.9.2. Baseline

There have been no uses of dicofol in the EU for at least the last 10 years. Furthermore, as reported in Ramboll (2019) there is no evidence of remaining stockpiles of dicofol in the EU, with the expectation that all will have been already managed as waste or exported. In the consultation made for that study the European Crop Care Association (ECCA) stated that **16 of their 20 members confirmed that they did not hold any stockpile of products containing dicofol and no chemical waste containing dicofol**.

In the US dicofol is reported to have been used in the **treatment of non-agricultural outdoor buildings and structures** however there is **no evidence of this use in the EU**. It is possible that there may be **soil contaminated with dicofol, especially in former production sites**, which could become waste (eg as a result of excavation for remediation purposes). No information was however found about sites contaminated with dicofol in the EU.

6.9.3. Impacts of the policy options

Only **one policy option** was considered towards an Annex IV value for dicofol in the POPs Regulation. **A stringent value of 50 mg/kg is proposed**, in line with those adopted for other organochlorine pesticides already listed in Annex IV of the Regulation (such as endosulfan, chlordane, dieldrin or DDT).

One potential source of waste containing dicofol could result from the excavation of contaminated soil or the dredging of sediments. References to environmental concentrations reported in the risk profile for Dicofol[181] indicate maximum concentrations of 250 µg/kg (dry weight) in sediments found in California Central Valley. In a national survey in France, dicofol was not detected in any of 154 sediment sampling points. The very limited information on reported values in contaminated soil / sediment are well below the limit value proposed.

Given that no relevant waste streams containing dicofol have been identified in the EU it can be reasonably assumed that there will be **no or minimal impact** on any aspect related to the management of waste containing dicofol.

6.9.4. Conclusion on preferred policy option

Following the **methodology** outlined in Annex IV of this report, which results on a range of 3 – 200 mg/kg, Ramboll (2019) proposed an **Annex IV value for dicofol of 50 mg/kg**. This applies a precautionary approach, lowering the value well below the lowest of the upper limitation criteria (health based) and **aligned** with those already adopted for other **comparable organochlorine pesticides** listed in Annex IV in the EU POP Regulation. In this case the value proposed is not that of the highest lower limitation

[180] Commission Delegated Regulation (EU) 2020/1204. 18.08.2020. L270. p.4
[181] UNEP/POPS/POPRC.12/11/Add.1. October 2016.

criterion (3 mg/kg based on background contamination). This is for consistency reasons with the limit values adopted at EU (POPs Regulation) and at the international level (Basel POP Guidelines), on a limit value of 50 mg/kg for similar pesticides. See figure VI-12 and section 6.6.9 of Annex VI of this impact assessment report.

For similar reasons of alignment an **Annex V maximum POP content limit of 5,000 mg/kg** is proposed as preferred policy option for dicofol.

7. HOW DO THE OPTIONS COMPARE?

Table 10 – Comparison of Options

Substances	**Option 2**	**Option 3** **(**and Option 4 where applicable**)**

Substances	Option 2	Option 3 **(**and Option 4 where applicable**)**
PBDEs	WEEE and ELV plastic treatment unchanged. No waste diverted from recycling to disposal (incineration and landfill). No impact envisaged on other waste streams either. According to WEEE recyclers the change in limit values, only 2 years after they were changed in 2019 introduces uncertainty to recyclers which disincentivises investment in the recycling business. Stakeholders report adverse impacts on collection, transport and treatment of WEEE/ELV plastic waste due to classification of waste as hazardous associated to national / regional interpretation that exceeding Annex IV PBDE limit should result in the classification of waste as hazardous. It has not been possible to determine the extent of this possible impact. No change in the amount of PBDEs destroyed or in emissions of PBDEs from waste streams considered. No additional beneficial impact on human or environmental health compared to the baseline. No impact on CO_2 emissions.	In the period 2021-2035 it is estimated a total of 5,300 t of WEEE plastics and 28,200 t of ELV plastics will be diverted from recycling to incineration. This represents about 1% and 2%, respectively of WEEE and ELV plastic recycled in the EU in 2020. This figure is reduced to 14,400 t of ELV plastic waste only, as a total for the period 2027-2035, if the measure is delayed to 2027. Overall 83,200 t of WEEE and ELV plastic diverted to incineration in the EU from recycling and landfilling over 2021-2035. If the measure is delayed to 2027 the amount of waste diverted to incineration is reduced to a total of 38,900 t for 2027-2035. No capacity problem to absorb this waste, in either scenario, is expected. In the preferred option (delay to 2027): **7 M€ in additional waste incineration costs** would be incurred by **recyclers** (2,5 M€ for material previously recycled + 4 M€ for material previously sent to non-hazardous waste landfill). In addition recyclers lose in this period 4 M€ (3,9) of revenue from the sale of recycled material (which can no longer be recycled). In addition recyclers are estimated to invest in total 3 – 6 M€ in equipment in the period 2027-2035 (likely in 2027 or earlier). **Landfill operators**: 3 M€ revenue loss. **Users of secondary plastics**: Increased cost of **6 M€** (2027 – 2035) to substitute recycled plastic with primary plastic. Cost spread over many companies so impact potentially small. All costs are total for the whole **period 2027-2035**. Only limited impacts on plastic C&D waste and on textiles is expected (where current situation is of very low recycling rates). Quantitative estimation not possible. According to WEEE recyclers the change in limit values, only 2 years after they were changed in 2019 introduces uncertainty to recyclers which disincentivises investment in the recycling business. This perception may be even stronger in this case given the limit value is stricter and, according to recyclers, very challenging to achieve. Stakeholders report adverse impacts on collection, transport and treatment of WEEE/ELV plastic waste due to classification of waste as hazardous associated to national / regional interpretation that exceeding Annex IV PBDE limit should result in the classification of waste as hazardous. It has not been possible to determine the extent of this possible impact. Between 22 and 280 t of listed PBDEs contained in waste are destroyed if option 3 is implemented immediately. This amount is reduced to 10 – 180 t if implementation is delayed to 2027. Reduction in exposure of the general population and workers to PBDEs, associated to reduced emissions (given a larger fraction of PBDEs in waste are destroyed). Environmental emissions avoided due to service-life in the next lifecycle of the (avoided) recyclate would be of between **25 kg and 310 kg** of PBDE. If implementation of the preferred option is delayed to 2027, the releases of PBDEs avoided are estimated to be of between **10 and 150 kg PBDEs.** Additional CO_2 emissions of about **167,000 t** over the period 2021-2035 if measure implemented immediately. If implementation is posponed to 2027 the increase in CO_2 emissions is estimatyed to be limited to **about 74,000 t** over period 2027-2035 Unquantified potential increased emissions of polybrominated dibenzo-p-dioxins and dibenzofurans (PBDDs/PBDFs) due to increased incineration. Adverse impact on health probably small.

Substances	Option 2	Option 3 (and Option 4 where applicable)
HBCDD	0,2% of all C&D waste generated in the EU (about 320 Mt/yr) would exceed the limit. This mixed demolition waste contaminated with EPS/XPS with HBCDD would be about 640,000 t / year. The additional costs to waste generators / demolition companies resulting from diverting from non hazardous waste landfill to a hazardous waste landfill would be around **135 M€ / year.** This is based on an additional landfill cost of 210 €/ton; cost of hazardous waste landfill: 260 €/t. Cost of non-hazardous waste landfill: 50 €/ton. **Uncertainty in the amount of mixed demolition waste concerned is very high.** Additional testing costs for generators of demolition waste and recyclers. Cannot be quantified. Possible need for investment in hand-held XRF analysers – 30,000 € per device.	Possible additional cost for construction / demolition companies in excess of **675 M€ per year** resulting from diversion of **3.2 Mt** mixed C&D waste from recycling and non-hazardous waste landfill to hazardous waste landfill (same assumptions as for Option 2). Uncertainty in the figure is very high. Additional testing costs for generators of demolition waste and recyclers. Cannot be quantified. Possible need for investment in hand-held XRF analysers – 30,000 € per device.

Substances	**Option 2**	**Option 3** **(**and Option 4 where applicable**)**
PCDD/Fs (dioxins and furans)	<u>Option 2 – 0.010 mg/kg</u> 36,000-72,000 t of ashes from domestic burning of wood and coal can no loger be used in agriculture and overall 181,000- 361,000 t are diverted to hazardous waste landfill or underground storage. Additional landfill costs: **40 – 79 M€/yr** Substitution costs for ashes (agriculture, construction) – **0.43 – 0.86 M€/yr** Additional testing costs to producers of MSWI fly ash, biomass ashes and of sewage, biowaste and greenwaste compost. Cost per test of about 410 €. Testing cost impacts per sector could not be quantified.	**<u>Option 3 - 0.005 mg/kg</u>** 36,000-145,000 t of **ash from domestic burning of wood and coal** can no loger be used in agriculture and overall 181,000-723,000 t are diverted to hazardous waste landfill or underground storage. Additional landfill costs: **40 – 159 M€/yr** 8,000 – 33,000 t of **biomass power production fly ash** cannot be used in agriculture, construction or geotechnical applications. 27,000 – 110,000 t diverted to hazardous landfill or underground storage, with additional landfill costs of **6 – 24,8 M€/yr** Total Option 3 landfill costs – 46 **– 184 M€/yr.** Extra costs for substituting ashes with primary materials: **0.5 – 2 M€** borne by operators in agriculture and construction. **<u>Option 3 + specific limit for land application (0.001 mg/kg)</u>** 36,000-181,000 t of **ash from domestic burning of wood and coal** can no loger be used in agriculture and overall 181,000-903,000 t are diverted to non-hazardous and hazardous waste landfill or to underground storage, with extra costs of **40 – 168 M€/yr**. 8,000 – 41,000 t of **biomass power production fly ash** cannot be used in agriculture, construction or geotechnical applications 27,000 – 110,000 t are diverted to hazardous landfill or underground storage + 8,000 to non-hazardous landfill. Extra landfill costs of **6 – 25 M€/yr**. 26,000-128,000 t of municipal solid waste incineration fly ash, and filter dust **cannot be used in construction**. 26,000-128,000 t are diverted to hazardous and non-hazardous landfill or underground storage, with extra costs of **6.2 – 30,6 M€/yr.** Total Option 3+land additional landfill costs: **52 – 224 M€/yr** **<u>Option 4 – general limit of 0.001 mg/kg</u>** Same as Option 3+ but biomass ash landfilling costs increased to **6 – 30,8 M€/yr** due to additional HW landfill costs. Total Option 4 additional landfill costs: **52,6 – 263 M€/yr.**

Substances	Option 2	**Option 3** **(**and Option 4 where applicable**)**
PCDD/Fs (dioxins and furans) (continued)		**Option 4 + specific limit for land application (0.00005 mg/kg)** 72,000-361,000 t of ashes from **domestic burning of wood and coal** can no loger be used in agriculture and overall 181,000-903,000 t are diverted to hazardous waste landfill or to underground storage. In addition 36,000-181,000 t diverted to non-hazardous landfill. Extra landfill costs of **41,6 -208 M€/yr.** 16,000 - 82,000 t of **biomass power production fly ash** cannot be used in agriculture, construction or geotechnical applications. 27,000 – 137,000 t are diverted to hazardous landfill or underground storage. 8,000 – 41,000 t are diverted to non-hazardous landfill. Extra landfill costs of **6,5 – 33 M€/yr.** 51,000-256,000 t of **municipal solid waste incineration fly ash**, and filter dust cannot be used in construction. Another 51,000 – 256,000 t t are diverted to non-hazardous landfill, hazardous landfill or underground storage. Extra landfill costs of **12,2 – 61,2 M€/yr.** 12,000,000 - 60,000,000 t of **agricultural digestate** cannot be used in agriculture or horticulture /domestic fertiliser and have to be disposed of to non-hazardous waste landfill. Extra landfill costs of **600 – 3,000 M€/yr.** Between 23,246,000 - 116,230,000 t of **mineral C&D waste** cannot be used in geotechnical applications or recycled and is diverted to non-hazardous waste landfill. Extra landfill costs of **1,162 - 5,811/yr M€**. Between 1,481,000 - 7,405,000 t of **municipal solid waste incineration bottom ash** cannot be used in construction and is diverted to non-hazardous waste landfill. Extra landfill costs of **74 - 370 M€/yr.** Total landfill costs of Option 4+land: **1,897 – 9,484 M€/yr** Likely capacity problems for non-hazardous waste landfills to absorb up to 183 Mt/year. This would represent a **23% increase in non-hazardous waste landfill disposal** as compared to amounts disposed in EU-27 in 2018. Under this option significasnt CO_2e would be generated (not avoided) due to the use of primary material to substitute previously recycled material that woud be diverted to landfill. Up to **76 Mt CO_2e** /yr are the estimated impact.

Substances	Option 2	**Option 3** **(**and Option 4 where applicable**)**
Dioxin-like PCBs	The choice between Option 2 (stand alone limit for dlPCBs) and Option 3 (aggregated limit with PCDD/Fs) has little practical impact. However impacts of the preferred policy option (Option 3) should be seen together with the options, definining the specific aggregated limits, discussed for PCDD/Fs.	Impacts of this option should be seen together with Option 3 impacts for PCDD/Fs, given it is proposed to integrate dl-PCBs in the limit for PCDD/Fs. In addition to the impacts described above in the section for PCDD/Fs, the integration of dl-PCBs into this limit under Option 3 (0.005 mg/kg) would have the following impacts: some additional testing costs for waste oil recyclers. If more stringent values for the sum of PCDD/Fs and dl-PCBs were adopted there would be additional impacts on producers of MSW incinerator bottom ash and fly-ash (10% and 2% diversion of material to landfill, respectively). This would represent additional maximum costs of about 1.2 M€/year for fly ash producers and of between 7,4 – 37 M€ for bottom ash for Option 4+land. Under this scenario additional substitution costs would be incurred by users in construction using bottom ashes, of between 0.6 and 3.3 M€. Possible diversion of waste oils from regeneration and significant disruption of supply to the recycling process if Option 4 limit value (0.001 mg TEQ/kg) for sum of PCDD+dl-PCB is chosen. Quantification not possible – based on limited analytical information and claims by GEIR.

Substances	**Option 2**	**Option 3** **(**and Option 4 where applicable**)**
Short-chain chlorinated paraffins (SCCPs)	**7,000 t – 70,000 t** of rubber from conveyor belts from mining are diverted from recycling to incineration over period 2021 - 2035. Extra waste management costs of **1.7 – 16.2 M€** for recyclers dealing with rubber from conveyor belts used in mining, which can no longer be recycled. The low estimate is based on a scenario where only SCCP-contaminated rubber from mining conveyor belts is disposed of by incineration. The high estimate results from **assuming that no sorting** is possible and all mining conveyor belt rubber will be incinerated. **Testing costs** for SCCPs in waste. 200 – 300 € per sample sent to the laboratory. Yearly testing costs could not be reliably estimated and will depend on sampling and testing regime. Not being able to sell the recyclate corresponding to the diverted rubber would also lead to a **loss in revenue for recyclers of 1.3 – 12.4 M€ in** (based on 200€/tonne estimated average market price of rubber recyclate). Users of secondary rubber, having to substitue with primary rubber would incur in additional estimated average costs of 500 €/t, resulting in increased costs of €2.3-26 million over 2021-35. Total **CO_2eq emissions not avoided** due to diversion of material from recycling to incineration: **6,738 – 67,830 t** in total over the period 2021-2035.	**8,000 t – 100,000 t** of rubber from conveyor belts from mining are diverted from recycling to incineration over period 2021 - 2035. Extra waste management costs of **1.8 – 21.8 M€** for recyclers dealing with rubber from conveyor belts used in mining, which can lo longer be recycled. **Loss in revenue** for recyclers due to diversion of material to incineration would be of **1.4 – 16.8 M€** over that period. Users of secondary rubber, having to substitue with primary rubber would incur in additional estimated average costs of 500 €/t, resulting in increased costs of €2.5-37 million over 2021-35.**Testing costs** for SCCPs in waste. 200 – 300 € per sample sent to the laboratory. Yearly testing costs could not be reliably estimated and will depend on sampling and testing regime. Greater risk that materials containing MCCPs (eg other rubber goods) will exceed limit in Annex IV (even if still meeting Annex I limit which allows placing on the market) and have to be incinerated. Total **CO_2e emissions not avoided** due to diversion of material from recycling to incineration: **7,752 – 96,900 t** over 2021-2035.

Substances	Option 2	Option 3 (and Option 4 where applicable)
PFOA, its salts and related compounds	Impacts unknown and probably unlikely.	Some impacts expected on some textile waste. Especially as regards textile waste from furniture, professional clothing and carpets. Although currently textile recycling is very limited some diversion from recycling to disposal via landfilling or incineration is possible. Increased testing costs for textile recyclers and textile waste producers, of the order of hundreds of thousands to low millions of euro (for the whole sector). Impacts on WEEE/ELV recyclers due to testing costs unlikely but cannot be ruled out. High level of uncertainty in all estimates due to lack of analytical data on waste. It has not been possible to derive any quantitative estimates of waste diversion or costs. These impacts would be reduced if the preferred alternative **Option 3bis** was put in place instead of Option 3. However necessity for testing and some testing costs would still exist. It is expected that the risk of impacts on textile recycling both now and in the future, would be smaller.
PFHxS, its salts and related compounds	Same assessment as for PFOA, its salts and related compounds.	Same assessment as for PFOA, its salts and related compounds as PFHxS, its salts and PFHxS-related compounds are likely to be found in the same waste streams.
Pentachlorophenol (PCP)	-	About 170,000 t of wood waste contaminated with PCP are estimated to be disposed of and incinerated in the EU in 2021, with amounts declining to below 100,000 in 2027, below 25,000 in 2029 and reaching 0 in 2032. Textile waste is expected to be irrelevant after 2022. No impacts are expected given that (re)introduction of the value in Annex IV will only re-enforce and maintain current practices under the baseline.
Dicofol	No relevant waste streams containing dicofol have been identified in the EU. Consequently no impacts are expected.	No relevant waste streams containing dicofol have been identified in the EU. Consequently no significant impacts are expected.

8. PREFERRED OPTION

8.1. Summary of preferred options (for all substances)

The options presented refer to different options for setting the Annex IV (low POP concentration limit) values for the substances in scope of the proposed measure.

Table 11: Preferred option for Annex IV limits

Substance	Option 1 Baseline	Option 2	Option 3	Option 4
PBDEs	1,000 mg/kg	500 mg/kg	Initial implementation of **500 mg/kg** followed by **reduction to 200 mg/kg**[182] **5 years after entry into application** of initial limit.	N/A (not applicable)
HBCDD	1,000 mg/kg	500 mg/kg	100 mg/kg	N/A
PCDD/Fs (dioxins and furans)[183]	0.015 mg TEQ/kg	0.010 mg TEQ/kg	0.005 mg TEQ/kg	0.001 mg TEQ/ kg
Dioxin-like PCBs[184]	No specific consideration of dl-PCBs. Included in existing total PCB limit of 50 mg/kg	Definition of a specific stand-alone limit for dl-PCBs	Inclusion of dl-PCBs into the limit for PCDD/Fs (under PCDD/Fs Option 3 – 0.005 mg TEQ/kg)	N/A
Short-chain chlorinated paraffins (SCCPs)	10,000 mg/kg	1,500 mg/kg	420 mg/kg	N/A
PFOA, its salts and related compounds	No limits exist	50 mg/kg (PFOA & salts) 2,000 mg/kg (PFOA-related compounds)	**1 mg/kg for PFOA and salts and 40 mg/kg for PFOA related compounds** [Note: The above value is proposed instead of the intially considered Option 3: 0.025 mg/kg (PFOA & salts) 1 mg/kg (PFOA-related compounds)]	N/A

182 Or the value for the sum of listed PBDEs in Annex I, for mixtures or articles, if this is higher at that time.
183 Sub-options of 3 and 4 to include an additional specific lower value for waste applied on land have been considered and not retained due to disproportionate impact and considerations regarding the appropriateness of the instrument (addressing via other dedicated legislation seems more appropriate). See section 5.2. of this report.
184 Options 2 and 3 do not represent numerical values but different approaches to setting a limit for dl-PCBs.

Substance	Option 1 Baseline	Option 2	Option 3	Option 4
PFHxS, its salts and related compounds	No limits exist	50 mg/kg (PFHxS & salts) 2,000 mg/kg (PFHxS-related compounds)	**1 mg/kg for PFHxS and salts and 40 mg/kg for PFHxS related compounds** [Note: The above value is proposed instead of the initially considered Option 3: 0.025 mg/kg (PFHxS & salts) 1 mg/kg (PFHxS-related compounds]	N/A
Pentachlorophenol (PCP) its salts and esters	No limit exists	N/A	100 mg/kg	N/A
Dicofol	No limit exists	N/A	50 mg/Kg	N/A

Legend: Preferred option is shaded

As indicated elsewhere in this report the preferred policy options are proposed supported by the methodology described in section 5.2 and in Annex IV of this report and taking into account the general objectives of protection of human / environmental health (as overarching objective), increased recycling / uptake of secondary raw materials and contribution to greenhouse gas emissions reduction (in support of the EU's climatic objectives). The table below presents a **qualitative assessment** of how the preferred policy option for each substance compares with the other options considered to be proposed for Annex IV limit values, in terms of the three mentioned objectives.

A situation of no change as compared to the baseline is described by (0). A positive effect on each objective is indicated by (+) and a negative effect by (-). A limited or unclear effect is defined by (+/-).

<u>Scoring of options with regards to objectives of the measure:</u>

PBDEs	Option 1 (baseline) 1,000 mg/Kg	Option 2 500 mg/Kg	Option 3 200 mg/Kg
Transition to high-quality, clean ("toxic-free") material cycles – minimisation of human health / environmental impacts.	0	+/-	++ (1) + (2)
Increase recycling and circularity	0	0	--(1) - (2)
Reduced GHG emissions	0	0	--(1) - (2)

(1) Limit of 200 mg/Kg applies upon adoption; (2) initially, a limit of 500 mg/kg applies, followed by the limit of 200 mg/kg that applies 5 years after adoption.

HBCDD	Option 1 (baseline) 1,000 mg/Kg	Option 2 500 mg/Kg	Option 3 100 mg/Kg
Transition to high-quality, clean ("toxic-free") material cycles – minimisation of human health / environmental impacts.	0	+	++
Increase recycling and circularity	0	-	--
Reduced GHG emissions	0	-	--

PCDD/Fs (dioxins and furans) + dl-PCBs	Option 1 (baseline) 0.015 mg TEQ/Kg	Option 2 0.010 mg TEQ/Kg	Option 3 0.005 mgTEQ/Kg	Option 4 0.001 mgTEQ/Kg
Transition to high-quality, clean ("toxic-free") material cycles – minimisation of human health / environmental impacts.	0	+	++ ++ (1)	++ +++ (2)
Increase recycling and circularity	0	-/+	- -- (1)	-- --- (2)
Reduced GHG emissions	0	-/+	- -- (1)	-- --- (2)

(1) In addition a specific limit of 0.001 mg TEQ/Kg would apply for application of waste on land; (2) in addition a limit of 0.000050 mg TEQ/Kg would apply for application of waste on land.

Dioxin-like PCBs (see together with options for PCDD/Fs)	Option 1 (baseline) Only general limit of 50 mg/kg applies to all PCBs. No specific consideration for dl-PCBs.	Option 2 In addition, a new stand-alone limit is introduced for dl-PCBs.	Option 3 In addition, dl-PCBs are included into the limit for PCDD/Fs.
Transition to high-quality, clean ("toxic-free") material cycles – minimisation of human health / environmental impacts.	0	++	++
Increase recycling and circularity	0	-	0/-
Reduced GHG emissions	0	0/-	0/-

Short-chain chlorinated paraffins (SCCPs)	Option 1 (baseline) 10,000 mg/Kg	Option 2 1,500 mg/Kg	Option 3 420 mg/Kg
Transition to high-quality, clean ("toxic-free") material cycles – minimisation of human health / environmental impacts.	0	+	++?
Increase recycling and circularity	0	-	-
Reduced GHG emissions	0	-	-

PFOA, its salts / related compounds	Option 1 (baseline)	Option 2 50 / 2,000 mg/Kg	Option 3 0.025 / 1 mg/Kg
Transition to high-quality, clean ("toxic-free") material cycles – minimisation of human health / environmental impacts.	N/A	0/+	++? + (1)
Increase recycling and circularity	N/A	0	--? -? (1)
Reduced GHG emissions	N/A	0	-? 0/-? (1)

(1) A modified Option 3 is proposed (1 mg/kg / 40 mg/Kg) as an intermediate value between the originally considered Options 2 and 3. The assessment of this group of substances is highly uncertain due to lack of maturity of the textile recycling sector and lack of information about concentrations of these substances in waste.

PFHxS, its salts / related compounds	Option 1 (baseline)	Option 2 50 / 2,000 mg/Kg	Option 3 0.025 / 1 mg/Kg
Transition to high-quality, clean ("toxic-free") material cycles – minimisation of human health / environmental impacts.	N/A	0/+	++? + (1)
Increase recycling and circularity	N/A	0	--? -? (1)
Reduced GHG emissions	N/A	0	-? 0/-? (1)

(1) A modified Option 3 is proposed (1 mg/kg / 40 mg/Kg) as an intermediate value between the originally considered Options 2 and 3. The assessment of this group of substances is highly uncertain due to lack of maturity of the textile recycling sector and lack of information about concentrations of these substances in waste.

Pentachlorophenol (PCP) its salts and esters	Option 1 (baseline)	Option 2	Option 3 100 mg/Kg
Transition to high-quality, clean ("toxic-free") material cycles – minimisation of human health / environmental impacts.	N/A	N/A	++
Increase recycling and circularity	N/A	N/A	+/-
Reduced GHG emissions	N/A	N/A	0

Dicofol	Option 1 (baseline)	Option 2	Option 3 50 mg/Kg
Transition to high-quality, clean ("toxic-free") material cycles – minimisation of human health / environmental impacts.	N/A	N/A	+
Increase recycling and circularity	N/A	N/A	0
Reduced GHG emissions	N/A	N/A	0

As regards **Annex V** values, an analysis of options has not been performed given that, based on the methodology described in Annex IV and further analysed in Ramboll (2019) for the relevant substances, only one value seems applicable for each. The proposed values are roughly consistent with the methodology for Annex V values described on Annex IV of this report and are ultimately based on **existing agreed Annex V values for similar substances**. Given the very limited application of Annex V limit values, further assessment is not considered proportionate or justified. A summary of the values proposed is presented in the table below.

Measures (substances)	Value	Observations
PBDEs	10,000 mg/Kg	Aligned with existing value for listed PBDEs in the POP Regulation. It is proposed that decaBDE is included in the list of PBDEs covered by the existing limit for PBDEs mentioned part B of Annex V of the Regulation.
PFOA, its salts and related compounds	50 mg/kg for PFOA & salts 2,000 mg/kg for PFOA-related substances	Value for PFOA and its salts aligned with existing value for a similar substance, PFOS. Value for PFOA related compounds based on accepted ratio PFOA/ PFOA-related substances derived in REACH restriction and subsequently taken up for UTC in Annex I of the POP Regulations.
PFHxS, its salts and related compounds	50 mg/kg for PFHxS & salts 2,000 mg/kg for PFHxS-related substances	Value for PFHxS and its salts aligned with existing value for a similar substance, PFOS and PFOA. Value for PFHxS-related substances based on accepted ratio PFHxS/ PFHxS-related substances derived in REACH restriction proposal and applied in the POPs Regulation.
Pentachlorophenol (PCP)	1,000 mg/kg	Value agreed and previously adopted under Regulation (EU) 2019/636.
Dicofol	5,000 mg/kg	Aligned with values in Annex V for comparable organochlorne pesticides such as DDT, endosulfan, dieldrin, etc.

Table 12: Preferred option for AnnexV limit values

8.2. Regulatory burden and simplification

An overview of the costs and benefits associated to the preferred policy options, to the extent they could be estimated, is provided in Annex III to this impact assessment. The different cost elements estimated refer mostly to a) loss of revenue due to sale of recovered materials b) additional waste management costs c) investment costs in equipment and d) additional costs due to substituting secondary raw material with virgin material. These are spread over a wide variety of actors, belonging to different sectors and therefore, aggregated figures provide only limited information as an estimate of impacts. With waste management companies operating in Europe undergoing significant concentration, due to a recent number of mergers and acquisitions[185] [186] [187] it could be envisaged that the economic impacts of the measure, many of which are distributional, can, overall, be accommodated.

A summary of the different cumulative impacts, to the extent it had been possible to estimate them is provided in Tables 14 – 17, further below.

[185] https://www.veolia.com/en/our-media/newsroom/press-releases/veolia-and-suez-announce-they-have-reached-agreement-allowing
[186] https://www.livingstonepartners.com/en-us/insights/51221/
[187] https://scholars.direct/Articles/environmental-studies/aes-3-022.php?jid=environmental-studies

If focus is placed on individual substances and main sectors affected, for PBDEs, overall yearly costs estimated on a maximum of 30 specialised WEEE/ELV **plastics recyclers** over the period 2027-2035 is estimated to be of a maximum of 1.1 M€ / year (total for all companies), plus additional one-off investment costs of 400 k€ - 800k€ per company, to be incurred by about half the companies concerned (to improve sorting / treatment). Many of the costs are **distributional** (i.e. result in increases in revenue by other operators, such as operators of waste incineration plants).

Higher additional waste disposal costs, of the order of 40 - 159 M€/yr (in the particular case of domestic burning soot and ashes, the lower-end estimate of 40 M€ is considered the most likely approximation) are estimated for municipalities having to separately collect and manage ashes from domestic fuel burning (mostly coal and wood), as a **consequence of revised PCDD/F** values. According to Eurostat[188], the annual expenditure of the institutional sector (government) in waste management services in the EU27, in the year 2019, was of 11,953 M€. The estimated additional waste management cost estimated represents approximately 0.33% of these costs.

For the proposed **HBCDD limit**, the estimated (highly uncertain) costs to demolition companies, and indirectly to their contractors, is estimated to amount up to 135 M€/yr in terms of waste management / landfill costs. According to RPA(2021) this could impact on average some 2,000 specialised demolition companies, which coincides with the number of member companies mentioned in the web of the European Demolition Association, leading to an average cost of approximately 68,000 €/company. The annual detailed enterprise statistics for construction (NACE Rev2 F) refer to a total of 24,000[189] companies engaged in demolition activities (F4311) with an annual turnover 10,250 M€ in 2018.

Table 13: Regulatory burden and simplification

Measures (substances)	Observations
PBDEs	A limit value for PBDEs already exists for waste. The tightening of these values may increase the amount and frequency of testing and bring about enhanced monitoring and enforcement by authorities. There is an unconfirmed risk of additional burden associated to national / regional implementations of rules on hazardous waste, and of waste shipment, which are not directly the result of this measure.
HBCDD	Potential, but highly uncertain impacts on disposal of mixed C&D waste. Contacts maintained with the European Aggregates Association (UEPG) indicate that impacts on recycled aggregate are unlikely due to strict input control and processing and limits for “lightweight contaminants” in the applicable European Standards.
PCDD/Fs (dioxins and furans)	A limit value for PCDD/Fs already exists for waste, consequently a new obligation, for instance in terms of testing are not introduced. The proposed tightening of limits may however require stepping-up testing for some waste strems where the risk of exceeding limits would be increased.

[188] Final consumption expenditure on environmental protection services by institutional sector. ENV_AC_CEPSGH
[189] Probably most micro or small enterprises.

Measures (substances)	Observations
Dioxin-like PCBs	Introducing a limit for dl-PCBs under the group limit for PCDD/Fs represents a simplification compared to creating a new, stand-alone limit for dl-PCBs. In most cases the same analysis already done for PCDD/Fs can be used to determine dl-PCBs, with little additional cost.
Short-chain chlorinated paraffins (SCCPs)	Limited impact and regulatory burden expected given measure will only affect recycling a very specific waste stream (rubber from conveyor belts used in mining).
PFOA, its salts and realted compounds	Limited impact is expected, associated to testing to be carried out and enforcement taks by Member States. Such impacts are unavoidably associated to setting any limit value that requires to be controlled.
PFHxS, its salts and related compounds	Same assessment as for PFOA, its salts and related compounds.
Pentachlorophenol (PCP)	No regulatory burden expected.
Dicofol	No relevant waste streams containing dicofol have been identified in the EU although presence in contaminated soil / sediments cannot be excluded. Consequently no or very limited regulatory burden expected.

Table 14: Cumulative costs of preferred policy option (including loss of revenue from recycling)

Substance	Net (additional) costs (annual average)	Total costs (annual average)
PBDEs	For period 2027-2035: Recyclers: **1.7 M€** (difference between landfill and incineration costs) and **6 M€** equipment investment costs. **Total net costs**: **7.7 M€.** Other costs are **distributional**, i.e. losses incurred by landfill operators are gains to incineration operators; losses of revenue of recyclers and additional costs to plastic converters are increased revenues to primary plastic producers. Annual average: **0.9 M€**	All costs are for years 2027 – 2035 (when implementation starts) **Landfill operators**: **3 M€** revenue loss in fees **Recyclers**: Total **10.5 M€**; 4 M€ revenue loss due to material no longer recycled; 2.5 M€ total incineration costs of this non-recyclable plastic and 4 M€ total incineration costs of material previously sent to landfill (net cost = 1.7 M€, i.e. difference between landfilling and incineration cost estimate – see left column). Additional maximum investment costs in equipment estimated **6 M€.** **Annual average : 2.2 M€** (including equipment)
HBCDD	Net additional cost to waste construction / demolition operators: **135 M€ / yr** (difference between non-hazardous landfill disposal (50 €/t) and hazardous waste disposal).	Hazardous landfill disposal costs for contaminated mixed demolition waste. Total cost / yr: **166 M€ (260 €/t).** The transfer of 31 M€ from non-hazardous waste landfill operators to a hazardous waste landfill operator is a distributional cost (which may happen even happen within the same waste operator).
PCDD/Fs (dioxins and furans)	**40 M€** - extra cost* of disposing domestic ashes / soot in hazardous waste landfill (as compared to 80% non-haz landfill / 20% agriculture) **15,5 M€** - extra cost of disposing biomass ashes in Hazardous waste	47 M€ - disposal domestic ashes / soot in hazardous waste landfill. 18 M€ -disposal biomass ashes in hazardous waste landfill

	landfill (as compared to 70% non-haz landfill and 30% agriculture / construction / geotechnical).	
Dioxin-like PCBs	None could be estimated. Some possible increase in testing costs for waste oil recyclers.	-
Short-chain chlorinated paraffins (SCCPs)#	**0.6 M€** - net cost to recyclers in additional waste management All other costs are **distributional:** Loss in revenue for rubber recyclers is compensated by recycled rubber from other sources or from primary rubber.	0.6 M€ - extra cost for waste producers /recyclers sending rubber to incineration (based in incineration cost of 260 €/t). 0.6 M€ - loss in revenue for recyclers (loss in sales of recycled rubber)
PFOA, its salts and related compounds	Cannot be quantified. Presumably low given current low textile recycling.	Cannot be quantified. Presumably low given current low textile recycling.
PFHxS, its salts and related compounds	Cannot be quantified. Presumably low given current low textile recycling.	Cannot be quantified. Presumably low given current low textile recycling.
Pentachlorophenol (PCP)	None / very limited	None / very limited
Dicofol	None / very limited	None / very limited
TOTAL / yr	**192 M€**	**234 M€**

*: Details on cost estimations for the different disposal options can be found in Table 7.20 of RPA (2021).

#: Costs quoted are annual average costs. Annual maximum cost modelled are provided in table 4.20 of RPA (2021).

All costs provided above are estimated annual average costs. When costs have been estimated as a range in the supporting study by RPA (2021), the average of the lower and upper values of the range have been used in this table. As an exception, the estimate provided for domestic burning ashes and soot contaminated with PCDD/Fs, is that of the lower-end of the range estimated, as explained in section 6.3.4.

Table 15: Cumulative impact of preferred option on recycling and on waste disposal capacities (tonnes / year)

Substance	Recycling (t/y)	Incineration (t/y)	Hazardous waste landfill (t/y)	Non-hazardous waste landfill (t/y)
PBDEs#	**-2,300** (-14,400)	+ 4,322 (+38,900)	- 2,711 (-24,400)	
HBCDD*	-	-	+ 640,000	-640,000
PCDD/Fs (dioxins and furans)@	-36,000 (domestic ashes/ soot) -24,000 (biomass ashes)	-	+ 181,000 (domestic ashes / soot) +68,500 (biomass ashes)	-181,000 (domestic ashes / soot) -68,500 (biomass)
Dioxin-like PCBs	None or very limited	None or very limited	-	-
Short-chain chlorinated paraffins (SCCPs)	**-2,600** (-38,500 t+)	+ 2,600	-	-
PFOA, its salts and related compounds	Cannot be quantified. Presumably low.	Cannot be quantified. Presumably low.	Cannot be quantified, presumably low.	Cannot be quantified. Presumably low.
PFHxS, its salts and related compounds	Cannot be quantified. Presumably low.	Cannot be quantified. Presumably low.	Cannot be quantified, presumably low.	Cannot be quantified. Presumably low.
Pentachlorophenol (PCP)	None / very limited	None / very limited	None / very limited	None / very limited
Dicofol	None / very limited	None / very limited	None / very limited	None / very limited
TOTAL t/yr	**-64,900**	**+ 6,922**	**+ 889,000**	**-889,000**

#: For PBDEs the figure in brackets is the accumulated tonnage for the period (2027-2035) which is the period in which the preferred policy option would have some impact. The yearly figure provided as an estimation of the amount of material diverted from recycling is the maximum amount modelled per year (which decreases over time).

*: Although it cannot be ruled out that some aggregate recycling could be affected, it is considered that the most likely diversion would be from non-hazardous waste landfill to hazardous waste landfill.

@: Tonnage and costs figures provided in section 6.3.3 and in Annex III of this report provide a lower and an upper estimate. For the purposes of this table the lower value of the range is used as best estimate of the amounts of domestic burning ashes and soot diverted to the different treatments, for reasons detailed in section 6.3.4 of this report.

+: Value quoted for SCCP rubber from conveyor belts if the yearly average, based on the mean of the low and high scenarios and represents a situation where 50% of SCCP rubber from mining conveyor belts would be segregated from rubber from other conveyor belts. The value in brackets is the estimated accumulated amount from 2021 – 2035 (15 years).

Considerations about treatment capacity:

In 2018, EU-27 Member States landfilled **806 Mt non-hazardous waste** and **27.2 Mt hazardous waste**. Increasing the total amount of hazardous waste landfilled by 0.9 **Mt (+3.3%) seems to be possible** without significant difficulty (in Ramboll 2019, a 5% maximum increase in waste sent to thermal treatment was proposed as acceptable, this could also apply to landfill). It should also be noted that figures for HBCDD and PCDD/Fs containing waste directed to hazardous waste landfill are highly uncertain and could be overestimates of the true amount. As regards capacities to admit waste diverted to non-hazardous waste landfill (relevant for some of the options considered for PCDD/F limits) information on remaining capacity of landfills in Europe is not available. According to an EEA 2009[190] "*information on the actual landfill capacity is not available but it seems fair to conclude that capacity has decreased. Despite this, data on current waste generation and landfill rates for municipal waste indicate that the remaining capacity at landfills is sufficient for many years to come*". Nonetheless it would seem that, in view of amounts of non-hazardous waste still landfilled in the EU every year, and considering the provisions in Article 5 of the Landfill Directive (as amended in 2018) to reduce the amounts of waste diverted to landfills (e.g. target to reduce by 2035 the amount of municipal waste landfilled to 10 % or less of the total amount of municipal waste generated), landfill capacity for non-hazardous waste does not appear to be an issue. This would not be the case for the most stringent option considered for dioxins and furans (see section 6.3.3).

Estimated non-hazardous waste incineration capacity in the EU is of about **100 Mt / year** (including MSWI and co-incineration). Sources reviewed by Ramboll (2019) indicate an excess capacity of about 12 Mt/year[191] but this value could be considerably lower according to the Confederation of European Waste-to-Energy Plants (CEWEP), which estimated a capacity gap of 42 Mt for MSW and commercial waste incineration in 2035.

[190] EEA Report No 7/2009. Diverting waste from landfill. https://www.eea.europa.eu/publications/diverting-waste-from-landfill-effectiveness-of-waste-management-policies-in-the-european-union

[191] The mixed municipal waste incineration capacity in the EU was 76,75 Mt in 2014 (Wilts et al, 2017 - https://www.eionet.europa.eu/etcs/etc-wmge/products/etc-reports/assessment-of-waste-incineration-capacity-and-waste-shipments-in-europe). In the same year 64,22 Mt of mixed municipal waste have been incinerated or energetically recovered in the EU [Eurostat 2018h], meaning a remaining capacity of 12 Mt (16%). Thus, for the derivation of a proposed limit value, an additional increase of up to 5% of the currently required capacities of the relevant thermal waste treatment sites is considered justifiable.

Estimated **hazardous waste incineration** capacity in the EU is smaller, of between **4.5 – 5 Mt/yr**, according to estimates of Hazardous Waste Europe. An increase in hazardous waste incineration of about **7,000 t/year (+ 0.15%)** should be easily accommodated by hazardous waste incineration operators in the EU (as also confirmed by Hazardous Waste Europe, personal communication).

Consequently the proposed preferred policy options **do not seem to entail a problem of capacity** for the waste management sector in dealing with the additional waste to be disposed.

Table 16: Cumulative CO_2_eq emissions mitigation effect and increased cost for users of secondary raw materials of preferred option

Substance	CO_2 eq emissions (t) / avoidance cost in € (per year)	Increased cost for users of secondary raw materials
PBDEs	74,000 t CO_2 eq (2027-2035) Average yearly emissions – **8,200** t/yr Mitigation value: **0.82 M€** /yr #	6 M€ (2027-2035) (based on estimated average additional cost of virgin vs recycled plastic). Additional cost per year: **0.67 M€**
HBCDD	None expected given no envisaged impact on recycling	No impact expected.
PCDD/Fs (dioxins and furans)	**8,750 t** CO_2 eq/yr. (Only accounts of effects associated to power-plant biomass ashes, given impact associated to domestic burning is unknown.) Mitigation value: **0.88 M€** /yr #	1.25 M€ - estimated additional cost to agriculture and construction.
Dioxin-like PCBs	-	-
Short-chain chlorinated paraffins (SCCPs)	**2,500 t** CO_2 eq/yr Mitigation value: **0.25 M€** /yr #	2.3-26 M€ (over 2021-35) extra cost of using virgin rubber. Additional average cost/ yr: **0.95 M€**
PFOA, its salts and related compounds	Cannot be quantified. Presumably low.	Presumably low / very low.
PFHxS, its salts and related compounds	Cannot be quantified. Presumably low.	Presumably low / very low.
Pentachlorophenol (PCP)	None or very limited (as compared to baseline)	None
Dicofol	None or very limited	None
TOTAL	**19,500 t CO_2 eq / yr** **1.95 M€ / yr**	**2.9 M€**

Climate change avoidance costs per tonne of CO_2 eq = 100 € (central estimate short and medium run value). The corresponding low and high estimated values are, respectively, 60 € and 189 € up to the year 2030. Source: Handbook on the external costs of transport – January 2019 – V1.1. European Commission. DG MOVE.

Although these emissions are not negligible, and any reduction in emissions contributes to the EUs efforts towards carbon neutrality by 2050, the aggregated emissions savings figure is not very significant and corresponds to 0.0005% the total GHG generated by households and industry in the EU-27 in one year (4 billion tonnes of CO_2 equivalents in 2018[192]).

Table 17: Cumulative effect on SMEs of preferred option

Substance	Effect on SMEs
PBDEs	Possible impact on SMEs due to the potential investment costs in improved equipment being more significant in relation to turnover than for large companies and also due to more difficult access to finance and more difficult negotiating position vis-à-vis downstream companies.
HBCDD	Greater difficulty for SMEs in construction and demolition sector to absorb sampling and testing costs. Currently not-quantifiable. Possible one-off costs of about 30,000 €/ company to purchase hand-held XRF analyser.
PCDD/Fs (dioxins and furans)	No significant impacts expected on SMEs.
Dioxin-like PCBs	Possible (limited) increase in oil testing costs for waste oil recyclers.
Short-chain chlorinated paraffins (SCCPs)	Additional testing costs, more difficult to absorb by SME rubber recyclers (the majority).
PFOA, its salts and related compounds	Testing costs for the whole textile recycling sector. Future costs estimated to be in the hundreds of thousands to low million Euro range / year.
PFHxS, its salts and related compounds	Testing costs for the whole textile recycling sector. Future costs estimated to be in the hundreds of thousands to low million Euro range / year. Testing done together with PFOA.
Pentachlorophenol (PCP)	None or very limited
Dicofol	None or very limited

Table 18: Cumulative effect on public authorities of preferred option

Substance	Effect on authorities
PBDEs	Limited/moderate enforcement costs. Limited lost tax revenue.
HBCDD	Limited but potential need for increased market surveillance of imported EPS/XPS packaging. Enforcement of mixed demolition waste disposal controls in landfills.
PCDD/Fs (dioxins and furans)	Potential implementation of separate collection system for domestic burning ashes.
Dioxin-like PCBs	Limited additional enforcement efforts. Can be complementary to those already associated to PCDD/Fs.
Short-chain chlorinated paraffins (SCCPs)	Limited increased enforcement costs.
PFOA, its salts and related compounds	Limited increased enforcement costs.

[192] See https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Greenhouse_gas_emission_statistics_-_air_emissions_accounts#Greenhouse_gas_emissions

PFHxS, its salts and related compounds	Limited increased enforcement costs.
Pentachlorophenol (PCP)	None or very limited
Dicofol	None or very limited

In the supporting study carried-out by RPA (2021) only a qualitative estimate of impacts on public authorities of the proposed policy options has been possible, it at all. Estimated impacts on authorities for substances for which new limits are added (or lowered) are related to expected need to increase enforcement efforts. Costs of enforcement, associated to increased dedication of inspection personnel, market surveillance, etc., could not be quantified for any individual proposed policy option (see table above). Consequently providing an aggregated impact estimation for public authorities is also not possible. It should be noted that for already listed substances, with a limit in Annex IV, the obligation to enforce existing values is already in place.

By way of illustration of potential enforcement costs for authorities, ECHA has included, in a number of recent opinions[193] on restriction dossiers under REACH, an estimate of average enforcement costs across EU Member States for complying with a REACH restriction to be approximately €55,600 per year (as total for all Member States). These costs are reported to be an order-of-magnitude estimate of administrative costs, are not substance specific and do not include testing costs. This same figure is quoted in a recent restriction proposal by France[194].

Using this indicative cost to estimate enforcement costs to the public administrations to implement requirements of the substances covered by the impact assessment would result in a total cost of 450,000 € per year (rounded and considering only 8 substances, given dl-PCBs would be enforced together with PCDD/Fs). These costs are not negligible but seem within the possibilities of national competent authorities, and in line with enforcement costs originating from other EU chemicals policies, such as REACH.

8.3. Future proofing

Overall, the preferred option would provide legal certainty over a period during which any investment would need to be made. The limit values take account of future flows and the most likely reason for any further revision would be new technologies being developed and coming on line for sorting and treatment.

---

[193] Opinion on PFHxS restriction (June 2020). https://echa.europa.eu/documents/10162/fdaed5b0-b6e4-9a21-b45d-ca607c05f845 ; Opinion on PFNA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFTDA; their salts and Precursors (September 2018) - https://echa.europa.eu/documents/10162/3336e40c-b52c-d9f6-3745-3b4caf61599e

[194] Annex XV restriction dossier for (certain) substances in single-use baby diapers (15 December 2020). https://echa.europa.eu/documents/10162/99f020fd-e8ae-1b66-4fe6-0ec40789db8a

Table 19: Future proofing

Measures (substances)	Observations
PBDEs	The preferred option would provide legal certainty to WEEE/ELV operators about the limits applicable to waste for the substances concerned, providing a stable situation for at least this decade.
HBCDD	The revised limit takes into account future changes in composition of demolition EPS/XPS insulation panel waste where concentrations of HBCDD will reduce due to substitution by polymeric flame retardant.
PCDD/Fs (dioxins and furans)	The preferred Option 3 proposed limit values are consistent with current operational standards of MSWI and ensure that ashes, especially fly ashes, used in construction applications in some Member States will have lower dioxin content (leading to lower risk of emission followiong solidification).
Dioxin-like PCBs	Integration of dl-PCB values with that for PCDD/Fs aligns Annex IV of the POPs Regulation with the approach used in other EU and international legislation, which deals with these two similar families of substances together.
Short-chain chlorinated paraffins (SCCPs)	No significant impact envisaged.
PFOA, its salts and realted compounds	The preferred policy option proposed is envisaged to provide a practical limit which would guarantee high quality recycled textiles (as regards PFOA content) without significant adverse impacts on the development of a a still emerging textile recycling sector.
PFHxS, its salts and related compounds	Same assessment as for PFOA, its salts and related compounds.
Pentachlorophenol (PCP)	No specific impacts. PCP-impregnated wood waste stream is expected to cease being relevant around the year 2032.
Dicofol	No relevant waste streams containing dicofol have been identified in the EU. However if any waste were to be identified / generated in the future (e.g. from remediation of a site contaminated with dicofol or from dredging of contaminated sediments) annex IV and V limits defining the management of this waste will be available and applicable.

8.4. International competitiveness

Table 20: International competitiveness

Measures (substances)	Observations
PBDEs	Direct impacts on competitiveness are expected to be very limited given the small diversion of recyclable material to other waste mangement options. Other market factors such as demand for secondary material and price of primary plastics are expected to have a much greater influece on competitivity. In the medium-long term compliance with Annex IV values is expected to bring about greater customer confidence in the sound environmental management of waste and in the resulting secondary materials.
HBCDD	No impact on competitiveness expected.
PCDD/Fs (dioxins and furans)	No adverse impact on competitiveness is expected.
Dioxin-like PCBs	No adverse impact on competitiveness is expected.
Short-chain chlorinated paraffins (SCCPs)	No impact in competitiveness expected given measure affects recycling of a comparatively very small stream of rubber waste.
PFOA, its salts and realted compounds	No adverse impact on competitiveness is expected. In the medium-long term compliance with Annex IV values is expected to bring about greater customer confidence in sound environmental management of waste and in the resulting secondary materials.
PFHxS, its salts and related compounds	Same assessment as for PFOA, its salts and related compounds.
Pentachlorophenol (PCP)	No impact expected on competitiveness given wood contaminated with PCP is not recycled.
Dicofol	No relevant waste streams containing dicofol have been identified in the EU. Consequently no impact on international competitiveness expected.

8.5. REFIT (simplification and improved efficiency)

No simplification measures were identified, linked to the fact that the POPs Regulation has recently gone through a recast exercise. The initiative is limited to setting values for specific substances in Annex IV and V and, in this context the scope for simplification measures is limited.

9. HOW WILL ACTUAL IMPACTS BE MONITORED AND EVALUATED?

Monitoring of the impacts and of the effectiveness of the POPs Regulation, including its provisions as regards waste, is already an existing obligation and, consequently, no additional measures or mechanisms are envisaged. **Synthesis reports** prepared by the Commission, based on Member State reporting on the implementation of the POP Regulation are published regularly and can be downloaded from the web[195].

Reporting is a key component of the POPs Regulation and builds upon the work completed at Member State level to tackle the issues posed by POPs. Under the first POPs Regulation ((EC) No 850/2004), Article 12 included obligations on Member States to report annually (on management of substances listed in Annex I or II) and triennially (on the broader issues, including emission inventories) to the Commission. Additionally, Article 12 then also placed obligations on the Commission to produce a report every three years on the EU's progress towards the aims of the regulation.

Taking into account the Commission Report on Actions to Streamline Environmental Reporting and its related Fitness Check, the recast to the POPs Regulation has introduced a different approach to reporting. Under Article 13 Member States are obligated to develop reports on their progress to implement the regulation, including data on annual monitoring and statistics that will be published at national level. These reports are to be kept up to date, with annual updates for any new data, or if no new data is available, with an update at least once every three years.

Under Article 17 of the recast POPs Regulation, the European Chemicals Agency, in cooperation with the Member States, specifies formats and software for the publication of data by the Member States pursuant to the Regulation and makes them available free of charge on its website. Additionally, for monitoring data the POPs recast highlights the importance of the new Information Platform for Chemical Monitoring (IPCheM), and that all monitoring data should be provided to IPCheM, again with formats to be agreed between the Member States and ECHA.

The POPs Regulation recast provides a stronger focus on POPs wastes and waste-management. In particular it indicates that for national reports and implementation plans Member States are encouraged to include any information on the identification of contaminated sites. Additional focus is also given to management of POPs within waste streams and traceability to avoid regrettable re-entry to the market through recycling. Recital 17 of the recast specifically states:

> "*In order to promote the traceability of waste containing POPs and ensure control, the provisions of the record keeping system established in accordance with Article 17 of Directive 2008/98/EC should apply also to such waste containing POPs which is not defined as hazardous waste according to Commission Decision 2014/955/EU*[196]".

[195] https://ec.europa.eu/environment/chemicals/international_conventions/index_en.htm

[196] Commission Decision 2014/955/EU of 18 December 2014 amending Decision 2000/532/EC on the list of waste pursuant to Directive 2008/98/EC of the European Parliament and of the Council (OJ L 370, 30.12.2014, p. 44).

This means that for wastes containing POPs, even when not classified as hazardous, the **record-keeping obligations that apply to producers or installations managing hazardous waste, will also apply**, including documenting the quantity, nature and origin of the waste and the destination of the waste. As a minimum this requires the holders of such waste to notify the competent authority of the POP content of their wastes.

Concerning management of stockpiles, the Regulation provides that all remaining stockpiles for which no use is permitted shall be managed as waste. Stockpiles greater than 50 kg meant for permitted uses shall be notified to the competent authority and managed in a safe, efficient and environmentally sound manner. Holders of a stockpile consisting of or containing any POPs for which no use is permitted shall manage that stockpile according to the POPs Regulation requirements.

More broadly, environmental monitoring under the Water Framework Directive will help to confirm whether the measures are benefiting the (aquatic) environment.