GUIDANCE

Guiding Methodology for Strengthening Collaboration with National Statistical Offices to Address Gaps in POPs Data and Related Information

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Abbreviations and Acronyms

ABS	Acrylonitrile-butadiene-styrene
AFFF	Aqueous film forming foam
ASR	Automotive shredder residue
ATSDR	Agency for Toxic Substances and Disease Registry
BAT/BEP	Best available techniques/best environmental practices
C&D waste	Construction & demolition waste
c-DecaBDE	Commercial decabromodiphenyl ether (containing decaBDE; BDE209)
c-OctaBDE	Commercial octabromodiphenyl ether (containing hexaBDE and heptaBDE)
c-PentaBDE	Commercial pentabromodiphenyl ether (containing tetraBDE and pentaBDE)
CFCs	Chlorofluorocarbons
CRT	Cathode ray tube
CoCs	Chemicals of Concern
decaBDE	Decabromodiphenyl ether
EEE	Electrical and electronic equipment
ELV	End-of-life vehicle
EPS	Expanded polystyrene
ESM	Environmentally sound management
FDES	Framework for the Development of Environment Statistics
GESP	Global E-waste Statistics Partnership
GHG	Greenhouse gas
GWP	Global warming potential
HBB	Hexabromobiphenyl
HBCD	Hexabromocyclododecane
HCFCs	Hydrochlorofluorocarbons
hexaBDE	Hexabromodiphenyl ether homologue
heptaBDE	Heptabromodiphenyl ether homologue
HFCs	Hydrofluorocarbons
HIPS	High impact polystyrene
HS	Harmonized Commodity Description and Coding Systems; "Harmonized System"
ICT	Information and communications technology
ITU	International Telecommunication Union
LCD	Liquid crystal display
MEAs	Multilateral Environmental Agreements
MFA	Material flow analysis
MCCPs	Medium-chain chlorinated paraffins
NSO	National Statistical Office
NIP	National Implementation Plan
ODS	Ozone-depleting substances
PAHs	Polycyclic aromatic hydrocarbons
PBDE	Polybrominated diphenyl ether
PCBs	Polychlorinated biphenyls
PCDD	Polychlorinated dibenzo-p-dioxins
PCDF	Polychlorinated dibenzofurans
PCNs	Polychlorinated naphthalenes

PCP	Pentachlorophenol
PE	Polyethylene
PEN	PCB Elimination Network
PFHxS	Perfluorohexanoic acid; perfluorohexanoate
PFOA	Perfluorooctanoic acid; perfluorooctanoate
PFOS	Perfluorooctanesulfonic acid; perfluorooctane sulfonate
pentaBDE	Pentabromodiphenyl ether homologue
PIR	Polyisocyanurat
POPs	Persistent organic pollutants
PP	Polypropylene
PUR	Polyurethane
PS	Polystyrene
PVC	Polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
RoHS	Restriction of certain hazardous substances in electrical and electronic equipment; EU Directive
SAICM	Strategic Approach to International Chemical Management
SC	Stockholm Convention
SCCPs	Short-chain chlorinated paraffins
SDGs	Sustainable Development Goals
SF_6	Sulphur hexafluoride
SLCP	Short-lived climate pollutant;
TBBPA	Tetrabromobisphenol A
tetraBDE	Tetrabromodiphenyl ether homologue
WEEE	Waste electrical and electronic equipment
UNFC	United Nations Framework Classification for Resources
UNFCCC	United Nations Framework Convention on Climate Change
UNITAR	United Nations Institute for Training and Research
UNU	United Nations University
UNSD	United Nations Statistics Division
USEPA	United States Environmental Protection Agency
wt	weight
XPS	Extruded polystyrene

1 Introduction

1.1 Background and purpose

The experience with setting priorities for POPs management in low- and middle-income countries and with reporting on the status of implementation of the Stockholm Convention is characterized by a frequent lack of robust data and inventories (UNEP 2018). For example, basic data like the amount of e-waste and related plastic or data on end-of-life vehicles (ELVs) are frequently lacking. Furthermore, data are often scattered at different institutions with challenges to be accessed by POPs inventories teams. The best case would be that major data needed for POPs inventories would be available at the National Statistical Office (NSO).[1] The NSO is defined as the leading statistical agency that has a coordination role within the national statistical system and is responsible for the development, production and dissemination of official statistics across multiple statistical domains (UN DESA 2019).

Ideally, data relevant to Multilateral Environmental Agreements (MEAs), such as data for inventories, would best be available at such an agency. This would include data relevant to POPs inventories, the establishment of greenhouse gas (GHG) inventories for the UN Framework Climate Change Convention (UNFCCC) and ozone-depleting substance (ODS) inventories. Such a central entity could best coordinate data and synergies of data. There might also be data that are better hosted by other institutions, which directly work with certain POP-containing products and equipment (e.g., for PCBs, the utility sector has a database for transformers; see Section 5.2) and are in the best position to take care of updates.

This guidance includes information and strategies for strengthening the collaboration with National Statistical Offices (NSOs) and other responsible institutions to address the identified gaps related to POPs data or relevant information supporting POPs data estimates (e.g., for the electronics sector, the transport sector and imported/in-use/end-of-live vehicles, etc.). It includes recommendations on strengthening the dialogue with NSO and other responsible institutions for improving and complementing the production of national statistics relevant to the POPs data for National Implementation Plan (NIP) review and updating.

1.2 Approach of this guidance

The Secretariat of the Basel, Rotterdam and Stockholm conventions (BRS Secretariat) has developed, and is continuously enhancing, a global knowledge base made of information and tools, fed and used by all members of the clearinghouse community. The priority areas defined by the Conferences of the Parties include information about national plans and strategies:

- environmentally sound management of chemicals and hazardous and other wastes
- priority waste stream inventories, for wastes such as e-waste, mercury wastes and POPs wastes and related technical guidelines
- illegal traffic
- POPs listed in Annexes A, B and/or C to the Stockholm Convention
- chemicals listed in Annex III to the Rotterdam Convention

While synergies of the BRS Conventions have been established in the last decade, there are further specific synergies of POPs inventories and other inventory activities where synergies can be explored:

[1] Countries might use different terminologies.

1.2.1 Linking to other UN activities and guidance documents for generating relevant data

There are other chemicals of concern (CoCs) where inventory activities have been established or are needed for appropriate management, such as a GHG inventory or mercury inventory conducted within the framework of the UNFCCC, Montreal Protocol and Minamata Convention. Where appropriate, links between POPs inventories and inventories of GHGs or mercury present in the same product and waste category are made (e.g., building insulation foams, vehicles, or electrical and electronic equipment and related waste).

Some of the data needed for the POPs inventory are related to product and waste categories containing relevant resources, like critical metals or plastic important for the circular economy (UNEP 2009, European Commission 2017). The United Nations Framework Classification for Resources (UNFC) started an initiative on anthropogenic resources. These activities have not yet resulted in the development of inventory guidance documents, but a few case studies (UNFC 2022).

The Sustainable Development Goals (SDGs) also have indicators related to chemicals and waste such as:

- Indicator 12.4.1: Information transmitted under chemicals and waste conventions
- Indicator 12.4.2: Hazardous waste generated and treated
- Indicator 12.5.1: National recycling rate

Information on POPs inventories is also relevant for certain SDG reporting.

1.2.2 Linking to the Framework for the Development of Environment Statistics (FDES)

The United Nations Statistics Division (UNSD) has developed a Framework for the Development of Environment Statistics (FDES) (UN DESA 2013). The FDES 2013 is a flexible, multi-purpose conceptual and statistical framework that is comprehensive and integrative. It marks out the scope of environment statistics and provides an organizing structure to guide their collection and compilation and to synthesize data from various subject areas and sources, covering the issues and aspects of the environment that are relevant for analysis, policy- and decision-making (UN DESA 2013). The FDES 2013 targets a broad user community, including environmental statisticians in NSOs, environmental ministries and agencies, as well as other producers of environment statistics. It helps to mark out the roles of the different data producers, thus facilitating coordination at different levels. While POPs and other pollutants like mercury or ODS are not specifically considered (e.g., by the survey and questionnaire of UNSD and UNEP (2022) for the FDES), they are more broadly covered in the part on hazardous waste in the questionnaire (UNSD and UNEP 2022).

1.2.3 Integrated approach with inventory and management of plastic-containing POPs

Most of the listed industrial POPs were and are used as additives in plastics as flame retardants (PBDEs, HBCD, HBB, Dechlorane Plus), as plasticizers (SCCPs, MCCPs), UV-stabilizer (UV-328) or as part of side-chain fluoropolymers (PFOS, PFOA, PFHxS). When moving now to a more circular economy for plastic management by the establishment of a global plastic treaty (UNEP 2022a), plastic will be increasingly recycled. The separation and environmentally sound management (ESM) of POPs containing plastic provide the opportunity for recycling of the non-impacted plastic fraction and potential energy recovery of POP-containing plastic fraction (UNEP 2021a; UNEP 2023).

Major plastic use sectors containing POPs are electrical and electronic equipment (EEE), the transport sector and the building sector in which together more than 1/3 of all plastic is used.[2]

[2] Since plastic in these three plastic use sectors has a long service life, the plastic stocks in these three sectors likely account for more than 50% of all plastic stocks in use.

Only a part of these plastics contains POPs and many of these POPs have been phased out and are no longer used, but are still present in articles/products in use or end of life. Therefore, it is a useful approach to develop in these major use sectors an overall plastic inventory which contains information on affected and non-affected plastic.

The management of plastics in buildings, EEE/WEEE, and the transport sector should not only address the presence of POPs in a share of these plastics, but also ODS, GHGs, lead, cadmium and mercury (GGKP 2024a). An overall inventory of plastics and these substances seems an opportunity for synergies and a global improvement of the management of plastic.

Plastic is also a major fuel for open burning of waste in low- and middle-income countries. Open burning is a major source of unintentional POPs release and a relevant source of release of black carbon (light-absorbing, short-lived climate pollutant (SLCP)), CO_2 and particulate matter. For minimization of unintentional POPs, the inventory and management of all plastic categories is of great importance and can be linked to POPs inventories.

1.2.4 Synergy with greenhouse gas (GHG) and ozone-depleting substance (ODS) inventory

The document shows linkages of the POP inventories to the inventories of the UNFCCC and the Montreal Protocol on ODS. This is particularly relevant for the electronics sector (Section 2), transport sector (Section 3) and building sector (Section 4), which are major sectors for POPs plastic additives and ODS/GHG banks with high global warming potential (GWP) (CFCs, HCFCs and HFCs) and ODS.

1.2.5 Considerations of resource recovery and waste management

Some of the inventory sectors of POPs, such as the transport sector, the building sector and EEE/WEEE, contain large resources like metals or plastic. These three sectors might contain more than 50% of all current plastic stocks in a country due to the long service life (Patel et al. 1998) and also a large share of the metal stocks (German Environment Agency 2021). For promoting resource recovery from waste (Purnell et al. 2019), a national database on major inventory sectors at an NSO could include pollutants and resources. This database could form a basis for promoting a clean circular economy by improving the recovery of resources (including plastic) and the management of POPs and other CoCs (GGKP 2024a).

1.3 National and international data sources

This document provides guidance on gathering information to develop POP inventories. It emphasizes strengthening cooperation with the NSO and other governmental and national stakeholders who might possess relevant data for the POP inventory. This includes administrative data sources (e.g., vehicle registration) and statistical data sources, such as surveys.

Furthermore, some international reports and approaches compile international data which can be used to develop POPs inventories. For example, the United Nations University (UNU) and the United Nations Institute for Training and Research (UNITAR) are publishing reports on global and regional data on electrical and electronic waste (WEEE) (https://ewastemonitor.info). Similarly, there are international compilations of data on vehicles/cars in use[3] that could be used if on the national level data access is difficult or not possible.

1.4 Data gathering

For POPs inventories, a range of data is needed which the NSO and other governmental institutions and stakeholders might possess or be informed about by line ministries or agencies

[3] Compilation of recent data with references https://en.wikipedia.org/wiki/List_of_countries_by_vehicles_per_capita

for future collection. This document gives some practical recommendations for gathering information for inventories of industrial POPs for some major use sectors where national statistical data are important. These include:

- Electrical and electronic equipment (EEE) and related waste WEEE (Section 2)
- Transport sector and end-of-life vehicles (ELVs) (Section 3)
- Building and construction sector (Section 4)
- Equipment containing polychlorinated biphenyls (PCBs) (Section 5)
- POPs pesticides, and industrial and unintentional POPs and related POPs contaminated sites (Section 6)

For all sectors, disposal to landfills and dump sites plays a role and it is recommended to include the disposal of POPs as it is considered (e.g., Material and Substance Flow Analysis (MFA/SFA)).

The document gives further information on the most important POPs used in these sectors, including:

- PBDEs listed in 2009 including tetraBDE/pentaBDE (c-PentaBDE) and hexaBDE/heptaBDE (c-OctaBDE); DecaBDE listed in 2017
- HBCD
- SCCPs and POP candidate MCCPs
- PCBs
- PCP and other POPs pesticides used in the construction sector; pesticide-contaminated sites
- POPs contaminated sites for POPs groups

For user-friendly reading, key information is highlighted in boxes in the following sections, including the major data needed for POPs inventories. Section 7 summarized recommendations for improving the data framework to support POPs inventories.

2 Providing Data for the Inventory of EEE/WEEE and Related POPs

2.1 Introduction

2.1.1 POPs and resources in EEE/WEEE

Waste electrical and electronic equipment (WEEE, or e-waste) is one of the fastest-growing waste streams. E-waste contains resources like valuable ferrous and non-ferrous metals (aluminium, copper, iron, gold, silver, platinum) and recyclable plastics (e.g., acrylonitrile-butadiene-styrene (ABS), high impact polystyrene (HIPS), polypropylene (PP)), but also a range of POPs (PBDEs, HBCD, SCCPs, PCBs, Dechlorane Plus, UV-328) and a POP candidate (MCCPs) (GGKP 2024a) which cause pollution if not managed in an environmentally sound manner. POPs are mainly contained as additives in the plastic fraction. EEE/WEEE has an average plastic content of approximately 20% with several EEE categories having higher plastic contents (see e.g., Table 1).

Among the total e-waste generated today, only 17.4% is documented to have been collected and recycled and the fate of the remaining 82.6% is unknown (Forti et al., 2020). This highlights that e-waste management based on robust national statistics needs to be improved globally.

Different EEE categories have different PBDE and other POPs flame retardant content due to different flammability risks (Charbonnet et al. 2020). For the PBDE inventory guidance (UNEP 2021b), impact factors for the most relevant EEE/WEEE categories have been compiled, highlighting the EEE/WEEE categories with the highest decaBDE and hexaBDE/heptaBDE (from c-OctaBDE) content (Table 1). Plastic polymers in WEEE may also contain other POPs flame retardants, however at lower concentrations (GGKP 2024a; Taverna et al. 2017). Therefore, data need to be generated on the current use of these EEE categories and related wastes in particular for cathode ray tubes (TVs and computers), LCD TVs, heating appliances, information and communications technology (ICT) and consumer equipment (Table 1). This defines the data that should be specifically compiled in the database of the NSO for supporting inventories of POPs in EEE/WEEE when compiling general national data on EEE/WEEE in the framework of a national EEE/WEEE inventory (Forti et al. 2018) or for developing national WEEE statistics as recommended by the United Nations (UNSD and UNEP 2022).

Table 1: Hexa/heptaBDE (of c-OctaBDE) and decaBDE in polymers in relevant EEE categories (UNEP 2021b; data from EU; Wäger et al. 2010; Hennebert and Filella 2018)

Relevant EEE category	**Total polymer fraction (mean)**	**∑hexa/heptaBDE content (mean) in plastics**	**decaBDE content (mean) in plastics**
	$f_{Polymer}$ [in % by weight]	$C_{\sum hexa/heptaBDE;Polymer}$ in [kg/tonne]*	$C_{decaBDE;Polymer}$ in [kg/tonne]*
Cooling/freezing appliances**; washing machines	25%	<0.05	<0.05
Heating appliances	30%	<0.05	**0.8**
Small household appliances	37%	<0.05	**0.17**
ICT equipment w/o monitors	42%	**0.12**	**0.8**
CRT monitor casings	30%	**1.37**	**3.2**
Consumer equipment w/o monitors	24%	**0.08**	**0.8**
TV CRT monitor casings	30%	**0.47**	**4.4**
Flat screens TVs (LCD)	37%	**0.009**	**2.7**

** The Basel provisional low POPs contents for PBDEs are1000 mg/kg (1 kg/t) or 500 mg/kg (0.5 kg/t) or 50 mg/kg (0.050 kg/t); RoHS limit for total PBDEs is 1 kg/tonne or 0.1 weight (wt) %.*
***Cooling and freezing appliances have low content of POPs but contain other CoCs in particular CFCs, HCFCs and HFCs.*

Electronics in higher quantities known for elevated PBDEs are in particular CRT TVs and CRT monitors of computers (see Table 1). Other high-risk EEE/WEEE where PBDEs are present at relevant quantities are e.g. LCD TVs or heating appliances.

2.1.2 Other chemicals of concern listed in MEAs where related inventory data are needed

There are specific EEE/WEEE categories that additionally contain other CoCs listed in other MEAs (GGKP 2024a) where data and inventory development synergy exist such as:

- Data on cooling/freezing appliances and air conditioners containing several GHGs (CFCs, HCFCs, HFCs) as well as data on circuit breakers and switchgears (sulphur hexafluoride (SF_6)) are needed for the GHG inventory for UNFCCC (IPCC 2019; GGKP 2024a).
- The same but older appliances contain ODS (CFCs, HCFCs) and the ODS bank inventory (GIZ 2017; GGKP 2024a).
- Data on EEE/WEEE containing mercury needs particular care in end-of-life management. It is essential to prevent that these appliances, or waste generated ends in cement kilns where mercury is released into the air (Waltisberg and Weber 2020).

Detailed information on quantity of EEE/WEEE categories containing these CoCs and POPs would best be included in a national database for proper planning of environmental sound management of the respective categories.

2.2 National statistics to support the POP (and GHG, ODS) inventory for EEE/WEEE

Data on EEE/WEEE import, current use/stocks and end-of-life (WEEE) should be available on a national level at the NSO or another appropriate institution which are able to provide and update information needed for POPs inventories for the Stockholm Convention, GHG inventory for UNFCCC, ODS inventory for the Montreal Protocol, mercury inventory for the Minamata Convention, or the Basel Convention reporting. The United Nations University (UNU) published Guidelines on Classification Reporting and Indicators for E-waste Statistics (Forti et al. 2018), which can be used to develop a database including data on EEE/WEEE categories. This would contain information on categories with higher POPs levels (Table 1), GHGs, ODS, or mercury.

2.2.1 Imports and export of EEE/WEEE, HS Codes and UN Comtrade database

Foreign trade (import and export) statistics for products are registered under the Harmonized Commodity Description and Coding System (HS codes) developed by the World Customs Organization. Virtually all countries compile national data using the HS classification. The data are compiled by the United Nations Statistical Division (UNSD) and published in the Comtrade database[4] (Forti et al. 2018). There are about 270 HS codes relevant to EEE (Forti et al. 2018). A list of HS Codes related to the UNU-KEYS is provided in Annex 1 of the UNU guidelines for e-waste statistics (Forti et al. 2018). For countries without a (large) production of EEE, the long-term import data can be used for an estimate of EEE and WEEE in the country when considering the average service life of equipment. This information on imported EEE has been compiled recently for Nigeria from 1990 to 2022 and the related total import of plastics and POPs in relevant EEE categories were calculation (Babayemi et al. 2025). For countries with larger production of EEE, the total production and the share of domestically sold and exported EEE need to be considered to develop the statistical data of the amount of EEE on the domestic market.

The import and production data can be aggregated by the NSO for an overview of EEE coming into the market and the major EEE categories in use/stock covering as well as those relevant for POPs inventories. Surveys on EEE in use can provide data or improve the quality of data if not available.

Based on the EEE import/use data and the service life of EEE (Wang et al. 2021) of individual EEE categories, an estimate of generated WEEE can be developed by a national research institution capable of developing material flow analysis (MFAs). Such MFA calculations can be compared with the WEEE data from waste management reporting in the country. By such an assessment, WEEE collection rates can be estimated and compared with the estimate of the Global E-waste Statistics Partnership for WEEE of the country[5] or contribute to this international database.

Box 1: Information on major EEE/WEEE categories that should be available for estimating PBDEs (and other POPs additives) in EEE/WEEE plastic (UNEP 2021b)

For a **PBDE/POPs inventory**, the amount of the major EEE categories containing PBDEs should be compiled in a national database for EEE/WEEE such as: • flat screen LCD TVs and other flat screen LCD • remaining CRT casings in the country

[4] https://comtrade.un.org
[5] https://globalewaste.org/country-sheets

- other ICT equipment
- other consumer equipment
- other EEE categories (also those relevant for GHG and ODS inventory like freezing/cooling equipment or air conditioner)
- related WEEE generated in the country

A robust EEE/WEEE inventory database available at the NSO is recommended.

Calculation formula for estimating PBDEs in EEE/WEEE plastic (see UNEP 2021b).

In the sectoral POPs inventory guidance, initial impact factors for several other POPs are compiled for WEEE plastic, but not yet for individual EEE/WEEE categories (GGKP 2024a).

2.2.2 Framework for the Development of Environment Statistics (FDES)[6]

The United Nations Statistics Division (UNSD) and the United Nations Environment Programme (UNEP) contribute to the development of the UNSD International Environment Statistics Database with a biennial data collection. This UN Framework for the Development of Environment Statistics (FDES) includes (see Section 1.2.2) for the generation of national statistical data a Subcomponent 3.3 "Generation and Management of Waste" statistics on the amount and characteristics of waste (including e-waste) (UN DESA 2019). UNSD and UNEP provide a structure for identifying and collecting waste statistics, including e-waste statistics with an updated questionnaire (UNSD and UNEP 2022). The NSO would fill in the national data in this questionnaire in the best case from data available in the NSO database. By slightly extending the levels of details for the collection of information on EEE/WEEE categories (see Table 1), the database of the NSO or a ministry responsible for WEEE and EEE (use/import) would include information that provides data relevant for POPs inventories (Table 1) and the more general data for FDES (see also Box 1)

Furthermore, a database of EEE/WEEE at the NSO could include information on major pollutants (POPs, mercury, GHGs, ODS) and resources for the different EEE/WEEE categories as a basis for promoting a clean circular economy aiming for the recovery of resources and management of POPs and other CoCs (GGKP 2024a).

2.2.3 Considerations of an overall plastic and resource inventory of the EEE/WEEE sector

It is estimated that 4% of global plastic production is used in the EEE sector (Geyer et al. 2017). But due to the longer service life of EEE compared to, for example, plastic packaging, the EEE sector accounts for up to 8% of the plastic present in a country (Patel et al 1998; Van Eygen et al. 2017) and is therefore relevant for the national plastic inventory and management.

The data of major EEE/WEEE categories containing POPs/PBDEs (Table 1) or the MFA estimates can also be used to estimate the total amount of plastics. An initial estimate of total plastic in EEE/WEEE in the country can be based on the total amount of EEE/WEEE in the country and an average plastic content of 20% (UNEP 2021b).

Box 2: Calculation formula for initial estimating plastic amount in EEE/WEEE (UNEP 2021b)

Calculation formula for estimating the total amount of plastic in WEEE from average plastic content: $\mathbf{M_{Plastic} = M_{EEE} \times 0.2}$

Where:

[6] The FDES structure links waste statistics to the International Standard Industrial Classification (ISIC), which facilitates the integration with economic statistics. This can further be linked to System of National Accounts (SNA) and to the System of Environmental-Economic Accounting (SEEA).

- $M_{plastic}$ is the total amount of plastic [in tonnes] (in electrical and electronic equipment (EEE))
- M_{EEE} is the amount of EEE [in tonnes] (imported, stockpiled, or entering the waste stream)
- Average plastic content is 20%

Please note: While the average plastic content of EEE/WEEE is 20%, different WEEE categories have different plastic content (see Table 1). Based on specific data of individual EEE/WEEE categories, the plastic content of individual categories can be estimated which can be helpful, for example, estimating the recycling potential when also including information on plastic type.

Detailed statistical EEE/WEEE data can be used for inventory and better management and recovery of valuable resources such as precious metals (e.g., gold, palladium, platinum) or critical metals (e.g., antimony, beryllium, cobalt, germanium, and indium) (UNEP 2009; European Commission 2017), see also section 7.2.

2.3 International information sources

The NSO and other national institutions can compare their national data with data from international statistics on EEE and WEEE.

2.3.1 UN Comtrade database

As noted above (Section 2.2.1), the UN Comtrade database contains import and export data of countries. Since the data are generated at the national level and reported from the country, the details are described above under national data (Section 2.2.1) and in Section 4.3.1. The Comtrade database has been used e.g. to estimate the total import of POPs and plastic relevant EEE to Nigeria and calculation of related plastics and the POPs contained (Babayemi et al. 2025).

2.3.2 Global EEE and WEEE statistics

The Global E-waste Statistics Partnership (GESP) has the objective to improve and collect worldwide e-waste statistics in an internationally standardized way. The GESP regularly publishes the Global E-waste Monitor with global and regional information (Forti et al. 2020). The GESP is developing country and regional sheets.[7] They contain information on the amount of total e-waste generated for a recent year (currently for 2019) and the amount of total new EEE brought to the market for a recent year (currently 2019).[7] These data together with impact factors suggested for individual POPs (Table 1; UNEP 2021b; GGKP 2024a) can be used for a rough estimate of total EEE currently in use (see case study on POPs in EEE/WEEE in Annex GGKP 2024a) and total plastic amount in EEE (see Box 1 and Box 2). For the EEE produced in recent years, the impact factors of PBDEs are an upper estimate since global production and use of DecaBDE has decreased in the last decade (UNEP 2021b) with remaining productions in China (GGKP 2024b).

[7] https://globalewaste.org/statistics/country

3 Providing Data for the Inventory of the Transport Sector and Related POPs

3.1 Introduction

3.1.1 POPs and resources in the transport sector

The transport sector (cars, buses, trucks, trains, planes and ships) is one of the large material flows of goods, and ultimately becomes a large waste, pollutants and resource stream. End-of-life management in the transport sector is important to recover resources like metals (e.g., aluminum, steel, copper, platinum, palladium) and plastic (ABS, HIPS, PP) and managing pollutants (GGKP 2024a; see PBDE BAT/BEP Guidance, UNEP 2021a).

C-DecaBDE was a main flame retardant detected in vehicles (Kajiwara et al. 2014) and is detected in automotive shredder residues (ASR) (Liu et al. 2019; UNEP 2021b). In North America, a total of 380,000 tonnes of c-DecaBDE was used from 1970 to 2013, with 133,000 tonnes (35%) applied in vehicles (Abbasi et al. 2015). Before 2005, a proportion of c-PentaBDE was used in the transport sector in the United States/North America for the treatment of flexible polyurethane (PUR) foams (automotive seating, headrests, car ceilings, acoustic management systems, etc.) and some were used in back-coating of textiles in car seats (Kajiwara et al. 2014; Abbasi et al. 2015; Liu et al. 2019; Table 2). While the PBDEs listed in 2009 (tetra- to heptaBDE) were only produced/used in the period from 1975 to 2004, decaBDE is still produced today and received exemptions for a range of plastic (spare) parts in legacy vehicles with continued use (Table 2). Also UV-328 listed 2023 is still used in vehicles. Other POP flame retardants (HBCD, HBB, Dechlorane Plus, SCCP/MCCPs) were also used in vehicles and are present at lower levels (GGKP 2024a).

Table 2: Specific exemptions for decaBDE for parts for use in vehicles (UNEP 2021b)

Specific exemption	Application	Expire date
a) Parts for use in legacy vehicles, defined as vehicles that have ceased mass production, and with such parts falling into one or more of the following categories:	(i) Powertrain and under-hood applications such as battery mass wires, battery interconnection wires, mobile air-conditioning (MAC) pipes, powertrains, exhaust manifold bushings, under-hood insulation, wiring and harness under hood (engine wiring, etc.), speed sensors, hoses, fan modules, knock sensors (ii) Fuel system applications such as fuel hoses, fuel tanks and fuel tanks under body (iii) Pyrotechnical devices and applications affected by pyrotechnical devices such as airbag ignition cables, seat covers/fabrics (only if airbag relevant) and airbags (front and side) (iv) Suspension and interior applications such as trim components, acoustic material and seatbelts	At the end of the service life of legacy vehicles or in 2036, whichever comes earlier
b) Parts in vehicles specified in paragraphs (a) (i)–(iv) above and those falling into one or	(i) Reinforced plastics (instrument panels and interior trim) (ii) Under the hood or dash (terminal/fuse blocks, higher-amperage wires and cable jacketing (spark plug wires))	At the end of the service life of vehicles or in 2036, whichever comes earlier

more of the following categories:	(iii) Electric and electronic equipment (battery cases and battery trays, engine control electrical connectors, components of radio disks, navigation satellite systems, global positioning and computer systems) (iv) Fabric such as rear decks, upholstery, headliners, automobile seats, headrests, sun visors, trim panels, carpets	

3.1.2 Other chemicals of concern listed in MEAs where related inventory data are needed

The transport sector additionally contains CoCs listed in other MEAs (GGKP 2024a) where data and inventory development synergy exist such as:

- Amounts of GHGs in air conditioners (CFCs, HCFCs, HFCs), tires (SF_6) and blowing agents in XPS are needed for the GHG inventory for UNFCCC (IPCC 2019).
- Amounts of ODS (CFCs) in cooling/freezing appliances and of ODS used as blowing agents in XPS in freezing and air conditioners are needed for the ODS bank inventory (GIZ 2017).
- Mercury has been used until approx. 2004 in high volumes in vehicles in four-wheel drive anti-lock braking systems (ABSy) and high-intensity discharge (HID), active ride control systems, in head and tail lights and under the hood and truck lighting (UN Environment 2019; New Jersey Department of Environmental Protection 2022). Mercury needs particular care in end-of-life management and data on quantity in current use and end-of-life would be useful information in NSO for appropriate waste management. Appliances containing mercury should be removed before shredding in the depollution step and should not end in shredder waste treated e.g. in cement kilns where mercury would be released into the atmosphere (Waltisberg and Weber 2020).

3.2 National statistics to support the POP (and GHG, ODS) inventory in the transport sector

3.2.1 Vehicles (cars, buses and trucks) in use

Cars and other vehicles (trucks and buses) account for the major share of the transport sector and contain the main quantity of PBDEs in the transport sector (UNEP 2021b). The focus and methodology for the inventory can therefore centre on these vehicles. But also trains and airplanes can contain PBDEs.

For the development of the inventory of POPs and other CoCs in vehicles, the following information needs to be gathered:

- Registered vehicles (cars, buses, and trucks) in use.
- Time-resolved age of registered vehicles since the different POPs and other CoCs (mercury, GHGs, ODS) were produced/used in certain time periods (GGKP 2024a; GGKP 2024b); e.g., PCBs were only used in capacitors, brake fluids and coolants in cars produced before the 1980s (USEPA 2018).
- Share of vehicles produced in different regions (certain POPs were mainly used in certain regions; e.g., major use of c- PentaBDE was in the US/North America before 2005).

The information on age distribution and origin of vehicles is also relevant for the inventory of mercury, GHGs and ODS (GGKP 2024a):

- Air conditioning systems in vehicles produced from 1995 until recently can contain the refrigerant HCFCs (R134a; GWP 1430). New vehicles have moved to the use of natural refrigerants such as CO2 with GWP 1 or fluorinated hydrofluoroolefins (HFOs) with low GWP refrigerants (e.g. R1234yf; GWP 4) but the same decay products such as the highly persistent trifluoroacetic acid (TFA). US vehicles already used R1234yf from 2013 on, while China car manufacturers started to switch in 2020.
- Refrigerator trucks produced before 2000 might still contain the ODS R22 (ODP 0.05; GWP 1,810) and newer trucks the GHG R404a (GWP 3,922) while only recently additionally contain R452a (GWP 2,141). These trucks also can contain XPS as insulation with CFCs, HCFCs, or HFCs as blowing agents; here the time of production of the truck is relevant.
- Older vehicles (pre-1994) contained mercury switches in the crash sensor module of airbags. Many cars manufactured prior to 2004 contain mercury switches in the ABSy, mercury in HID, in head and tail lights and under the hood and truck lighting (UN Environment 2019; New Jersey Department of Environmental Protection 2022).

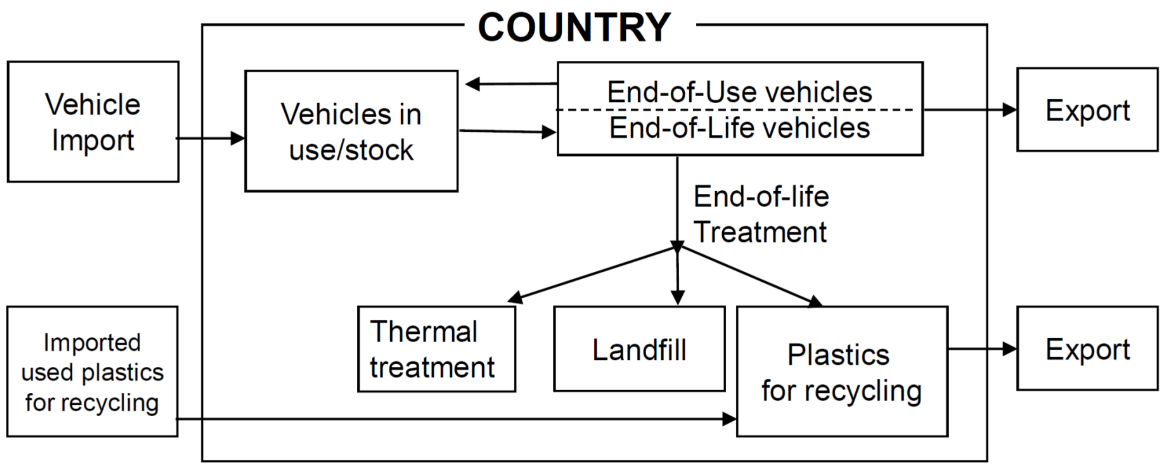
Box 3: Information on registered vehicles at NSO or the Ministry of Transport

Information on registered vehicles and end-of-life vehicles

- The number of imports and origin/region of vehicles.
- The number of vehicles registered/current operation including the age distribution of vehicles.
- Quantity of end-of-life vehicles for the inventory year (with age distribution).
- Share of vehicles produced in in different regions (also preferably time-resolved).
- Information on other transport sectors (trains, aircraft and ships)

Details on calculating the PBDE amount for the individual life-cycle stages of vehicles (import/production, in-use, waste management and export) are described in the PBDE inventory guidance (UNEP 2021b).

Figure 1: Assessing POPs in the life cycle of vehicles and related plastic waste and recycling



3.2.2 Other means of transport (trains, aircraft and ships)

Trains, aircraft and ships contain flame retarded plastic and polymers. For example, decaBDE has been used in unsaturated polyester (UP) resins in rail vehicles at a loading of 8.5% (Morf et al. 2003). DecaBDE received exemption for aircrafts for which type approval has been applied for before December 2018 and has been received before December 2022 and spare parts for those aircraft (UNEP 2021b).

If a country has a relevant train, airplane and/or ship fleet, these sectors are best included in the assessment. Furthermore, if trains, airplanes, or ships are dismantled in a country, the amount of plastic and polymers should be inventoried and managed in an environmentally sound manner. For countries with airlines, decommissioning of aircraft would be included in the inventory.

As most trains, ships and airplanes contain air conditioning systems and refrigerants, they would be included in a national database of GHGs and ODS in the transport sector.

3.2.3 Information on spare part trade and business

Spare parts and the remanufacturing of vehicle parts and reuse play a crucial role in vehicle repair recovery from ELVs. This practice aligns with the circular economy for the transport sector. Notably, spare vehicle parts are exempt from relevant POPs regulations in vehicles.

An inventory of spare parts is likely not possible considering that normally many small and medium-sized companies and the informal sector are involved. However, information on the approximate size of the spare part business and the commercial value of the total business as well as information on major supply chain structure could be available at the NSO, Commerce Registers, or Ministry of Transport.

3.2.4 Considerations of an overall plastic and resource inventory of the transport sector

It is estimated that 7% of global plastic production is used in the transport sector (Geyer et al. 2017). However, vehicles, aircraft, vessels and other means of transport have long service lives and, as a consequence, the transport sector accounts for about 15% of the plastic present in a country (Patel et al 1998; Van Eygen et al. 2017) and is therefore relevant for a national plastic inventory and national plastic management. An initial estimate of polymers in vehicles in the country can be based on the average polymer content in cars (plastic, foams and synthetic textiles) of approximately 15%.[8] Considering the average weight of a car (1.333 tonnes), this means that approximately 200 kg are polymers (UNEP 2021b). This value can be used to calculate the total amount of plastic/polymers in cars registered in the country and cars entering end-of-life. The calculated values give an indication for the waste management sector and other stakeholders of the management need of polymers in transport.

Box 4: Calculation formula for initial estimating plastic in vehicles (UNEP 2021b)

Calculation formula for estimating plastic in vehicles:
The total amount of polymers in a midsize car is approx. 200 kg.
Plastic in vehicles = Total vehicles * 200 kg

A national database on the transport sector at the NSO would include pollutants and resources for the different types of vehicles as a basis for developing and promoting a clean circular economy by promoting the recovery of resources from vehicles and the ESM management of POPs containing polymers and other CoCs (Purnell et al. 2019; GGKP 2024a).

[8] The polymer content and the weight of vehicles changes over time with increasing share of polymers over time.

3.3 International information sources

The NSO and other national institutions can compare their national data with data from international statistics on vehicles and link to the Framework for the Development of Environment Statistics (FDES) (see Section 1.2.2 and recommendations in Section 7.3).

3.3.1 Registered vehicles

The per capita number of road motor vehicles per 1,000 inhabitants and total vehicles per country is compiled for all countries on a Wikipedia website.[9] This includes cars, vans, buses, freight and other trucks, but excludes two-wheelers. For most countries, the data source is relatively recent while for a few sources the information is several years old. These data can be compared with the data compiled in the country.

For an estimate of passenger cars versus trucks/buses for the country, the share of cars and trucks/vehicles from the global inventory of vehicles might be used which is 73% cars and 27% trucks/buses if no robust information is available from national statistics.

The total vehicles per country are also compiled for all countries on a WHO website[10] and further other international databases.

3.3.2 Framework for the Development of Environment Statistics (FDES)[11]

The United Nations Statistics Division (UNSD) and the UNEP contribute to the development of the UNSD International Environment Statistics Database with a biennial data collection. This UN Framework for the Development of Environment Statistics (FDES) includes for the generation of national statistical data a Subcomponent 3.3 “Generation and Management of Waste”. While a detailed section for e-waste has been developed in the questionnaire, a similar section has not yet been created for the transport sector. A more detailed inventory could be developed within the framework of POPs inventories for the Stockholm Convention and CFC, HCFC and HFC inventories for the UNFCCC and Montreal Protocol. This inventory might provide future data for the UN Framework for the Development of Environment Statistics.

4 Providing Data for the Inventory of POPs in Buildings and Construction

4.1 Introduction

4.1.1 POPs in the building sector

A range of POPs are or were used in construction such as HBCD, PBDEs, SCCPs/MCCPs, PCBs, PCP and other POP pesticides, PFOA, PFOS and others (see sectoral guidance GGKP 2024a).

The service lives of polymers in buildings are decades and up to a century; therefore, most of the POPs used in building materials in the last 60 years are still present in buildings (Charbonnet et al. 2020; Li et al. 2016). An overview of polymer use in construction and related POPs additives (formerly) used, is compiled in Table 3. This indicates the major plastic/polymers impacted by POPs (please note that only a share of the respective plastic contains POPs and that also other hazardous additives are present). A range of POPs are no longer produced and are only present in stocks in buildings (UNEP 2022b, GGKP 2024a), while other POPs are still produced and used in new building products (e.g., c-DecaBDE, MCCPs, SCCPs).

[9] “List of countries by vehicles per capita” (https://en.wikipedia.org/wiki/List_of_countries_by_vehicles_per_capita).
[10] https://www.who.int/data/gho/data/indicators/indicator-details/GHO/number-of-registered-vehicles
[11] The FDES structure links waste statistics to the International Standard Industrial Classification (ISIC), which facilitates the integration of economic statistics. This can further be linked to the System of National Accounts (SNA) and to the System of Environmental-Economic Accounting (SEEA).

In some countries with flammability standards requirements, all EPS/XPS applications in construction require flame retardants (e.g., Germany, the Netherlands, the UK). While Finland, for example, only requires flame retardants in EPS/XPS) for wall and ceiling insulation; XPS/EPS in ground and frost insulation does not require flame retardants. In some other countries, the legislation does not require the use of flame retardant in PS in construction but other protection measures against fires (e.g. Sweden, Norway) (Seppälä 2013). In China, flame retardants were only used in insulation since 2000 (Li et al. 2016). Such information would be considered when establishing a national database on POPs in polymers in buildings.

Depending on the flammability standards in a country and production policies, all or only some insulation materials and other polymers might be flame retarded (Seppälä 2013; Charbonnet et al. 2020; UNEP 2021c).

Table 3: Polymers in construction and related POPs additives (UNEP 2021b, 2021c with additions)

Polymers and uses	POP	Content (%)	References
Expanded polystyrene (EPS)	HBCD	0.5–1%	UNEP 2021c
Extruded polystyrene (XPS)	HBCD, c-DecaBDE	1–3%	Morf et al. 2003
PUR foam in insulation	c-DecaBDE, c-PentaBDE	4–13%	Leisewitz & Schwarz 2000
PUR foam fillers	c-DecaBDE, c-PentaBDE	22%	Leisewitz & Schwarz 2000
PE insulating foam	c-DecaBDE	20%	Morf et al. 2003
PE and PP plastic sheeting	c-DecaBDE	10%	Morf et al. 2003
Roller blind and curtain	c-DecaBDE, c-PentaBDE, HBCD	4%	Kajiwara et al. 2013
Adhesive layer reflective tapes	c-DecaBDE	1–5%	RPA 2014
Intumescent paint	c-DecaBDE, c-PentaBDE	2.5–10%	RPA 2014
PVC plastic sheeting	SCCPs/MCCPs, (c-DecaBDE)	5–20% (5%)	Morf et al. 2003; Chen et al. 2021
PVC hosepipes for plumbing	SCCPs/MCCPs	0.5%–10%	Chen et al. 2021
PVC flooring, roofing, wallpaper, foils	SCCPs/MCCPs	0.5%–10%	Chen et al. 2021
Cables	SCCPs/MCCPs, PCBs, PCNs, c-DecaBDE	0.5%–10%	Chen et al. 2021

4.1.2 Other chemicals of concern listed in MEAs where related inventory data are needed

Buildings and constructions additionally may contain CoCs listed in other MEAs (GGKP 2024a) where data and inventory development synergy exist, such as:

- GHGs (CFCs, HCFCs, HFCs) in insulation foams (XPS/EPS and PUR/PIR foam) and air conditioners as well as SF_6 in sound insulating glazing of windows. Data on GHGs are needed for the GHG inventory for UNFCCC (IPCC 2019).
- ODS (CFCs) in air conditioning and cooling/freezing appliances and insulation foams (XPS/EPS and PUR/PIR). Data on ODS are needed for the ODS bank inventory (GIZ 2017).
- Mercury is a contaminant in PUR insulation foam and PUR flooring for sports/gymnastics such as tartan from production (ATSDR 2006). Mercury needs a particular care in end-of-life management and data on quantity in current use, and end-of-life would be useful information an NSOs for appropriate waste management so that these materials do not

end up in cement kilns where mercury is released into the atmosphere (Waltisberg and Weber 2020). Data on mercury are needed for the mercury inventory for the Minamata Convention or the Basel Convention.

Insulation foam is also relevant for GHG, ODS and mercury inventory. It is suggested that POPs, together with ODS, GHGs and mercury, would be considered in a national database for the building and construction sector at the NSO. This might initially be developed for federal and other public buildings for proper planning of environmentally sound management of construction and demolition (C&D) waste with improved deconstruction strategies.

4.2 National statistics to support the POPs (and GHG and ODS) inventory for buildings and construction

Data on insulation foams in current use and end-of-life (C&D waste) should be available on the national level at the NSO or another appropriate institution, which should be able to provide the information needed for POPs inventory for the Stockholm Convention, Basel Convention reporting, GHG inventory for the UNFCCC, and ODS inventory for the Montreal Protocol.

A major use of POPs in construction is polymer insulation foams (EPS, XPS, PUR, PIR). Information on insulation foams used since the 1970s should be gathered from NSO and the Ministry of Construction/Housing. If detailed information on insulation foams is not yet in a national database, then it would be gathered by other stakeholders like the construction industry to develop a database.

This should include the information on the flammability standard for insulation foams which determines if all insulation foam is flame retarded and also if other plastic used in construction in the country needs to be flame retarded (background in Charbonnet et al. 2020). For individual insulation foams and other plastic used in construction the following information would be gathered:

- Total amount of individual insulation foams used in buildings and construction in the country since the 1980s (see Section 4.2.1, 4.2.2, 4.2.3)
- Total amount of plasticized PVC in construction (4.2.3)
- Total amount of cables in construction (4.2.5)
- Time window in which the individual POPs have been used and the concentrations of the flame retardants used (information given by the Sectoral guidance (GGKP 2024a) and individual inventory guidance documents)

While the Stockholm Convention implementation focuses solely on POPs, it is important to acknowledge that other flame retardants also possess hazardous properties (Shaw et al. 2010; van der Veen and de Boer 2012; Blum et al. 2019). The database would also include other related CoCs such as CFCs, HCFCs and HFCs.

POP pesticides, such as PCP, lindane, DDT, endosulfan and others, were used for wood protection in construction timber and in wooden panelling indoors and outdoors. Stakeholders for gathering information on POPs treated wood in construction are:

- Ministry of Environment
- Ministry of Agriculture or Forestry
- Ministry of Construction/Housing

4.2.1 EPS/XPS insulation and related HBCD and decaBDE used in construction

The major use of HBCD (approx. 90%) has been in EPS and XPS in the building and construction sector (UNEP 2021c). Insulation foam in buildings was the only use of HBCD exempted in the Stockholm Convention (UNEP 2021c) which ended in 2021. HBCD was the major flame retardant in EPS/XPS use since the 1970s and until 2013 when HBCD was gradually substituted by other flame retardants (UNEP 2021c) with a final stop of production and use in 2021.

Therefore, it can be assumed that all flame retarded EPS/XPS used for insulation in construction from 1980 to 2013 contain HBCD and that most of this foam is still in use. EPS/XPS installed from 2014 to 2021 might include HBCD or alternative flame retardants depending on the substitution process in a country and newly installed EPS/XPS from 2022 onwards does not contain HBCD. Also, decaBDE has been used to some extent in XPS foam as an alternative.

For EPS/XPS applications, the total historic use of the HBCD-treated materials in construction would be compiled and the resulting current stock of HBCD and related XPS/EPS in buildings and constructions calculated (see below). Total volumes of EPS/XPS use might be available from NSO or industry associations and related stakeholders (Box 5).

For an inventory, the total volume of XPS and EPS in current use would be noted since these are the materials which finally need to be managed when buildings are demolished in future.

Box 5: Information needed from NSO or the construction sector on EPS/XPS and HBCD use

- Total amount of EPS and total amount of XPS used in the construction sector for the individual years from the 1970s to current use.
- Information if EPS/XPS insulation foams were flame retarded and since when or which period they were flame retarded.
- Since when HBCD has been phased out/substituted by alternative flame retardants in the country.

HBCD is applied in EPS at a typical loading of 0.5 - 1.0 % by weight and in XPS at a typical loading of 0.8 – 3 % in XPS by weight (UNEP 2021c). These concentrations can be applied when calculating the HBCD amount from the used insulation foam in the country in a time-resolved inventory for the database of the NSO or appropriate other governmental institution.

The time-resolved use of XPS foam is also needed for GHG (CFCs, HCFCs and HFCs) and ODS (CFCs and HCFCs) inventories.

4.2.2 PUR foam and PUR foam fillers and related POPs in use

PUR foam is another major polymer used as insulation materials in construction either as sheets or as spray foam. DecaBDE and c-PentaBDE have been used in PUR insulation foam as flame retardants. While the use of c-PentaBDE stopped in 2004, the use of decaBDE continued and has been exempted.

In addition, SCCPs and MCCPs were and are extensively used as flame retardants in PUR spray foams up to 50% of the content of the foam (Chen et al. 2021; Brandsma et al. 2021). Furthermore, phosphorous flame retardants are used as major flame retardants in sheets or as spray foam (Brandsma et al. 2021), which are also CoCs and need to be managed at end-of-life in ESM.

For an inventory, the total amount of PUR foam in current use in buildings would be compiled since all PUR foam materials finally need to be managed in an ESM when buildings are refurbished or demolished.

Box 6: Information needed from NSO or Ministry of Construction on PUR foam and fillers

- Total amount of PUR foam (sheets and spray foam) used in the construction sector from the 1970s to current use (best for the individual years)
- Information since when PUR insulation was used as flame retardant
- Information on the use of different flame retardants in PUR foam
- The time-resolved use of PUR foam is also needed for GHG (CFCs, HCFCs and HFCs) and ODS (CFCs and HCFCs) as well as mercury inventories

4.2.3 PVC and related use of SCCPs/MCCPs and decaBDE

PVC is the most used plastic in construction and plasticized PVC can contain POPs as an additive (Table 3; GGKP 2024a; Chen et al. 2021) as well as other plasticizers of concern like certain phthalates (GGKP 2024a). The major POPs used in PVC are SCCPs and MCCPs as secondary plasticizers in PVC. DecaBDE has also been used in PVC in construction in the past (Table 3).

Plasticized PVC can also contain phthalates that are restricted in some regions (UNEP 2022b; UNEP 2023). Other PVC produducts in construction can contain lead and cadmium.

It is recommended that information on POPs and other CoCs in PVC in construction is included in a database on plastic in construction at a country's NSO.

Box 7: Information needed from NSO or Ministry of Construction on PVC in construction

- Total amount of plasticized PVC (e.g., flooring, cables, sheets, membranes) used in the construction sector from the 1970s to current use (preferably time-resolved for the individual years).

Please note: The share and amount of PVC containing POPs depends on the origin of PVC (see Babayemi et al. 2022) with major use of SCC/MCCP PVC in China (Chen et al. 2021). Detailed assessment of POPs and other CoCs in the PVC would be compiled by the inventory team including information available at the NSO.

4.2.4 Other polymers containing POPs or other CoCs

Other polymers like polyethylene (PE) insulation foam and PE or PP foil in buildings and construction can contain decaBDE (see Table 3; GGKP 2024a). There are only limited data on the amount of PBDE flame retardant PE and PP with major information from Europe (Morf et al. 2003; Table 3).

PE and PP can also contain the ultraviolet (UV) stabilizer UV-328 recommended for listing as POPs (GGKP 2024a). Therefore, it is recommended that information on POPs in PE and PP in construction is included in a database on plastic in construction at an NSO.

Other flame retardants can also have hazardous properties such as halogenated organophosphorus OPFR (Shaw et al. 2010; van der Veen and de Boer 2012; Blum et al. 2019).

Box 8: Information needed from NSO or Ministry of Construction on PP and PE in construction

- Total amount of PE and PP in construction (sheets and foams) used and in stocks in the construction sector (time-resolved for the years if available).

Please note: The share and amount of PP and PE impacted with POPs and other CoCs would be assessed and compiled by the inventory team, including information available at the NSO.

4.2.5 Cables and related POPs in construction

Cable insulation is another relevant use of several POPs (PCBs, SCCPs/MCCPs, decaBDE) in and around (in the subsoil) construction. PVC is the most common sheath type, but also PE, PP and PTFE are used.

Box 9: Information needed from an NSO or Ministry of Construction/Housing on cables in construction

- Amount of cables and share of polymers used in cables in the construction sector currently in stock.

Please note: The share and amount of cables impacted with POPs and other CoCs would be assessed and compiled by the inventory team including information available at the NSO.

Countries might have centralized and/or decentralized databases in the presence of subsurface service lines. These databases are meant to be consulted before earthworks start to prevent damage on these various networks. The Netherlands, for example, has a special organization (Cables and Flowline Information Centre, KLIC) managing this countrywide database.

Valuable metals are used in cables (copper, aluminium, gold, silver, tungsten). Therefore, an inventory of cables could be a part of an inventory of metal stock for urban mining (German Environment Agency 2021).

4.2.6 Sealants and adhesives and related POPs used in construction

Sealants and adhesives are another relevant use of several POPs (PCBs, SCCPs/MCCPs) in construction. SCCPs/MCCPs are used in different sealant/adhesive materials, including polysulphide, polyurethane, butyl and acrylic materials in building and construction, and double/triple glazed windows.

Box 10: Information needed from an NSO or Ministry of Construction/Housing on sealants and adhesives

- Information on different types of sealants and adhesives used (time-resolved if available).
- If polysulfide joint sealants (Thiokol) were used from 1950 to 1975 (high risk of PCBs) and amount of these sealants.

4.2.7 Considerations for an overall plastic and resource inventory in the construction sector

While 19% of global plastic production is used in the building and construction sector (Geyer et al. 2017), the very long service life of buildings of 30 to more than 80 years (Wang et al. 2021; Li et al. 2016) has a consequence that the sector accounts for approx. 30% of all plastic stocks in a country (Patel et al. 1998). This stock will further increase and is therefore relevant for a national plastic inventory and will be increasingly relevant for national plastic management in the future. For planning of national waste management, the amount of polymers and related POPs in C&D waste can be predicted from dynamic MFA/SFA (Li et al. 2016; Annexes in GGKP 2024a[12]).

Therefore, it is recommended to include polymer stocks in buildings and construction in a national database at an NSO or Ministry of Construction, including information on POPs, GHGs and ODS. This is a basis for planning the waste management and evaluating opportunity for recycling polymers and ESM of POP-containing polymers in C&D waste (see also Recommendation 7.2).

Buildings and construction also contain resources like alumina, copper, iron and other metals.

4.2.8 Gathering information on wood used in construction and related POPs, and other hazardous substances

PCP and other POPs pesticides (DDT, aldrin, chlordane, dieldrin, endosulfan, lindane, mirex) have been extensively used for wood treatment since the 1940s often for timber used in buildings and railway sleepers. For PCP, the use of utility poles is exempted under the Stockholm Convention (GGKP 2024a). While many countries have stopped the use of PCP and other POPs before 2000, some countries have continued the use of PCP. Wood in construction has a service life of decades and up to centuries and therefore treated wood containing PCP and other POPs is still in use in many countries. Other CoCs have been used in wood treatment like chromated

[12] Three inventory case studies have been published as Annexes of the sectoral inventory guidance on POPs (GGKP 2024a).

copper arsenate (CCA) and creosote oil (containing PAHs). Wood waste containing POPs or other CoCs needs environmentally sound management.

Data on the use of pesticides for wood treatment might be available from a Ministry of Agriculture and Forestry or an NSO. The following information would be gathered and included in a database at the NSO:

- Which POP pesticides have been used for which period for treating wood in the construction sector.
- Use areas of treated wood stocks (residential buildings, other buildings, utility poles, cross arms, railway sleepers) and the estimated amount of total treated wood containing POPs and treated wood containing other CoCs.

4.3 International information sources

The import of materials for buildings and other constructions can partly be assessed by data from the UN Comtrade database (Section 4.3.1 and Section 2.3.1).

4.3.1 UN Comtrade database

The UN Comtrade database[4] contains import and export data of products for individual countries. It contains relatively detailed HS Codes on individual polymers like polystyrene (HS Code 3903 and related more specific codes for polymers of styrene) or PVC (HS Code 3904 and related more specific codes for polymers of PVC) which can be used for an assessment of polymer import as has been done for the African continent (Babayemi et al. 2019). Some of the HS Codes are quite specific for insulation in buildings and construction such as "HS Code 39039020: HS Classifications of Brominated polystyrene". Other HS Codes like the different HS Codes for PVC (under HS 3904) are not specific for construction. However, since the construction sector accounts for around two-thirds of the global demand for PVC (Ceresana 2020), the amount of PVC can roughly be estimated. A recent study in Nigeria used the HS Codes of PVC, PUR foam and rubber for an initial inventory of imports of SCCPs and MCCPs in products to Nigeria for the preceding 20 years (Babayemi et al. 2022). Since most PUR spray foams are used in construction and two-thirds of PVC is used in construction a first estimate of SCCPs and MCCPs in construction can be made.

4.3.2 Global status report on buildings and construction

UNEP, in cooperation with the International Energy Agency, publishes the "Global status report on buildings and construction" every year. The major focus of the report is energy efficiency "Towards a zero-emissions, efficient and resilient buildings and construction sector". The report relates to the use of POPs that the report promotes insulation of buildings and highlights the use of recycled materials for reducing carbon footprint (UNEP 2022b). However, information on POPs and other CoCs such as GHGs (CFCs, HCFCs, HFCs) are not yet addressed by these reports.

5 PCB (and PCN) Inventory Data

5.1 Introduction

PCBs are a class of aromatic compounds listed in the initial 12 POPs under the Stockholm Convention. Some 1.5 million tonnes of PCBs have been produced from 1929 to 1990 as technical PCB mixtures and have been used worldwide in many applications as dielectric fluid in capacitors and transformers (Table 4), and to a lesser extent in building materials (e.g., sealants, paints, plastic additives in cables) (PEN 2016, UNEP 2019a, 2021e).

Polychlorinated naphthalenes (PCNs) were listed as POPs in 2017 and were used in the same application as PCBs, however, with lower production volume (150,000 t). Since the major use of PCNs was from the 1930s to 1960s, most PCN equipment has been managed and the remaining equipment can be addressed within the PCB assessment/management (UNEP 2021d,e).

The elimination of PCBs on a global scale remains a significant challenge. In particular, developing countries and countries with economies in transition, but also a number of developed countries (Melymuk et al. 2022), still have challenges in identifying PCBs, removing PCBs from use, and achieving environmentally sound management of PCB oils and equipment contaminated with PCBs (PEN 2016, Weber et al. 2018a,b).

The requirement to prepare a PCB inventory is regulated in Part II of Annex A of the Stockholm Convention, according to which each Party shall take action with the following priorities:

(i) Make determined efforts to identify, label and remove from use equipment containing greater than 10 % PCB and volumes greater than 5 litres.

(ii) Make determined efforts to identify, label and remove from use equipment containing greater than 0.05 % PCB and volumes greater than 5 litres.

(iii) Endeavour to identify and remove from use equipment containing greater than 0.005% PCB and volumes greater than 0.05 litres.

Environmentally sound waste management of liquids containing PCBs and equipment contaminated with PCBs needs to be achieved by 2028. The undertaking of a detailed inventory and a robust database and update of a database is an indispensable prerequisite for the achievement of the 2028 objective.

Many countries lack reliable records on current and past PCB production, imports and exports. Lack of effective information management is a common shortcoming in PCB inventories. Some of the reasons for not achieving effective information management are a poorly executed organizational structure, lack of information backup and retention policies, plus the cost of collecting, storing and securing PCB information throughout its life cycle (PEN 2016). When updating the PCB inventory, it is important to avoid these mistakes and to set up an effective information management system. This may include the development and maintenance of a national database that is periodically updated (PEN 2016).

Table 4: Equipment containing PCBs according to application and location (UNEP 2021e)

Equipment	**PCB functionality**	**Major uses**
Transformers	Dielectric fluid	**Large:** industrial facilities, public buildings, hospitals, hotels
		Small: railroad vehicles, vessels; dental offices
Capacitors	Dielectric fluid	**Large:** Power factor correction capacitors; fixed paper capacitors for motors, capacitors for direct currents,
		Small: Motor start capacitors, light ballasts and capacitors for fluorescent lights and mercury lamps; Household electrical appliances, such as air-conditioners, washing machines, monochrome TVs, microwave ovens
Other uses	Dielectric fluid	High voltage switches, circuit breakers, voltage regulators, liquid-filled electrical cables
	Hydraulic fluids	Hydraulic fluids in mining equipment; stage systems in theatres, transportation systems and pump systems
	Heat transfer fluids	As heating/cooling agent in chemical, food and synthetic resin industry; preheating agent of the fuel oil of vessels, central heating systems
	Lubricating oil	In vacuum pumps, electronic components manufacture; laboratory, instrument and research applications; and waste water discharge sites

5.2 National database for inventory of transformers, capacitors and related waste oils

A database enables the authorities to control the location and nature of the PCB equipment, as well as the success of all related activities. Major equipment are transformers and capacitors with some further uses (Table 4). A PCB database should include the full list of PCB-containing equipment, including the producer, type, mode, series number, size, picture, and so on (PEN 2016; Box 11).

Also, other PCB-containing equipment such as equipment containing PCB hydraulic fluids, heat transfer fluids and lubricating oil would be included in a national database (Table 4).

If any PCN-containing equipment is discovered within the PCB inventory of transformers, capacitors, or other uses, then it would be recorded and integrated into the PCB database with an appropriate note.

5.2.1 PCB transformers

As many utilities may have problems with the maintenance of their databases, it is recommended to generate one central database for all (relevant) transformers and update all information by marking all PCB-containing transformers. Such a database is best hosted by the utility sector(s) and not by the NSO. Such a comprehensive database should contain all the necessary information needed for PCB management (Box 11). If there are different owners of transformers, then the database would have selected data access for the respective owners for an update. The Ministry of Energy and Ministry of Environment should have full access to the database for national reporting (Article 15), NIP update and for an overview of the management progress towards phase-out by 2025 and elimination by 2028. Summary information from the database can be included in the NSO for transparency for the public considering confidential business information.

Since the mid-1980s, almost all manufacturers of transformers stopped the use of PCB oils. However, any maintenance using "dirty" equipment for oil filtration (with vacuum systems) could result in PCB contamination of formerly PCB-free transformers. Therefore, in the database for transformers, PCB devices with "pure" PCB (so-called PCB- or Askarel transformers) and transformers containing PCB-contaminated oil should be clearly distinguished. Transformers older than 1990 with unclear content/nameplate are to be considered as potentially PCB-containing until negative tested. Also, transformers produced after 1990 that had oil exchange maintenance might be considered PCB contaminated depending on the maintenance conditions.

Transformers are always listed in certain databases. The main problem with such databases or lists lies in the quality and update of recording. Therefore, a national database with rigorous Quality Assurance/Quality Control (QA/QC) of information and updates is recommended.

Box 11: Recommended database information for suspected/verified PCB transformers and capacitors

- Manufacturer and serial number (country of production if available)
- Year of production
- *Upper and lower voltage (kV or MV)**
- Total and liquid weight (in kg or tonnes)
- *Basement of installation (e.g. pole mounted, on the ground)**
- Condition of transformer/capacitor (e.g. corrosion, leakage)
- Tested for PCBs? (yes or no; type of test)
- PCB content (PCB/Askarel transformer or PCB contaminated transformer (mg/kg))
- In case of PCBs, foreseen actions for a PCB-free transformer/capacitor; estimated time for phase-out
- Sampling team and date of sampling

- Neighbourhood (e.g. gasoline station or school)
- Data on storage sites with retired PCB equipment (amount of equipment and oil)

**Information specific for transformers*

Transformers and other PCB-containing equipment may be out of operation and are partly collected at storage sites. Such phased-out PCB-containing equipment needs a thorough inventory and is included in the database. All storage sites and sites where PCB equipment was and is maintained are potentially contaminated with PCBs and PCDFs and would be included in the database of POPs-contaminated sites for further assessment (See Sections 6.4 and 6.7.3).

5.2.2 PCB capacitors

Capacitors are widely used as parts of electrical circuits in many common electrical devices (Table 4). They exist in many forms, styles, lengths, girths, and from many materials (UNEP 2021e). Capacitors can be split into two categories: ballast capacitors and power factor correction capacitors.

A) Ballast capacitors weigh between a few grams and up to one or two kilogrammes and were used as motor start capacitors, in light ballasts, fluorescent lights and mercury lamps, household electrical appliances, such as air-conditioners, washing machines, monochrome television sets and microwave ovens (PEN 2016). The identification is often not possible. Therefore, it is recommended to consider all capacitors produced before 1985 as PCB capacitors and dispose of them according to international regulations. A national database should include an estimate of the remaining ballast capacitors and the measures to manage these capacitors in the end-of-life of WEEE, ELV and buildings.

B) Power factor correction capacitors are larger and might contain information on PCB filling. Most capacitor manufacturers used “pure” PCB during the PCB period (between 1955 and 1985). Verified and suspected PCB capacitors with pertinent information (Box 11) would be included in the database. It is recommended to take photos of the equipment whenever possible and to record them in the PCB database (PEN 2016).

5.2.3 Circuit breakers

Circuit breakers used until the 1980s can contain PCBs. They can also contain the strongest climate gas SF6 (GWP 23,500), which also should be inventoried and managed at end-of-life.

5.3 Hydraulic systems in mining and other sectors

A share of PCBs has been used in so-called “semi-open applications” in hydraulic systems mainly in the mining sector. Further hydraulic systems with PCB uses were, for example, stage systems in theatres, transportation systems and pump systems (Table 4). For countries with large underground mining activities, this stock can be large. Therefore, an inventory of major hydraulic equipment older than 1990 should be assessed, and contaminated and suspected hydraulic equipment added to the national database.

5.4 National database for inventory of PCBs in buildings and construction

More than 300,000 tonnes of the produced PCB (21%) have been used from the 1950s to 1970s in open applications which are responsible for more than 50% of all PCB releases (UNEP 2019a; Breivik et al. 2007). The Stockholm Convention stipulates that each Party shall endeavour to identify other articles containing more than 0.005 % PCBs and manage them in an environmentally sound manner. A major use of PCBs was in elastic polysulphide sealants used in prefabricated concrete buildings. Other constructions built in the 1950s to 1970s contain PCBs, such as dams (sealants and paints) and metal bridges or swimming pools (paint) in the 1960s and 1970s (UNEP 2019a). PCB sealants contain up to 25% PCB and single buildings or large bridges can contain more than 1 tonne of PCBs in sealants or paints (Jartun et al. 2009; Weber et al. 2018a).

PCBs in buildings and construction can be assessed, inventoried and documented in the frame of an overall inventory of POPs in buildings (GGKP 2024a; Chapter 4). Such an inventory might be combined with a national asbestos profile (Arachi et al. 2021) and an inventory of asbestos in buildings. In many countries, asbestos was used in construction in the same time period (for some countries until today) and partly in the same products (UNEP 2019a). A national inventory might be initiated with federal buildings as currently done for asbestos in Canada (Government of Canada 2022). A preliminary inventory of potentially PCB/PCN-affected buildings and dams constructed in the 1950s to 1970s has been compiled for South Africa (Weber and Okonkwo 2019). An initial national database of POPs, asbestos, GHGs/ODS in buildings might be hosted by the NSO or the Ministry of Construction and might include in a first step an inventory of federal buildings considering the construction date and the time periods of the use of PCBs and other POPs in buildings as well as asbestos, ODS and GHGs (see Chapter 4 and GGKP 2024a).

6 National Information for POP Pesticides, Industrial and Unintentional POPs and Related Contaminated Sites

6.1 Background

Article 6(1)(e) of the Stockholm Convention notes that Parties shall endeavour to identify POPs contaminated sites. The NIP guidance document suggests including a section on "*Information on the state of knowledge on contaminated sites and wastes, identification, likely numbers, remediation measures, and data on releases from sites*" (UNEP 2017a). A draft guidance on BAT and BEP for the management of POPs-contaminated sites has recently been developed, providing information to define contaminated sites and a science-based, stepwise approach to undertake identification and inventory and sustainable management of POPs-contaminated sites (UNEP 2024).[13]

While there is no single global definition of contaminated sites, most (inter)national definitions have elements in common that define a site as having been polluted to the extent it is a hazard to human health and/or the environment (UNEP 2024).

POPs are highly persistent in the environment and have resulted in POPs contaminated sites along their life cycle – production, storage, use and disposal. POPs contaminated sites have a high potential to cause human health impacts, food chain contamination, environmental damage, and harm biodiversity (UNEP 2024). As new POPs are added to the Stockholm Convention, the scale of the problem grows with both legacy and current use chemicals contributing to the challenge of managing these polluted sites.

The purpose of a contaminated sites inventory is to provide the basis for risk-based prioritizing and decision-making on further investigation, management and implementation of containment and/or remedial actions. A comprehensive inventory allows for an overview of the extent of contamination within regions, industrial sectors and across a country (UNEP 2024). Summary information would be integrated into the updated NIP in the suggested section on POPs contaminated sites (UNEP 2017a).

6.2 National database and GISs for POPs contaminated sites

POPs-contaminated sites are one category of priority contaminants and may be integrated into a general database of contaminated sites considering also other priority pollutants (e.g., metals

[13] http://chm.pops.int/?tabid=8779

and metalloids of concern, polycyclic aromatic hydrocarbons (PAHs), oil/gasoline). POPs-contaminated sites are often sites with more than one contaminant, these co-contaminants are among others heavy metals, gasoline (forming light non-aqueous phase liquids (LNAPLs)) and chlorinated solvents (forming dense non-aqueous phase liquids (DNAPLs)). Many industrial countries have developed contaminated site databases (European Environmental Agency 2021). The USEPA also developed Site Specific National Cleanup Databases (USEPA 2022a). Many countries have one national database where contaminated site relevant information is compiled. For some countries, individual federal states might be responsible for managing soil pollution in their territory and hosting and updating contaminate site databases (European Environmental Agency 2021). Information relevant to the characterization and management of contaminated sites is compiled in Box 12 and can be considered for a national contaminated site database. The NSO could host such a national database and also coordinate a national database in countries where provincial/federal state authorities host regional databases.

Geographic Information Systems (GISs) today are increasingly used for the management of contaminated sites. These GISs are used in projects dealing with one individual site and projects on the regional and county level dealing with multiple sites. More data are collected using remote sensing images available on the internet, collected by using airborne drones and/using scanners mounted on any type of vehicle. With such information, Digital Terrain Models (DTMs) are made to be used as the basis for the project-specific GIS.

All GISs are used to collect, store, analyse and present soil, bottom sediment and groundwater-related data. Data can be easily analysed by GIS to, for instance, discover/reveal and present the relation between the (presence/absence) CoCs (POPs) and:

- A specific co-contaminant
- The physiographic position in the landscape
- A specific soil texture
- A position in the soil profile

In some countries, soil information systems using GIS are available on websites[14] to inform the public about soil contamination in their city, region and/or country.

Box 12: Recommended database information for suspected and verified POP-contaminated sites

- Site history (past and current industries and operations and events that might have caused pollution; historical (aerial) photographs)
- Site description and site definition (including GPS coordinates; past and current site layout and responsible polluters)
- Site characteristics, (including a (initial or developed) conceptual site model with the potential source(s), source receptor pathway(s) and receptor(s)); related reports, figures (representative cross-sections) and maps describing soil and groundwater data
- Description of site surroundings with sensitive objects
- Status of the site assessment and site management
- POPs and other contaminants present or likely present; amounts of different contaminated waste, soil, sediment and groundwater
- Local or regional environmental monitoring data
- Contamination levels in soils, water, biota and reference to related reports/publications
- Affected population and other receptors; community participation
- Enforcement activities

[14] e.g. https://www.nijmegen.nl/diensten/bouwen-en-wonen/bodeminformatie-opvragen

- Scope and role of response actions
- Remedial actions (justification; remedy selected for cleanup; status of remediation)

6.3 POPs pesticide-contaminated sites

Information on potentially POPs pesticide-contaminated sites along the life cycle (production, formulation, storage and use) and pesticide waste/stockpiles and associated contaminated sites would be compiled for the database along with information on individual sites (Box 12). The summary of this assessment would be integrated into the NIP in the suggested section on POPs contaminated sites (UNEP 2017a).

6.3.1 POPs pesticide production sites

Large contaminations are documented for (former) POPs pesticide production sites and related landfills (Vijgen et al. 2011; Vijgen et al. 2022) and uncontrolled dumpsites. Therefore, former production sites and related landfills/uncontrolled dumpsites would be listed in in the POPs contaminated site inventory with related information (Box 12).

6.3.2 POPs pesticide stockpiles and related contaminated sites

The management of POPs pesticide stockpiles was and is a main activity in developing countries, particularly in Africa and Eastern Europe, the Caucasus and Central Asia (EECCA) (Vijgen et al. 2018). Most countries have developed an inventory of pesticide stockpiles in their NIP development. The information on POPs pesticide stockpiles and wastes and related contamination of soils/environment should be available in a database at the Ministry of Agriculture or the NSO and should be refined and updated over time.

A mechanism should be in place to ensure that if new stockpiles are discovered or if a stockpile has been eliminated at a site the database and the inventory is updated. Since sites, where pesticide stockpiles have been removed, are often still contaminated sites with impacted soils, the sites should be transferred to the database of POPs contaminated sites with information on the status of soils and other information on the site (Box 12) (UNEP 2024).

6.3.3 POPs pesticide use

The long-term use of POPs pesticides can contaminate sites. Examples are e.g. highly DDT-contaminated eggs in areas where DDT is sprayed for vector control (Bouwman et al. 2015) or chlordecone use in banana plantations (Jondreville et al. 2013).

The former and current use data of POPs pesticides should be compiled and available at the Ministry of Agriculture or the NSO. Major former-use areas of POPs pesticides can be indicated as risk areas with selected information from Box 12.

6.4 PCB-contaminated sites

PCB-contaminated sites are generated along the entire life cycle of PCBs: former production and use in production, use, storage and maintenance of PCB equipment and end-of-life treatment and related disposal with related exposure risk for livestock and human exposure (Weber et al. 2018a,b).

6.4.1 Former PCB production sites and associated landfills

PCB production sites were large emitters of PCBs with associated contamination of the production sites, the landfills and the wider environment including animals and population (Kocan et al. 2001; Turrio-Baldassarri et al. 2009; ATSDR 2015). Therefore (former) production sites and related landfills would be listed in the POPs contaminated site database with related information (Box 12).

6.4.2 Industries having used PCBs in production

Some production industries have used PCBs for the production of transformers, capacitors, paints, sealants, flooring, paper, or textiles. Such companies have used PCBs on a 100 to 1,000 tonnes scale with associated releases and contamination (Zennegg et al. 2010; Weber et al 2018a,b). Therefore, sites where PCBs were used in production and related landfills would be listed in the POPs contaminated site database with related information (Box 12).

6.4.3 Industries having used, maintained and/or stored PCB-containing equipment

Areas, where PCB transformers were used, maintained, or stored, are potentially PCB-contaminated sites. This includes the utility sector, but also large metal smelters and the steel industry. The areas with the largest risk are areas where transformers were/are stored or maintained. Therefore, sites, where PCBs are/were used, maintained, or stored, would be listed in the POPs contaminated site database as potential contaminated sites with related information (Box 12).

6.4.4 Waste management and disposal sites of PCB equipment and oils

PCB-contaminated sites are generated in the end-of-life treatment of PCB waste oils and equipment. This includes scrap yards and landfill or dump sites where PCB equipment or oil was disposed. PCBs have also entered secondary metal industries as scrap (copper, aluminium and steel) with associated release and in a recent survey of free-range chicken around metal smelters all free-range eggs sampled around 21 metal industries were above regulatory limits for dioxin-like PCBs (Petrlik et al. 2022). Therefore, sites where PCB waste was managed or disposed of would be listed in the POPs contaminated site database as potentially contaminated sites with related information (Box 12).

6.5 PBDE, HBB and HBCD waste and contaminated sites and hotspots

While PBDEs and HBCD have resulted in environmental contamination there are no established soil limit values for PBDEs or HBCD but only environmental quality standards (Weber et al. 2019; UNEP 2021b). For dump sites in Africa the contamination of surrounding soils could be related to contamination in chicken eggs and the exposure resulted in a high exceedance of ATSDR Minimum Risk Level (MRL) of 3 ng/kg/day for lower brominated PBDEs and intermediate exposure duration (Oloruntoba et al. 2021). The data suggested that soil levels for ∑7PBDE (tetraBDE-octaBDE) should be below 10 ng/g (Oloruntoba et al. 2021). Similarly, also elevated HBCD levels have been detected in chicken eggs. This indicates that sites where PBDEs or HBCD have been released can pose a risk to humans and should be inventoried.

6.5.1 Former PBDE and HBCD production sites and associated landfills

As for other POPs, production sites can have high PBDE and HBCD concentrations in soils (Remberger et al. 2004; Deng et al. 2016, McGrath et al. 2017; UNEP 2021a; UNEP 2021c). Therefore (former) production sites where PBDEs or HBCDs have been used and related landfills would be listed in the POPs contaminated site database as potentially contaminated with related information (Box 12).

6.5.2 Industries having used PBDEs or HBCD in production

Companies that have used PBDE or HBCD in production such as producers of flame retarded EPS/XPS for insulation or plastic for electronics as well as flame retarded textile manufacturing can have elevated levels in soils, sediments and biota (Dames and Moore 2000; Remberger et al. 2004; McGrath et al. 2017; UNEP 2021b; UNEP 2021c). Therefore, sites where flame retarded products were produced and related landfills would be listed in the POPs contaminated site database as potentially contaminated with related information (Box 12).

6.5.3 Management and disposal of PBDE and HBCD containing waste

PBDE and HBCD contamination of soils can result from end-of-life treatment of PBDE/HBCD containing e-waste and end-of-life vehicles in particular from open burning of waste (Alabi et al. 2012; McGrath et al. 2017; UNEP 2021b; UNEP 2021c). PBDE contaminations have also been detected around shredder plants (Hearn et al. 2012). Landfill and dump sites also release PBDEs and HBCD in leachates and from fires with associated contamination of the surroundings (Weber et al. 2011; Oloruntoba et al. 2019). Since e-waste and end-of-life vehicles contain multiple POPs (PBDEs, HBCD, PCBs, SCCPs), heavy metals and other CoCs (GGKP 2024a), areas where such waste is dumped or openly burnt would be listed in the POPs contaminated site database as potentially contaminated with related information (Box 12).

6.6 Sites contaminated with PFOS, PFOA, PFHxS[15] and related compounds

PFOS, PFOA and PFHxS[15] contaminated sites are generated along the entire life cycle: production, use in production, use in firefighting foam, release from textiles, carpets and other products during use and release from end-of-life treatment and related disposal to landfills and related leachates and ground water pollution. This can results in drinking water and soil contamination and exposure of livestock and humans (Weber et al. 2011, 2019; UNEP 2017b, 2021f, 2022d, 2024; Brusseau et al. 2020; Salvatore et al. 2022; Cordner et al. 2024).

6.6.1 PFOS/PFOA production sites and associated landfills

PFOS/PFOA production sites were and are large emitters of PFOS and PFOA with associated contamination of the production sites, the landfills and the wider environment including ground and drinking water, biota/livestock and population (Oliaei et al. 2015; Lerner 2020; Liu et al. 2021). Sludge from such production has been marketed as biosolids and has contaminated large areas (Washington et al. 2010; Nordic Council of Ministers 2019).

Therefore, former production sites and related landfills and areas where waste sludge was applied would be listed as potential POPs contaminated sites in the database with related information (Box 12).

6.6.2 Industries having used PFOS, PFOA, or related substances in production

A wide range of production industries has used PFOS or PFOA in fluoropolymer production, the plating industry, and the production of surface-treated paper, textiles, leather and carpet (UNEP 2017b, 2022d). Large contaminations are documented for releases from fluoropolymer production (Bao et al. 2011; Gebbink and van Leuven 2020; Liu et al. 2021). Also releases from other industries have contaminated groundwater, surface water and soils at production sites (e.g. USEPA 2022c; Qu et al. 2020). The mismanagement of sludge from such factories can also result in huge, contaminated sites (Nordic Council of Ministers 2019). Therefore, former sites where PFOS, PFOA, or related substances were used in production and related landfills as well as areas where sludge was disposed, or used as biosolids can be listed as potential POPs-contaminated sites in the database with related information (Box 12).

6.6.3 Open uses of PFOS in firefighting foams and oil drilling

The largest number of sites contaminated with PFOS, PFOA and PFHxS have been generated from the use of firefighting foams for class B fires like aqueous film-forming foam (AFFF) (Hu et al. 2016; UNEP 2017b, 2022d). Areas where PFOS-containing firefighting foam were and are used are airports, oil and gas drilling, refineries, industrial sites, military installations, fuel storage

[15] PFHxS was listed in June 2022 in the Convention and no inventory guidance has been developed yet. Since PFHxS was used in a similar application as PFOS but was produced in much smaller quantities and is also present unintentionally in PFOS it is suggested to mainly consider PFOS and PFOA but list PFHxS as a co-contaminant until an inventory guidance is available.

sites, and large power plants and fire-sensitive installations that have frequent firefighting practice. Cleaning firefighting equipment such as trucks also can result in contaminated sites (Cornelsen et al. 2021). Large, fixed firefighting foam installations have also likely resulted in contaminated sites from (yearly) testing. In addition, oil drilling sites used PFOS and PFOA for oil well exploration. Therefore, sites, where PFAS firefighting foams are/were used, would be listed in the POPs contaminated site database as potentially contaminated with related information (Box 12).

6.6.4 Open uses of PFOS and PFOA and related substances in pesticides

A PFOS-related substance (sulfluramide) is/was used as an insecticide against ants and cockroaches and the use against leaf-cutting ants is an acceptable purpose in the Stockholm Convention. Areas where these pesticides were used can be considered PFOS-contaminated. PFOA and related substances have also been used in pesticides as inert ingredients or anti-foaming agents (UNEP 2022c). Additionally, USEPA documented that fluorinated high-density PE containers contain PFOA and other PFASs and contaminate the pesticide with release to the environment (USEPA 2022b).

Therefore, sites where PFOS or PFOA and related substances were used as pesticides or where pesticides were used which were packed in fluorinated pesticide containers would be listed in the POPs contaminated site database as potentially contaminated with related information (Box 12).

6.6.5 Waste management and disposal sites of PFOS/PFOA and related substances

Sites where wastes containing PFOS/PFOA and related substances were disposed of can be considered a long-term reservoir for the release and contamination of PFOS and PFOA to the environment and in particular to ground and surface water (Oliaei et al. 2015; Propp et al. 2021) with risk for drinking and irrigation water (Hu et al. 2016; Costello and Lee 2020; Liu et al. 2021). The largest share of PFOS and a considerable share of PFOA related substances have been used in fluorinated side-chain polymers in carpets, textiles, paper and furniture (Fricke and Lahl 2005; OECD 2022) which finally ended the last 60 years in landfills. They degrade only slowly with half-lives in the scale of many decades to century (Washington et al. 2015).

Also, sites where large amounts of waste are stored and processed like waste transfer stations or waste incinerators can release high levels of PFAS to the environment via leachate (Liu et al. 2022).

Therefore, sites where PFOS and PFOA containing wastes were stored in larger amount and where such waste is/was disposed would be listed in the POPs contaminated site database as potential contaminated sites with related information (Box 12) in particular risk for ground and drinking water.

6.7 Inventory of emission sources and contaminated sites of PCDD/PCDF and other unintentional POPs (UPOPs)

6.7.1 Background

Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs), together with polychlorinated biphenyls (PCBs), polychlorinated naphthalenes (PCNs), hexachlorobenzene (HCB), pentachlorobenzene (PeCB) and hexachlorobutadiene (HCBD) are listed in Annex C of the Stockholm Convention (SC) as unintentionally produced POPs (UPOPs). While PCBs, PCNs, HCB and PeCB have also been industrially produced and used in several applications (e.g., Chapter 0), PCDD/PCDFs were not produced commercially with the exemption of analytical standards, and they have no known use.

PCDD/PCDFs and the other UPOP formation and/or releases arise mainly from:

- Chemical production processes – e.g., the production of chlorine, chlorinated phenols, PCBs and other chlorinated aromatic compounds; the production of chlorinated solvents; the use of chlorine in industrial processes like the production of magnesium or pulp and paper.
- Thermal and combustion processes such as the destruction of POPs and other organochlorine-containing waste, incineration of wastes, the thermal processing of metals scraps and open burning of waste.

The emission inventory for UPOPs sources would be compiled and updated in a national database hosted by NSO or another appropriate governmental institution (see Section 6.7.2).

Since most PCDD/PCDFs and other UPOPs are very persistent in soils for decades and rather centuries, they have accumulated in soils and sediments over time from these sources with related exposure of biota including livestock and chicken/eggs (UNEP 2013b; Weber et al. 2008, 2018b; Petrlik et al. 2022). Therefore, the inventory for UPOPs contaminated sites would be compiled and updated in a national database hosted by the NSO or another appropriate governmental institution and would consider food production (see Section 6.7.3).

6.7.2 Data compilation for source inventory of unintentional POPs

The Stockholm Convention requires in Article 5a(i) "*An evaluation of current and projected releases, including the development and maintenance of source inventories and release estimates, taking into consideration the source categories identified in Annex C*". Source categories are compiled in the UNEP Toolkit for identification and quantification of unintentional POPs (UNEP 2013a) which can be used to develop a national database at the NSO to compile activity rates (e.g. waste incinerated, or tonnes of steel or cement produced). For the compilation of these activity rates and the selection of the related source categories the UNEP Excel template available on the download page of the Toolkit[16] can be used for calculating the UPOPs emission (UNEP 2013a). Therefore, the Toolkit Excel sheet[16] might be used by the NSO to compile PCDD/PCDF inventory data and used for reporting.

Since PCDD/PCDFs and the other listed unintentional POPs (PCBs, PCNs, HCB and PeCB) are formed together during incineration and other thermal processes, the Toolkit recommends, for practical reasons, that inventory activities be focused on PCDD/PCDFs, as these substances are indicative of the presence of other unintentional POPs (UNEP 2013a). For these sources PCDD/PCDFs are considered to constitute a sufficient basis for identifying and prioritizing sources and control measures for all Annex C POPs and for evaluating their efficacy.

The reporting template for Article 15 reporting includes, however, in addition to a template for PCDD/PCDFs also templates for other UPOPs. Therefore, also data on other UPOPs may be calculated and reported. For some sources, the UNEP toolkit includes certain impact factors for other UPOPs (in particular PCBs) or HCBs which can be calculated with activity rates.

6.7.3 Inventory and data compilation for PCDD/PCDF and other UPOP-contaminated sites

Soils and sediments have accumulated PCDD/Fs and other UPOPs over the last century of releases from the application of organochlorines containing UPOPs (PCP, 2,4,5-T or PCBs). E.g. the use of PCP as a pesticide in the 1950s to 1980s has resulted in large PCDD/PCDF contaminated sites e.g. in Australia, China, Japan, or Suriname in rice paddy fields, sugar cane, pineapple plantations or areas for snail control (Weber et al. 2008). Also, the long-term release from incinerators, metal industries or open burning has contaminated soils (Vernez et al. 2023; Weber et al. 2008; UNEP 2013b). The PCDD/F-contaminated sites, soils, and sediments from the past releases are still relevant for food contamination (e.g., fishes, chicken/egg, grazing cattle

[16] The UNEP Toolkit Excel can be downloaded here http://toolkit.pops.int/Publish/Main/Download.html

and milk and dairy products) and should be mapped and managed to reduce human exposure (Weber et al. 2018b; Petrlik et al. 2022). Furthermore, reservoir sources, such as landfills/dumps from chlorine and organochlorine production can contain large amounts of PCDD/PCDFs and other UPOPs which should be known.

The UNEP Toolkit has listed major source categories of potential PCDD/PCDF and other UPOP-contaminated sites with associated descriptions (UNEP 2013b) and case studies.[17]

Box 13: Major source categories of PCDD/PCDF and other UPOP-contaminated sites

The UNEP Dioxin/UPOP Toolkit lists major categories of contaminated sites (UNEP 2013b):

- Production of chlorine (in particular chloralkali processes having used graphite electrodes)
- Production sites of chlorinated organics (e.g., chlorophenols, chlorinated pesticides, PCB) or HCB precursors (e.g., perchlorethene, trichloroethene, tetrachlormethane) and waste deposits
- Application sites of PCDD/PCDF containing pesticides and other chemicals
- Timber manufacturing and treatment (PCP use in wood preservation)
- Textile and leather factories (use of PCP, chloranil and others)
- Use and storage sites of PCBs
- Factories having used elemental chlorine in production processes (e.g., magnesium production, or pulp and paper production)
- Waste incinerators and disposal sites of ashes
- Metal industries listed in Annex C of SC
- Major fire accidents
- Dredging of sediments, depots/deposits of (nautical) dredge material, and contaminated flood plains
- Dumps of wastes/residues from UNEP Toolkit source groups 1-9

7 Recommendations for Improving the Data Framework for Supporting POPs Inventories

7.1 Strengthen the National Statistical Office and National Statistical System (NSS)

It is recommended to strengthen the National Statistical Office (NSO) and the National Statistical System (NSS)[18] with elements listed in Box 14, including recommendations for the improvement of NSOs, according to the Manual of the National Quality Assurance Framework (NQAF) (United Nations 2019) and establishing and promoting a dialogue between the NSO and the line ministries possessing data and those which need data.

Box 14: Recommendation for strengthening the NSO and NSS for data compilation and management

- Develop or improve the National Quality Assurance Framework (NQAF) by core principles (see United Nations 2019).

[17] http://toolkit.pops.int/Publish/Annexes/E_11_Example11.html

[18] The NSS is the ensemble of statistical organization and units (statistical agencies) within a country that develop, produce and disseminate official statistics on behalf of the national government (and other levels of government). It is the responsibility of each country to define the scope of its NSS (see also statistical agencies, data providers and statistics producers and data ecosystem) (United Nations 2019).

- Support a coherent and robust system for statistical quality management that assures trust in and the quality of official statistics for POPs and other chemicals of concern considering elements described in the Guidance for QA/QC of POPs data (GGKP 2024c).
- Enhance the dialogue between line ministries and NSO. The different needs for data from the NSO are compiled in the individual Boxes in this report. The NSO team to assess how much of these data are available and what additional data need to be generated and filled into the NSO databank.
- Clarify what further information is needed and explore from which ministries and other stakeholders this information can be gathered
- Decide which relevant data for POP inventories to be hosted by the NSO and which data to be hosted by other stakeholders (e.g. PCB inventory possibly by the utility sector);
- Ensure a long-term vision for the need for statistical capacity development for environmental-relevant data and where the NSO/NSS should be in five to ten years and set milestones for getting there[19]
- Promote open access to and use of data and improve accessibility of statistics[20] to manage for results, enhance government effectiveness, and increase public confidence
- Increase resources for statistical systems: promoting domestic allocations to statistics and integrating and aligning external support to statistics into development assistance programme (United Nations 2019);
- Develop programmes to increase the knowledge and skills needed to use statistics (United Nations 2019);

Some countries have never before been addressed by official statistics, which is why neither the respective data nor the measurement concepts and methodologies are available. Even for those indicators where the statistical production would be feasible, the statistical capacities are not necessarily developed. Thus, it should ensure that countries are adequately resourced to provide these data. Strategies must be agreed, adopted and implemented at national and global levels (United Nations 2019).

Many NSOs also need to improve their capacity to generate data for SDG indicators, including data on chemicals and waste. Within the SDGs evaluation are indicators related to enhancing capacity building and the global partnerships, including capacity building for improving data availability and data quality:[21]

- Indicator 17.18 "by 2020, support developing countries, including for least developed countries and small island developing States, to increase significantly the availability of high-quality, timely and reliable data disaggregated by income, gender, age, race, ethnicity, migratory status, disability, geographic location and other characteristics relevant in national contexts".
- Indicator 17.19: "By 2030, build on existing initiatives to develop measurements of progress on sustainable development that complement gross domestic product, and support statistical capacity-building in developing countries".

[19] https://unece.org/fileadmin/DAM/stats/documents/ece/ces/ge.30/2019/mtg1/WP31_Suchodolska_slides_ENG_revised_again.pdf
[20] https://www.oecd.org/sti/ieconomy/enhanced-data-access.htm
[21] https://w3.unece.org/sdg2022/story-12.html

7.2 Considerations of an overall plastic and resource inventory of the three sectors

Some of the inventory sectors of POPs contain large resources like metals or plastic such as the transport sector, the building sector and EEE and related waste (WEEE). These three sectors might contain more than 50% of all current plastic stocks in a country due to the long service life (Patel et al. 1998). These sectors also contain a large share of the metal stocks, which are key stocks for a circular economy (German Environment Agency 2021).

For promoting resource recovery from waste (Purnell et al. 2019), a national database on these sectors at the NSO could include pollutants and resources as a basis for developing and promoting a clean circular economy by improved recovery of resources (including plastic) and the management of POPs and other CoCs from major sectors like vehicles, EEE and building and construction sectors (GGKP 2024a).

Box 15: Recommendation for an overall plastic inventory in the three major POPs-relevant plastic sectors

- An overall plastic inventory in the three sectors (EEE, transport* and building) which contains information on affected and non-affected plastic or the most relevant polymers. For data and estimation see Box 2 and Box 4 for an estimate of plastic amount in EEE/WEEE and vehicles. The data needed for plastic/polymer used in construction is compiled on Boxes Box **5** toBox **10**.

**This might also include information on spare parts of vehicles and related trade and business*

7.3 Development of robust statistics for EEE/WEEE, the transport sector and construction sector

The United Nations Statistics Division (UNSD) and the United Nations Environment Programme contribute to the development of the UNSD International Environment Statistics Database with a biennial data collection. This UN Framework for the Development of Environment Statistics (FDES) [22] includes for the generation of national statistical data a Subcomponent 3.3 “Generation and Management of Waste”. While for e-waste, a detailed section has been developed in the questionnaire, this has not been developed (yet) and is not requested yet for the transport sector or the building and construction sector. Such a request might come in the future

Box 16: Recommendation for developing robust statistics for EEE/WEEE, transport and construction sector

- Developing robust statistics for the transport sector and the building and construction sector.
- The NSO would fill in the national data in this questionnaire in the best case from data available in the NSO database. If further data are needed, other institutions would be approached for data, or inventory activities be initiated and conducted to generate the data.
- Detailed information on specific hazardous waste such as POPs waste and POPs in products in use and stocks should be available on national levels in the NSO and other institutions.
- Extending slightly the levels of details for the collection of information on EEE/WEEE categories (see Table 1), the database of the NSO or a ministry responsible for WEEE and EEE (use/import) would include information that provides data relevant for POPs inventory (Table 1) and the more general data needed for reporting to FDES.

[22] The FDES structure links waste statistics to the International Standard Industrial Classification (ISIC), which facilitates the integration with economic statistics. This can further be linked to System of National Accounts (SNA) and to the System of Environmental-Economic Accounting (SEEA).

- A more detailed inventory might be developed in the frame of POPs inventories for the Stockholm Convention and CFC, HCFC and HFC inventory for UNFCCC and the Montreal Protocol for the transport sector and building/construction sector. This might serve in future data for the UN Framework for the Development of Environment Statistics

7.4 Other chemicals of concern listed in MEAs where related inventory data are needed

For effective management of POPs, the use or, where appropriate, the expansion of synergies among the relevant global multilateral environmental agreements (MEAs) on chemicals based on the division of tasks is important. The importance of cooperation has increased in recent years.

In a survey for a UNEP report (UNEP 2018) on the experience of developing and implementing NIPs for the Stockholm Convention, 95% of the Parties interviewed (all developing countries) confirmed that work of the convention would be linked to work on other multinational agreements: the Basel and Rotterdam Conventions, the Mercury Minamata Convention, the Montreal Protocol and the Strategic Approach to International Chemicals Management (SAICM). This synergistic implementation was driven primarily by limitations in human and financial resources, which made it difficult to comply with individual MEAs. In this respect, the synergistic approach has proven to be the most cost-effective and technically feasible. From this perspective, consideration should be given to how to further national capacity building for the convention (and other chemicals conventions) and that SAICM can be more closely interlinked in the future in developing countries to share information and knowledge, technical assistance and better finance international chemicals management.

Box 17: Recommendation on an integrated approach for assessment of POPs and other CoCs listed in MEAs

For an integrated approach, synergies should be considered and utilized in sectors where POPs and other CoCs (see Sections 2.1.2, 3.1.2 and 4.1.2) are present:

- Data compilation and inventory of POPs together with ODS, GHGs and mercury in major use sectors (EEE, transport and building sector).
- Expansion of synergies among the relevant global multilateral environmental agreements (MEAs) on chemicals.

Synergy approaches for inventory might be developed in the frame of POPs inventories for the Stockholm Convention in cooperation with CFC, HCFC and HFC inventory for the UNFCCC and the Montreal Protocol (ODS). This can contribute to future coordinated data for the UN Framework for the Development of Environment Statistics. This synergy can also be extended to the management of waste as appropriate.

7.5 Development of a national waste catalogue including codes for POPs containing waste

For the management of waste and pollutants such as POPs in waste, a categorization of waste is necessary, including for example, the definition of hazardous waste and POPs limits defining waste as hazardous (e.g., low POPs content or other limits as e.g. defined in German legislation [23]). Given the increasing importance of waste-related policies, the main recommendation to official national statistics providers is to develop a national work plan on

[23] A German regulation defines POPs limit at which certain POPs waste are considered hazardous waste in addition to considering low POPs limits for managing respective POPs waste fractions in ESM.

waste statistics (UNECE 2021). The inventories of POPs can on one hand contribute to such waste statistics in different sectors which are often not available in emerging economies. On the other hand, the development of a national waste statistic can provide a database for the POPs inventory part in the end-of-life of POP waste. The development of a robust waste catalogue is also a basis for the generation of robust statistical data on waste categories.

Waste wood is partly treated with POPs or other CoCs (e.g. creosote/PAHs or chromated copper arsenate (CCA)) and accumulates in various forms, compositions and quantities. These include, for example, wood and wood-based material residues from wood processing and wood from construction waste as well as used wood products such as furniture, or packaging.

Box 18: Recommendation on assessing, developing or improving the national waste catalogue including waste categories containing POPs

The existing official waste statistics and the waste catalogue should be reviewed and where needed be updated or developed to ensure that they:

- are consistent with the concepts, scope, definitions and classifications used in the international questionnaires of UN (UNSD and UNEP 2022), the Basel Convention reporting format and e.g. waste categories of OECD/Eurostat
- consider major waste fractions containing POPs (above low POPs limits), e.g.:
  - waste containing PCBs, POPs pesticides or PFOS/PFOA/PFHxS
  - certain plastic fractions of WEEE, construction and transport containing POPs (GGKP 2024a)
  - certain waste wood fractions (also considering other CoCs)
- are fit-for-purpose to respond to the needs of national and international waste-related policies.
- set national environmentally sound disposal standards for the respective waste categories to ensure the proper and harmless recycling of waste wood.
- develop and establish detailed requirements for the recycling and energy recovery as well as the disposal of these wastes

7.6 Recommendation on database information for PCBs containing equipment and buildings

In Section 6, some key information on PCB inventory needs is compiled, including information on closed and open applications. The recommended database information for suspected/verified PCB equipment is compiled in Box 11 in Section 5.2. The information on recommended database information for PCBs in buildings is in Section 5.4 and is also related to Section 4.2.6.

7.7 Recommendation on database information for POPs-contaminated sites

In Section 6, the importance of a database for POPs-contaminated sites are described, including key information on individual POPs and their relevance for POPs-contaminated sites along the life cycle. The recommended database information for suspected and verified POPs contaminated sites is compiled in Box 12 a list of recommended database information for a contaminated site database is compiled.

7.8 Improvement of custom reporting and related Comtrade data HS Codes

The Harmonized Commodity Description and Coding System (HS) was developed by the World Customs Organization for product classification, which describes all goods that may be traded internationally. For goods to successfully cross international borders, the correct HS code must be declared. This code determines the rate of duty and tax to be paid on the item in respective countries.

The HS code system uses a six-digit number internationally as the basis for further local country or regional classification (see GGKP 2024b). The Harmonized System includes 5,300 item or product descriptions displayed as "headings" and "subheadings". The importer or exporter has a legal responsibility to correctly classify the goods shipped. In theory, all countries using the HS Agreement should classify a given product with the same HS section, chapter, heading and subheading. However, in practice, this can be different. Also, customs in countries might have challenges with appropriate statistics and reporting. All 180 WTO member countries using the HS Agreement should classify a given product with the same HS six-digit code[24] (section, chapter, heading and subheading); not all countries apply the same HS version and the rules in an identical manner (GGKP 2024b). The reporting to the UN Comtrade database is not always consistent or is missing for certain exports (GGKP 2024b).

For certain POPs, specific HS Codes have been established while for several currently produced POPs no specific HS Codes are available but they are often imported under non-specific HS Codes e.g., for imported chemicals or products that may or may not contain the POP (GGKP 2024b). Furthermore, the largest share of industrial POPs is imported in products like plasticized or flame retarded plastics (e.g., PVC, rubber or PUR spray foam) or products containing such polymers.

For a consistent control of imports of POPs and POPs in products and their inventory and information transfer to NSO or other institutions, it is recommended to have a mechanism in place to consistently use and assess HS Codes and monitor imports containing POPs or potentially containing POPs (Box 19).

Box 19: Recommendation for HS Code use and custom reporting

The following are recommendations for the appropriate use of HS Codes and custom reporting

- Use the most recent HS Nomenclature 2022 edition (seventh edition) established under the International Convention on the Harmonized Commodity Description and Coding System, effective from 1 January 2022.
- Train customs authorities, companies and authorities on the use and reporting of HS Codes.
- For export of POPs or POPs containing mixtures it should be assured that the appropriate HS Codes are applied consistently.
- If chemicals are imported under HS Codes specific for POPs a mechanism for assessment of further use and checking if an exemption for use exists should be in place including respective action and restriction if no exemption is registered. The respective guidance documents of the BRS Secretariat on the import and export of POPs and related monitoring will be considered (UNEP 2019b, 2021g). Discovered imports of POPs would be included in the NSO database.
- If the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) is implemented, then imports and exports of chemicals are accompanied by safety data sheets (SDS) and CAS numbers. These CAS numbers are specific for a certain chemical and can be used as an identifier of POPs if the HS Codes for these POPs are not specific. A mechanism for an assessment or spot check of chemicals or products imported under HS Codes under which POPs can be imported is recommended (UNEP 2021g).

[24] Some countries or regions use 8, 10 or longer digit codes (GGKP 2024b). But all are based on the six-digit codes which are the first 6 digits.

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