BROCHURE

Managing POPs:
Stakeholders in the Electronics Sector

Subject to Output 4.1 of the GEF ID 10785 project titled: "Global Development, Review and Update of National Implementation Plans (NIPs) under the Stockholm Convention (SC) on Persistent Organic Pollutants (POPs)"

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The GGKP is a global community of organizations and experts committed to collaboratively generating, managing and sharing green growth knowledge. Led by the Global Green Growth Institute (GGGI), Organisation for Economic Co-operation and Development (OECD), United Nations Environment Programme (UNEP), United Nations Industrial Development Organization (UNIDO) and World Bank Group, the GGKP draws together over 90 partner organizations. For more information, visit www.greengrowthknowledge.org.

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This brochure was developed by Anastasiya Buchok (Senior Project Associate, GGKP, GGGI), summarizing guidance authored by Dr. Roland Weber: "Sectoral guidance for inventories of POPs and other chemicals of concern in buildings/construction, electrical and electronic equipment, and vehicles". Technical review was provided by Dr. Roland Weber, an international consultant specializing in Persistent Organic Pollutants (POPs) and National Implementation Plans for POPs reduction and control.

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Introduction

This brochure highlights stakeholders involved in the management of Persistent Organic Pollutants (POPs) and other Chemicals of Concern (CoC) in the electronics sector. It is part of a series, with additional brochures exploring the construction and transport sectors (GGKP 2024a; GGKP 2024b).

POPs pose significant environmental and health risks, making their management a global priority under the Stockholm Convention. Stakeholders in the electronics sector play a critical role in addressing this challenge, as POPs can be present in plastics and other polymers, electronic equipment and electronic waste, impacting both people and the environment. By exploring who are the stakeholders at each stage of the electronics lifecycle, this brochure aims to help:

- Identify potential groups of stakeholders for effective POPs management and awareness raising
- Identify potential sources of POPs and period of their use in electronics
- Identify other CoC in electronics
- Implement preventive measures and sustainable practices

This informative guide is designed to be a valuable resource for a diverse audience, including:

- National focal points of the Stockholm Convention
- Policymakers and government officials involved in the NIP review and update process
- The general public
- Stakeholders in the electronics industry

Join us in this journey towards a cleaner, safer electronics industry. Together, we can build a future where progress harmonizes with environmental stewardship, and where every stakeholder plays a vital role in achieving this vision.

POPs in the Electronics Sector: Overview

In 2022, a staggering 62 million tonnes of Waste Electrical and Electronic Equipment (WEEE), or e-waste, were generated globally, with over 12 million tonnes composed of plastic, necessitating environmentally sound management (Baldé et al 2024; UNEP 2021).

Anticipating a future surge in e-waste volume, the recycling landscape faces hurdles. Despite the high quality and value of e-waste plastic, recycling rates remain low due to the presence of such POPs as PBDEs and HBCD, and the intricate mixtures of Electronic and Electrical Equipment (EEE) plastics (UNEP 2021). Throughout the lifecycle of EEE, hazardous substances released from EEE/WEEE pose significant threats to human health and the environment.

From manufacturing, where direct contact with CoC can lead to adverse effects, to the use phase, where non-chemically bonded POPs are released into indoor environments, contaminating air and dust and exposing individuals (ILO 2012; Rauert & Harrad 2015; Lucattini et al. 2018).

Electronic waste, often undergoes cross-border movements from industrial to developing countries, contributing to large-scale releases and contamination, especially through the open burning of WEEE plastic (ILO 2012; Lebbie et al. 2021; Petrlik et al. 2022).

While most POPs literature often focuses on stakeholder engagement for inventory development, this brochure goes beyond the data collection exercise. It examines key stages of electronics' lifecycle, involving both direct and indirect stakeholders for comprehensive POPs management and awareness raising.

The subsequent sections offer an overview of the areas of application, products, materials and substances in the electronics sector that utilize or contain POPs (*Table 1*); periods of use of POPs in the sector (*Table 2*); relevant groups of stakeholders throughout the life cycle of electronics (*Table 3*); and other CoC present in electronics (*Table 4*).

POPs in the Electronics Sector: Areas of Application

Table 1: Overview of the areas of application, products, materials and substances in the electronics that utilise or contain POPs

POPs	Application
C-decaBDE	Flame retardant with use in many plastic types in casings of EEE, cables, and other plastic parts in EEE
C-octaBDE (hexaBDE and heptaBDE)	Flame retardant with former use mainly in cathode ray tube casings in TV and computers, office equipment
C-pentaBDE (tetraBDE/ pentaBDE)	Flame retardant in PVC cables, printed circuit boards, and polyurethane (PUR) foam
HBCD	Minor flame retardant used in high impact polystyrene (HIPS) in CRT casings and other HIPS plastic parts
SCCP (and MCCP)	Plasticizer and flame retardant in cables and other PVC and rubber parts
PCBs and PCNs	Capacitors in certain equipment, such as ballasts in fluorescent lamps; cables (PVC and others)
PFOA	Medical devices; non intentional in fluoropolymers
PFOS	Medical devices
Dechlorane Plus	Flame retardant use for wire and printed circuit board housing, other plastics and rubber parts
UV-328	UV absorber in liquid crystal displays

POPs in the Electronics Sector: Period of Use

The electronics industry has used POPs since the 1930s, and while many have been banned from production, managing POPs in existing electronics and waste remains challenging. Manufacturers' reluctance to disclose plastic additives complicates separation, recycling and efforts towards a circular economy.

When engaging stakeholders in POPs management within the electronics sector, it is crucial to consider the historical periods of POPs usage. Understanding these timeframes helps identify relevant stakeholders and supports data collection and inventory efforts.

For POPs no longer in use, efforts should focus on assessing in-use stock and managing waste and recycling. For POPs still in use, a comprehensive lifecycle – covering R&D, production, use and end-of-life stages – is essential.

Table 2 provides a summary of POPs usage periods in electronics to guide stakeholder identification.

Table 2: Overview of the periods of use of POPs in electronics sector

Chemical	Current use	Former use	Period of use
C-decaBDE	■	■	1970s to present
C-octaBDE (hexaBDE and heptaBDE)		■	1970s - 2000s
C-pentaBDE (tetraBDE/pentaBDE)		■	1970s - 2000s
HBCD		■	1970s - 2010s
SCCP* and MCCP	■	■	to present
PCBs		■	1950s - 1980s
PCNs		■	1930s - 1960s
PFOA and PFOA-related compounds	■	■	1960s to present
PFOS and PFOS-related compounds		■	until 2000s
Dechlorane Plus		■	1970s - 2020s
UV-328	■	■	1970s to present

Source: GGKP (2024c)

* SCCP was exempted for use in PVC until 2023

■ Use of chemical

POPs in the Electronics Sector: Why Stakeholders?

POPs such as c-decaBDE, UV-328 and Dechlorane Plus remain in use in the electronics sector with specific exemptions, while SCCPs and MCCPs continue to be used, despite the SCCP exemption having expired. These substances are still present in the production of plastic parts for some new electronics. Due to the long service life of certain electronic devices of more than 25 years, most legacy POPs formerly used in EEE are still present in some stock of EEE and will eventually enter waste streams, requiring environmentally sound management.

Recycling and recovering plastic from WEEE must account for plastics containing POPs – both legacy POPs from discontinued production and those still in use (*Table 2*). Additionally, plastic and other parts of EEE/WEEE often contain other CoC, such as halogenated organo-phosphorus flame retardants (OPFRs) or phthalates (*Table 4*). Effective end-of-life management requires environmentally sound destruction of POP-containing plastics and removal of other CoC, enabling the recycling of clean plastic fractions. Stakeholder engagement is crucial for the comprehensive management of POPs throughout the lifecycle of electronics.

Here is why it matters:

Mitigating health and environmental risks
Identifying stakeholders from the industry responsible for the design of electronics, regulatory bodies, importers and retailers, and contractors to those unaware of POPs presence in electronics, allows for a comprehensive assessment of the potential risks associated with POPs and extended coverage for outreach. With this knowledge, preventive measures can be tailored to minimize health hazards and environmental contamination to a broader audience.

Regulatory compliance
Various regulations like the Restriction of Hazardous Substances (RoHS) and multilateral environmental agreements (MEAs) govern the use of POPs and other CoC in electronics and other sectors. Defining stakeholders helps in ensuring compliance with these regulations reducing legal liabilities.

Transparency and accountability
Clearly defining stakeholders fosters transparency in the production and further recycling of electronics. It ensures that everyone involved is aware of the presence and consequences of POPs and other CoC, promoting collective accountability for their safe handling, protection of the environment and human health.

Effective communication
Effective stakeholder management facilitates communication between different stakeholder groups. This open dialogue enables the sharing of knowledge, best practices and safety protocols related to POPs, ultimately enhancing efficiency of the Stockholm Convention on POPs and other MEAs.

Sustainability and reputation
In today's environmentally conscious world, sustainable electronics is highly valued. Engaging stakeholders in POPs and other CoC management aligns with sustainability goals, enhancing the industry's reputation and attracting environmentally responsible partners and clients.

POPs in the Electronics Sector: Who Are the Stakeholders?

Table 3 below provides an overview of potential stakeholders directly and indirectly involved in POPs and other CoC use and management throughout the lifecycle of electronics.

Table 3: Relevant groups of stakeholders throughout the lifecycle of electronics

Throughout the Lifecycle	• Ministry of Health, Ministry of Environment and Climate Change, Ministry of Gender, Children and Social Protection • Environmental agencies, Disaster management agency • Community and neighborhood groups • Environmental NGOs • Indigenous people • Youth, women and other gender groups • Civil society organizations

Design and Research	Production	Operation and Use

• Regulatory Bodies and Authorities
  ◦ Ministry of Industry
  ◦ National regulator/accreditation body for electronic products
• Industry and Technical Service Providers
  ◦ Original equipment manufacturers (OEMs)
  ◦ Electronics manufacturing companies
  ◦ Electronics engineers and designers
  ◦ Environmental consultants
• Plastic associations
• Research and development teams (scientists, researchers)
	• Ministry of Industry, Ministry of Labor
	• Industry and Technical Service Providers
	  ◦ Electronics manufacturing companies
	  ◦ Producers of raw materials and POPs containing items
	  ◦ Raw materials suppliers (importers, retailers, etc.)
	  ◦ Storage facilities
	• Quality and Compliance Bodies
	  ◦ Quality control and testing laboratories
	  ◦ Certification/accreditation bodies
	• Research Institutions
	• Trade associations, Plastic associations
	• Workforce
	  ◦ Workers of the factories, production and manufacturing facilities
	  ◦ Storage facilities workers
	  ◦ Labor unions
	• Project owners and end users
	• Corporate end users/consumers (medical institutions, offices, data centres, etc.)
		• Ministry/Department of Trade, Ministry of Labor
		• Companies providing repair and maintenance service for electronics
		• Trade associations, Plastic associations
		• Workforce
		  ◦ Employees of corporate end users of electronics
		  ◦ Employees of corporate
		  ◦ Operation and maintenance service workers
		  ◦ Labor unions
		• Project owners and end users
		• Corporate end users/consumers of electronics (offices, medical institutions, data centers, etc.)

End of Life (Waste Streams)

• Industry and Technical Service Providers
  ◦ E-waste collection companies/stations
  ◦ Waste management companies
  ◦ Dismantling and separation facilities
  ◦ Recycling facilities
  ◦ Incinerators
  ◦ Materials and parts buyers
  ◦ Buyers of recyclable component
• Organizations providing accreditation to recycling companies ensuring high standards of environmental responsibility and safety
• Workforce
  ◦ Individuals employed in collection, dismantling, separation, recycling and overall waste management
  ◦ Labor unions
• Corporate owners and operators of electronics (both private and public)
• Individual users of electronics

Other Chemicals of Concern: Electronics Sector

POPs are only a part of pollutants in EEE/WEEE that need to be managed in an environmentally sound manner. *Table 4* provides an overview of selected CoC relevant to other MEAs, and their major use in the electronic sector as a basis for their consideration. Please consult the sectoral guidance for details on these CoC (GGKP 2024c). In addition to the chemicals under MEAs, the EU RoHS Directive represents a substance-specific regulation for the electronic sector (https://rohsguide.com/rohs3.htm), an approach which has already been adopted in a similar manner in various countries (https://rohsguide.com/rohs-future.htm). A detailed overview on CoC in EEE/WEEE has been compiled by the Environmental Protection Agency in Sweden (Swedish EPA 2011). The collection and evaluation of data on the presence of CoC in the transport sector, coordinated with POPs inventory activities, could serve as a basis for (future) integrated management of pollutants in WEEE.

Table 4: Selected CoCs (other than POPs) in electronics related to MEAs or SAICM

CoC	MEA or SAICM	Short description	Use in EEE	Relevance
Heavy metals such as lead, cadmium and mercury	SAICM, Minamata Convention	Toxic metals, neurodevelopmental disorder	Used in a variety of EEE products	High
Polycyclic aromatic hydrocarbons (PAHs)	UNECE LRTAP Convention	Many PAHs are carcinogenic, mutagenic, or toxic for reproduction	Unintentional trace contaminants in black plastics and rubber parts	Medium
Other PFASs (not POPs)	SAICM	Very persistent, very mobile (compounds or degradation product)	Flame retardant (PFBS); NIAS in fluoropolymers (and thermal degradation products)	Medium
Phthalates	SAICM EPI (EDC)	Certain phthalates are EDCs and reprotoxic	Plasticiser in cables and other plastic parts (mainly PVC)	Medium
Halogenated organo-phosphorous flame retardants (OPFRs)	SAICM EPI14	Certain halogenated OPFRs are carcinogen or toxic for reproduction	Major flame retardants in casings and other plastic parts	Medium
Asbestos	Rotterdam Convention Annex III	Classified as carcinogenic to humans	Electrical panels, wire insulation, cable wrap and electrical paper	Medium
CFCs, HCFCs, HFCs	Montreal Protocol	Ozone depleting substances; GHG	Refrigerants in air conditioner, cooling equipment; heat pumps	High
Tributyltin compounds	Rotterdam Convention Annex III	Neurotoxic and immunotoxic	Biocides in anti-fouling paints, preservatives for wood and others. Organotin stabilizers impurity (PVC)	Medium
Manufactured nano-materials	EPI under SAICM	The combination of particle size with certain hazards may affect impacts	Various uses	Low

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