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Matters related to the implementation of the Convention: measures to reduce or eliminate releases from intentional production and use: polychlorinated biphenyls

Preliminary assessment of efforts made toward the elimination of polychlorinated biphenyls

Note by the Secretariat

1. As referred to in the note by the Secretariat on polychlorinated biphenyls (UNEP/POPS/COP.7/6), in its leadership role within the Polychlorinated Biphenyls Elimination Network (PEN), the Chemicals Branch of the Division of Technology, Industry and Economics of the United Nations Environment Programme (UNEP Chemicals), in cooperation with the Secretariat and in consultation with the PEN advisory committee, developed a preliminary assessment of efforts made toward the elimination of polychlorinated biphenyls, taking into account national reports submitted by parties pursuant to Article 15 of the Convention and other relevant sources of information.

2. The preliminary assessment of efforts made toward the elimination of polychlorinated biphenyls submitted by UNEP Chemicals is reproduced in the annex to the present note. The present note, including its annex, has not been formally edited.

* UNEP/POPS/COP.7/1.

Annex

Preliminary assessment of efforts made toward the elimination of polychlorinated biphenyls developed by UNEP Chemicals, in cooperation with the Secretariat and in consultation with the PEN advisory committee

Preliminary Assessment of Efforts Made Toward the Elimination of Polychlorinated Biphenyls (PCB)

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Acronyms and Abbreviations

BCRC-AF	Basel Convention Regional Centre for Francophone Africa
BRS Secretariat	Secretariat of the Basel, Rotterdam and Stockholm Conventions
CLEEN	Chemical Legislation European Enforcement Network
CEE	Central and Eastern Europe
COP	Conference of the Parties
DPRK	Democratic People's Republic of Korea
DTIE	Division of Technology, Industry and Economics
EU	European Union
GEF	Global Environment Facility
GRULAC	Latin America and the Caribbean Countries Group
NAFTA	North American Free Trade Agreement
NIPs	National Implementation Plans
PBBs	Polybrominated biphenyls
PCB	Polychlorinated biphenyl(s)
PCTs	Polychlorinated terphenyls
PEN	PCB Elimination Network
PIFs	Project identification forms
POPs	Persistent Organic Pollutants
UN Comtrade	United Nations Commodity Trade Statistics Database
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
WEOG	Western European and Others Group

Executive Summary

At its sixth meeting, in Geneva, Switzerland, 28 April-10 May 2013, the Conference of the Parties (COP) to the Stockholm Convention on Persistent Organic Pollutants (POPs) requested the BRS Secretariat[1] to prepare a report on progress toward the elimination of polychlorinated biphenyls (PCB) on the basis of the third national reports submitted by Parties pursuant to Article 15 of the Stockholm Convention[2]. In its leadership role within the PCB Elimination Network (PEN), UNEP Chemicals[3], in cooperation with the BRS Secretariat and in consultation with the PEN advisory committee, developed a preliminary assessment of efforts made toward the elimination of PCB, taking into account national reports submitted by parties pursuant to Article 15 of the Convention and other relevant sources of information. It aims to summarize available information on the amounts of PCB produced, eliminated to date, and still in need of elimination.

As the information available from the third national reports was found insufficient to fulfil the mandate, additional sources of information were consulted, including national implementation plans (NIPs), national reports under the Basel Convention, Global Environment Facility (GEF) projects, and technical reports. Moreover, a survey was conducted among Basel and Stockholm Convention Regional Centers, UNEP Regional Offices, GEF implementing agencies, and the advisory committee of the PEN. Data were systematically collected from these sources and assessed by making extrapolations, harmonizing units, avoiding double counting, *etc*. In a last step, the total mass of PCB at various stages in the life-cycle was obtained.

In compiling and evaluating the data, numerous challenges were encountered, resulting in some important limitations as regards the statistical analysis and the conclusions to be drawn: Most notably, the vast majority of national inventories were found to be preliminary and very limited in scope and coverage. Information on already executed elimination was equally incomplete. For some countries, no information was available. This report is therefore a preliminary assessment and the estimates are subject to a high degree of uncertainty. Nonetheless, the assessment is sufficient to provide a general idea of the progress towards eliminating PCB.

The total amount of PCB is estimated between 1 and 1.5 million tonnes, produced by a small number of countries (12) and companies (17) since the late 1920s. Available information suggests that production of PCB might be ongoing in at least one country. It is important to note that due to dilution and cross-contamination, the mass of equipment and materials containing or contaminated with PCB is much larger than the amounts of PCB produced.

According to the data provided in the national reports, only less than 600 thousand tonnes of PCB and PCB-containing equipment have been eliminated to date. This report, including the above-mentioned additional sources, estimates that between 1.6 and 3.1 million tonnes have been destroyed. Expert judgment suggests that the actual amounts destroyed are in the upper part of the range or possibly even beyond. According to available data, almost 50 % of the total was eliminated between 2002 and 2006, with a sharp increase after 2001. The steady decline from 2007 onwards may suggest that disposal activities are losing momentum as the 'low-hanging fruits' have already been picked. It is estimated that GEF-funded projects account for the elimination of at least 15 thousand tonnes to date. In addition to the amounts that have already been eliminated, an estimated 0.5 to 3.7 million tonnes are scheduled for elimination through national or regional action plans as well as GEF-funded projects.

[1] The Secretariat of the Basel, Rotterdam and Stockholm Conventions
[2] Conference of the Parties to the Stockholm Convention, 2013
[3] The Chemicals Branch of the United Nations Environment Programme's (UNEP) Division of Technology, Industry and Economics

The progress in eliminating PCB varies considerably across UN regions. About 87 % of the eliminated mass was from the Asia-Pacific Region and the Western European and Others Group (WEOG). The regions also followed different approaches in disposing of PCB wastes. While the Latin American and Caribbean Group (GRULAC), the African Region, and – to a lesser extent – the Central and Eastern Europe (CEE) Region exported most of their waste for destruction in other regions, WEOG and – slightly less pronounced – the Asia-Pacific Region destroyed almost all of their waste either domestically or within the region.

The total mass of PCB equipment and materials that still needs to be eliminated is estimated at *ca*. 9.3 million tonnes. Transformers account for the largest share, followed by capacitors. Data on the amounts of PCB in open applications are very scarce and limited to very few developed countries. This estimate is at best indicative, given the many limitations discussed above. It is difficult to judge whether it is more likely to underestimate or overestimate the amounts still in need of elimination.

Almost 84 % of the total mass of equipment and materials containing or contaminated with PCB has been reported by the Asia-Pacific Region, followed by the CEE Region at *ca*. nine percent, WEOG and the African Region at *ca*. three percent, and GRULAC at *ca*. two percent. This large discrepancy between the Asia-Pacific Region and the other regions can to a far extent be explained by varying quality in reporting. For the African Region in particular, data are incomplete and need improvement. Meanwhile, in the case of WEOG, only small amounts in closed applications remain to be eliminated.

Based on these data, it is estimated that approximately 20 % of the total amount of PCB has been eliminated to date – about 80 % remain to be destroyed. The African Region has the longest way ahead towards achieving the goal of eliminating PCB: *Ca*. 97 % still need to be eliminated. The approximate shares lie at 89 % for the Asia-Pacific Region, 81 % for the CEE Region, 64 % for GRULAC and 19 % for WEOG.

Further work will be necessary in order to refine the present analysis as well as to incorporate additional data as they become available. Despite the preliminary character of this assessment, a number of conclusions and recommendations can be drawn.

It is strongly recommended that steps are taken to ensure that comprehensive, clear, reliable and well-structured data become available. For this purpose, inventories need to be completed and improved, national databases established, methodologies harmonized, and the reporting format consolidated and the NIP guidance amended. It is also timely to address open applications.

The limited data available are sufficient to highlight the need to expedite and intensify efforts to eliminate PCB to meet the 2025/2028 goals of the Stockholm Convention. While some progress – although difficult to quantify – has been made towards the elimination of PCB, the majority of countries (with some notable exceptions) are currently not on track to achieve the environmentally sound management of PCB by 2028. It is also necessary to confirm whether PCB are still being produced. If so, steps need to be taken to ensure that they are phased out as soon as possible. This may need to include technology transfer. In order to move forward, it will be necessary to leverage substantial and additional financial, human and technical resources. There is an abundance of expertise and materials developed within the framework of former and existing PCB projects that can be used in achieving the objectives.

1. Introduction and Mandate

The Stockholm Convention on POPs[4] entered into force in May 2004. It aims to eliminate the production, use, and trade of POPs in order to protect human health and the environment. Among others, the Convention obliges Parties to eliminate the use of PCB in equipment by 2025 (Article 3, paragraph (1) (a)). Moreover, Parties have to make determined efforts designed to lead to environmentally sound waste management of liquids containing PCB and equipment contaminated with PCB having a PCB content above 0.005 % as soon as possible but no later than 2028, subject to review by the COP (Article A, Part II, paragraph (e)).

At its sixth meeting, held in Geneva, Switzerland from 28 April to 10 May 2013, the COP to the Stockholm Convention, through decision SC-6/6 on PCB requested the Secretariat to prepare a report on progress towards the elimination of PCB[5]. The report has to be prepared in accordance with paragraph (h) of part II of Annex A to the Convention, which notes that the COP shall review progress towards elimination of PCB at five year intervals or other period, as appropriate, taking into account the reports on progress in eliminating PCB submitted by Parties.

The report has to be compiled on the basis of the third national reports submitted by Parties pursuant to Article 15, according to which Parties shall, *inter alia*, provide to the Secretariat statistical data on their total quantities of production, import and export of the chemicals listed in Annex A and Annex B, including PCB. The Secretariat was further requested to submit the report to the COP for evaluation at its seventh meeting, to be held in May 2015. That information, which has been made available in full (see UNEP/POPS/COP.7/INF/36) and summarized (see UNEP/POPS/COP.7/27), was insufficient to assess progress toward the elimination of PCB.

In its leadership role within the PEN, UNEP Chemicals, in cooperation with the BRS Secretariat and in consultation with the PEN advisory committee, developed a preliminary assessment of efforts made toward the elimination of polychlorinated biphenyls, taking into account national reports submitted by parties pursuant to Article 15 of the Convention and other relevant sources of information.

The objective of this report is to summarize available information on the amounts of PCB produced, the amounts that have been eliminated and the amounts that still need to be eliminated, in order to determine how much progress has been made towards the elimination of PCB. Several elements need to be included in such an analysis: First, it is necessary to gain an understanding of how much PCB has been produced and, to the extent possible, how much equipment and material has been manufactured with PCB. Next, the report provides an estimate of the amounts that have already been destroyed. Finally, an estimate of the amounts that are still in need of elimination is given. The substantive part of this report is structured according to these three elements. It is preceded by a discussion of the sources of information and methodology relied upon for this report as well as the limitations and challenges that were encountered in gathering data and conducting the statistical analysis.

This report is an initial assessment based on the data available. Inventories are mostly of preliminary nature and not suited to give a precise picture. The same applies to reporting on the amounts of PCB that have been eliminated. The estimates given below can therefore only be made with a high degree of uncertainty. While the findings should be interpreted with caution, they are sufficient to give a general idea of the progress towards PCB elimination. Based on the conclusions that can be drawn from these findings, the report provides recommendations on the way forward towards elimination of PCB. Many countries have made efforts to identify and eliminate existing stockpiles of liquid and solid PCB wastes. However, progress has been limited and varies considerably across

[4] UNEP, 2001
[5] Conference of the Parties to the Stockholm Convention, 2013

regions. In order to achieve the objective of the Stockholm Convention, it will be necessary to upscale efforts substantially, including by leveraging additional funding for the identification and elimination of PCB wastes and making destruction technologies available to developing countries and countries with economies in transition. Parties will also need to address open applications which have so far not received sufficient attention.

2. Methodology

2.1. Sources of Information

According to this report's mandate, the evaluation of progress towards eliminating PCB is to be based on the third national reports under the Stockholm Convention. Deadline for submission was 31 August 2014. Among others, the reports contain information on Parties' progress in eliminating PCB. While useful data are available from these reports, they are not sufficient to draw a comprehensive picture of the situation.

For many countries, little, if any, relevant quantitative information is available. As of 27 January 2015, out of the 179 Parties to the Convention, only 58 submitted the third national reports[6]. Where available, reporting is often fragmented and incomplete. Moreover, despite the standardized reporting format, there is considerable variance in how data are presented (many countries use the comments section, rather than the table, thereby reverting to their own format). Finally, closer examination of the data reveals instances where the units of measurement have apparently been confused[7].

Overall, the data available from the third national reports were found insufficient to fulfil the mandate. Therefore, additional sources of information had to be consulted in order to (a) prepare a comprehensive report on quantitative data and (b) to fill the gaps where available information was incomplete. The following additional sources have been consulted:

- The first and second national reports submitted by Parties under the Stockholm Convention reporting procedure. Deadlines for submission had been set at 31 December 2006 and 31 October 2010, but were extended to 31 July 2007 and 31 July 2011, respectively. 45 Parties submitted their first national report and 95 the second report[8].
- Initial and – where available –updated NIPs[9]: According to Article 7 of the Stockholm Convention, Parties are required to prepare and submit a plan for the implementation of their obligations under the Convention, and to review and update it, as appropriate, on a periodic basis. While general in scope, the NIPs include sections on PCB, including information on – often preliminary – inventories as well as amounts of PCB eliminated. As of 27 January 2015, 152 Parties have submitted their first NIP and 19 of them the reviewed and updated one.
- National reporting under the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal[10]: Parties to the Basel Convention provide data on imports and exports of hazardous wastes and other wastes, including PCB wastes at 0.005 %. The relevant codes are A1180[11], A1190[12] and A3180[13]. Data were available for the years 2009, 2010 and 2011.

[6] Secretariat of the Basel, Rotterdam and Stockholm Conventions, 2014a

[7] Tonnes reported as kilogramme or vice versa

[8] Secretariat of the Basel, Rotterdam and Stockholm Conventions, 2014a

[9] *Ibid.*, 2014b

[10] *Ibid*., 2009, 2010, 2011

[11] Waste electrical and electronic assemblies or scrap containing components such as accumulators and other batteries included on list A, mercury-switches, glass from cathode-ray tubes and other activated glass and PCB-capacitors, or contaminated with Annex I constituents (*e.g*., cadmium, mercury, lead, polychlorinated biphenyl) to an extent that they possess any of the characteristics contained in Annex III (note the related entry on list B B1110).

[12] Waste metal cables coated or insulated with plastics containing or contaminated with coal tar, PCB 11 , lead, cadmium, other organohalogen compounds or other Annex I constituents to an extent that they exhibit Annex III characteristics.

- PCB-related projects funded by the GEF: These projects typically include components such as the development of national inventories, the environmentally sound management of PCB and the elimination of national stockpiles of PCB. Implementing agencies are the United Nations Development Programme (UNDP), the United Nations Industrial Development Organization (UNIDO), the World Bank and United Nations Environment Programme. The GEF website currently lists 40 approved national projects and three approved regional projects targeting PCB; However, there may be additional projects on chemicals management that include PCB[14]. Most of these are currently under implementation. For the purpose of this report, data have been extracted from documents such as project identification forms (PIFs) and, where available, mid-term and/or final evaluation reports[15].
- The United Nations Commodity Trade Statistics Database (UN Comtrade)[16]: UN Comtrade collects standardized official annual trade statistics reported by countries. While concerned with merchandise trade, the statistics also cover the category 'waste oils containing polychlorinated biphenyls (PCBs)/polychlorinated terphenyls (PCTs)/polybrominated biphenyls (PBBs)'[17].
- A survey: The Secretariat and UNEP Chemicals Branch conducted a survey for the purpose of gathering additional, up-to-date information on the amounts of PCB (a) destroyed within national boundaries, (b) exported for destruction, (c) imported for destruction, (d) stored safely awaiting destruction, and (e) still available/in use or in need of safe storage/destruction. While the primary aim was to collect data from GEF implementing agencies on completed and ongoing GEF projects, the reporting template (see Annex A) was also sent to the members of the advisory committee of the PEN, the UNEP Regional Offices, and the Basel and Stockholm Convention Regional Centres.

In addition, information from technical reports and other sources was consulted, including

- Peer-reviewed articles published in scientific journals
- The global[18] and regional reports of UNEP's Regionally Based Assessment of Persistent Toxic Substances[19]
- The Basel Convention Regional Centre for Francophone Africa's (BCRC-AF) 'consolidated inventory report' of the project on 'demonstration of a regional approach to environmentally sound management of PCB liquid wastes and transformers and capacitors containing PCB'[20]
- Regional workshops organized under the umbrella of the Stockholm Convention[21]
- Information available through regional economic integration organizations, such as the European Union (EU) (*e.g.*, the Chemical Legislation European Enforcement Network's (CLEEN) 'EuroPCB: inventory PCB enforcement in member states'[22] or North American Free Trade Agreement's (NAFTA) (*e.g.*, the 'PCB Implementation Task Force Final Evaluation Report on the North American Regional Action Plan on PCBs'[23])

[13] Wastes, substances and articles containing, consisting of or contaminated with polychlorinated biphenyl (PCB), poly-chlorinated terphenyl (PCT), polychlorinated naphthalene (PCN) or polybrominated biphenyl (PBB), or any other polybrominated analogues of these compounds.
[14] GEF, 2014. The project data base publicly available on the GEF's website has been searched using the query 'PCB'. It should be noted that there may be additional projects covering PCB inventories and/or disposal, notably those more generally targeted at the environmentally sound management of POPs. However, for this initial report, these have not been taken into account.
[15] Some project documents (*e.g.* mid-term or final evaluations) have been provided by the implementing agencies, others have been accessed on the website of the GEF (GEF, 2014).
[16] United Nations, 2014
[17] Code 271091
[18] UNEP, 2003
[19] *Ibid.*, 2002a, 2002b, 2002c, 2002d, 2002e, 2002f, 2002g, 2002h, 2002i, 2002j, 2002k, 2002l
[20] Basel Convention Regional Centre for French-speaking countries in Africa in Senegal, 2007
[21] Secretariat of the Basel, Rotterdam and Stockholm Conventions, 2014c
[22] Chemical Legislation European Enforcement Network, 2005a, 2005b
[23] CEC, 2006

2.2. Terminology and classifications

The Stockholm Convention requests parties to identify, label and remove from use equipment containing greater than 0.05 % PCB and volumes greater than 5 litres as well equipment containing greater than 0.005 % PCB and volumes greater than 0.05 litres (Annex A, part II, paragraph (a))[24]. In line with this approach, existing stockpiles and the amounts destroyed reported in this document refer to equipment containing greater than 0.005 % and volumes greater than 0.05 litres, unless otherwise specified.

Many countries classify equipment containing greater than 0.05% PCB as equipment manufactured with PCB[25] and equipment containing between 0.005% and 0.05% PCB as equipment contaminated with PCB[26]. This distinction is also used in the present report. Some countries distinguish between scheduled and non-scheduled[27] or high- and low-density PCB[28], respectively. Some countries refer to equipment with a PCB content between 0.0002% and 0.005% as equipment with 'residual PCB'[29]. Equipment containing less than 0.0005% is often considered 'PCB-free'[30]. Alternatively, many countries set the threshold at 0.0002%[31]. The term 'PCB-assumed' is mostly used to refer to equipment or material that is considered as containing greater than 0.005% PCB until further laboratory analysis can specify the PCB content[32] (test kits used for initial screening do not provide conclusive results and are only the first stage in determining PCB content[33]).Many countries have made efforts to identify and eliminate existing stockpiles of liquid and solid PCB wastes. Elimination is here understood as referring to the destruction or irreversible transformation of PCB wastes. A number of methods are commercially available for this purpose and are listed in the Basel Convention's general technical guidelines for the environmentally sound management of wastes consisting of, containing or contaminated with POPs[34].

2.3. Data Collection and Evaluation

In a systematic approach, first, UNEP Chemicals set-up a table (MsExel format) listing the countries by regional groups and organized the variables of interest in columns for each country: Therein, one worksheet lists the amounts of PCB still in need of elimination, including the year to which the data apply (*e.g.* the year in which a number of transformers were incinerated or the year in which the specified amount of capacitors were in use), type of equipment, number of units, solid mass, liquid mass, total mass, PCB content, status in life-cycle, year in which the information was provided, and the specific source of information. Where necessary, comments were added providing further relevant information or clarifying assumptions that had been made in gathering the data (*e.g*. conversions or extrapolations). In a second worksheet, the amounts of PCB already eliminated were summarized; additional columns featured the disposal operation (*e.g.*, high-temperature incineration or alkali-metal reduction), whether the waste was domestically disposed, imported or exported, and the status, *i.e.* if elimination was complete, ongoing or planned.[35]

[24] UNEP, 2001
[25] Sometimes also referred to as 'pure PCB'.
[26] See for example: Ecuador, 2006, p. p. 45
[27] See for example: Commonwealth of Australia, 2006, p. 35
[28] See for example: People's Republic of China, 2007, p. 76
[29] See for example: Mexico Distrito Federal, 2007, p. 93
[30] See for example: Republique de Madagascar, 2008, p. 41.
[31] See for example: Ministry of Environment and Forests Bangladesh, 2007, p. 101
[32] See for example: Ministry of Environment, Forestry and Water Administration of Albania, 2006, p. 13
[33] UNEP Chemicals branch, 2002, p. 20.
[34] Basel Convention, no date.
[35] The full data set will be published on the website of the Secretariat of the Basel, Rotterdam and Stockholm Conventions (BRS Secretariat).

Second, the table was populated with data from the sources listed above. The data were sorted on three levels: first the country, second the source of information and third the year to which the information applied. In many instances, adjustments, assumptions and/or extrapolations had to be made to insert the data in the respective columns of interest, including the following:

- Where no information was given on the PCB content of the equipment or material in question, it was assumed to contain/be contaminated with PCB at concentrations greater than 0.005%[36].
- If specification on the volume was lacking, it was assumed to be greater than 0.05 litres.
- While the PCB content is often specified in the sources, the volume is specified in very few instances. For the purpose of this report, it is therefore assumed that where equipment or material is reported as containing or contaminated with PCB, it also containing volumes greater than 0.05 litres.
- Where expert judgment suggested that a quantity was reported using the wrong unit of measurement (*e.g.* as kilogram instead of tonne) or separator (*i.e.* using a comma for decimal marks or a dot as thousands separator), it was adjusted accordingly.
- Some countries report liquid in volume (*e.g.*, litres), rather than mass (*e.g.*, tonnes). In order to include such data in the statistical evaluation, it was necessary to convert these volumes into mass. PCB has a density between 1.182 kg/L and 1.566 kg/L and for the purpose of this report, a density of 1.5 kg/L is assumed [37]. It should be noted that the density may in fact often be much lower due to a dilution of the oil; however, it is considered more desirable to over- rather than to underestimate the amounts of PCB still to be destroyed.
- Another harmonization included the conversion of short tons to metric tons.
- If a range of values was given, the middle point was taken to allow for statistical analysis, specifying the whole range in the comments cell.
- Where an estimate of the total amount of equipment typically containing or contaminated with PCB and an estimation of the share was given based on sample analysis, extrapolations were made. This was only done where the sample size was considered sufficiently high and representative of the national situation. A number of preliminary inventories estimate the total amounts of equipment and material typically containing or contaminated with PCB, such as transformers or capacitors, in the country, without an estimation of the share actually containing or contaminated with PCB. In such cases, the relevant figures have not been included as they would disproportionately skew the overall results.
- Whenever data were reported for an interval (*i.e.* year x until year y), it was distributed evenly across the years.

Third, the gathered data were 'cleaned' by examining each row and cell individually. Extreme outliers were subjected to special scrutiny and, in case of doubt regarding the accuracy of the data, either removed from the set with a corresponding note in the comments or, if possible, otherwise adjusted. In doing so, the data were interpreted in the light of further information provided by the country in question as well as by other countries. Thus, comparisons were made with countries that can be assumed to have similar patterns in terms of PCB use and destruction based on factors such as electricity consumption or technological capacity, additional sources were used to validate or reject, *etc*.

Since multiple sources have been used to gather data, there is a potential risk of 'double counting', *i.e.* different sources reporting the same amounts. To avoid this, efforts were made for each country

[36] During the preparation of inventories, it is often assumed that non-labeled equipment was manufactured with PCB, equipment containing a producer label not mentioning the PCB content is suspected to be contaminated with PCB and that equipment having a green 'PCB-free' label is free of PCB (UNEP Chemicals Branch, 2002, p. 9, p. 13; ibid., 2013, pp. 29-31; UNEP, no date, p. iv)

[37] This is in line with the Secretariat of the Basel Convention's Training Manual on the 'Preparation of a National Environmentally Sound Management Plan for PCBs and PCB-Contaminated Equipment (Secretariat of the Basel Convention, 2003)

(as well as across countries, in the case of trade data), to remove from the set any amounts that can be considered as already covered by another source according to best judgment. This exercise was complicated by the fact that the same data were often reported in different formats (for example, one source lists a certain number of transformers without specifying the mass, while another source only reports the mass).

In deciding which data to include/exclude, the following criteria were applied: As a default, where available and if considered solid according to expert judgment, data from the national reports were treated favourably in a 'hierarchy of sources'. NIPs (in most, but not all cases providing the same data as national reports) were second. More recent data from other sources were used to verify and, where considered necessary, adjust as well as to fill potential gaps. In a number of cases, data from national reporting were so incomplete and/or obviously inaccurate as to warrant using other sources. Information from alternative sources was also used if it was considerably more recent and comprehensive.

Lastly, the total mass of PCB was calculated from all reported units. In doing so, difficulties were encountered as the total mass is often not reported. Many countries report a few or only one of the relevant variables (*e.g.*, only the number of capacitors or the liquid mass is given). Where it was not specified, the following steps were taken in order to arrive at an estimate for the total mass: Average ratios were calculated between the total mass and the respective other variables where these were reported in conjunction. In the case of the equipment and material still in need of elimination, this was done for each of the main categories/types of equipment identified (transformers, capacitors, *etc.*). The thus obtained ratios were then applied as conversion factors to obtain estimates of the total mass based on other reported variables. The various figures thus obtained were then summed and added to the total mass already reported, thus yielding overall estimates of the total mass already eliminated as well as the total mass still in need of elimination. This is explained in more detail below.

2.4. Challenges and Limitations

In compiling the data presented in this report, a number of challenges were encountered, resulting in some important limitations as regards the statistical analysis and the corresponding conclusions that could be drawn. These limitations essentially relate to the quality of national inventories. A non-exhaustive overview is provided below:

- For 16 countries, no quantitative data were available (four from Africa, eight from Asia-Pacific, and three from GRULAC and one from CEE[38]).
- To date, the large majority of countries developed preliminary inventories only. These are typically very limited in scope as regards coverage of the types of equipment (*e.g.* only covering transformers and capacitors), sectors (in many cases limited to the public electricity network) and geography (in many cases only urban areas and certain provinces are taken into account).
- Data on the amounts of PCB in open applications are very scarce and limited to very few developed countries. It shall be noted that Part II of Annex A of the Stockholm Convention calls upon Parties to identify other articles containing more than 0.005 % PCB (*e.g.*, cable-sheaths, cured caulk and painted objects) and manage them in an environmentally sound manner.
- This report does not address PCB-contaminated sites. Only very few data are available on their number, although it can be estimated to be relatively high, often with considerable PCB content[39].

[38] Africa: Angola, Libya, Mozambique, Nambia; Asia-Pacific: Bahrain, Fiji, Kuwait, Maldives, Myanmar, Micronesia, United Arab Emirates, Yemen; CEE: Bosnia and Herzegovina; GRULAC: Saint Kitts and Nevis, Saint Vincent and the Grenadines, Trinidad and Tobago.

- Finally, PCB currently landfilled are not included in this report. In the EU alone, this amounts to more than 200,000 tonnes[40].
- Most inventories rely on very rough estimates, sometimes based on incomplete data and/or analysis of small sample sizes.
- The practice of retro-filling transformers that had originally been manufactured with PCB with mineral oil is widespread[41], with the result that the newly introduced oil may become contaminated with PCB. It is very difficult to estimate the amounts of oil thus contaminated.
- Optimally, information is available on all PCB-suspect types and materials including the respective number of units, solid mass (*e.g.*, of drained but contaminated transformers), liquid mass (*e.g*. of the transformer oil), total mass, and PCB content. However, countries typically just report a few or only one of these variables. For instance while one country may report the number of transformers, another may only report the estimated total mass of dielectric oil. This limitation does not only apply to developing countries and economies in transition but also to many developed countries.
- The data are often insufficient to assess a development and identify trends regarding the amounts of PCB in use, out of service and eliminated over time. In theory, inventories conducted at different points in time could be used to assess the amounts of PCB eliminated within that period. In practice, however, such data cannot be used to make precise estimates, for instance because newly identified stocks might have been added in the meantime. Thus, it is not unusual to see the amounts reported in inventories increase over time. The national reports for example do not provide any clarifications in this respect.
- Due to a lack of consistency, including within individual reports, it is often very difficult to assess how decimal marks and thousands separators are used. The units are sometimes not clearly indicated. Another difficulty related to the fact that in many instances countries report that PCB waste has been imported/exported without specifying the country of origin/destination. Despite available guidance materials, inventories are not harmonized in structure and detail of information. Instead of relying on a standardized approach, different methodologies are followed in conducting inventories. For example, some are based on voluntary registration, others on regulatory enforcement, and yet others on questionnaires. Methods include for instance sampling, extrapolation, site visits, *etc*.

Due to these shortcomings, assessments that were carried out on the ground following preliminary inventories have often revealed that the actual situation is dramatically different. It was beyond the scope of this initial assessment to try to fill the gaps prevalent in the available data. As a follow-up activity, it could therefore be recommended to carry out additional country-specific research where no quantitative data are available (thereby considering factors such as the country's electricity production and drawing comparisons with countries having similar economic characteristics) and to address the issue of open applications.

An alternative to using national inventories is to follow a mass balance approach. This means taking the total amount of PCB produced as a baseline to estimate how much equipment and material containing PCB has been in use and thus to arrive at an assessment of the mass still in need of elimination. However, such an approach is not feasible: Data on the production of equipment and materials containing PCB are incomplete. Moreover, it is important to note that due to dilution and cross-contamination, the mass of equipment and materials containing or contaminated with PCB are necessarily much larger than the amounts of PCB produced: A single tonne of PCB can generate multiple tonnes of PCB wastes.

[39] See for instance Republique de Madagascar, 2008, p. 41

[40] BIPRO, 2005, p. 56

[41] See for example Department of Environment and Natural Resources of the Philippines, n.d., pp. 6-7

Furthermore, large amounts of PCB have been released to the environment (*e.g.*, due to leakage of transformers or bad practices such as open burning of PCB wastes) and can thus not be subject to 'elimination' in the sense that equipment can. Unknown amounts may have been stolen and/or disposed illegally. A lot of PCB might have gotten 'lost', *e.g.*, due to a lack of documentation and poor labelling.

3. Results

3.1. Total production of PCB

The starting point for an assessment of progress towards eliminating PCB is to know how much PCB has been produced. From multiple sources the total amount of PCB produced is estimated between 1 and 1.5 million tonnes (see Table 1), which is in agreement with earlier reports[42]. Production has been limited to a small number of countries (12) and companies (17). Commercial production started around 1929-1930 and has progressively been phased out in the second half of the century. Most sources suggest that production ended in 1993. However, according to its NIP, the Democratic People's Republic of Korea (DPRK) continued producing PCB at least until 2006[43]. Information received during the fifth meeting of the advisory committee of the PCB Elimination Network (PEN) suggests that production is ongoing.

While few countries produced PCB, a number of countries imported PCB to produce transformers and capacitors or other equipment and material[44]. However, comprehensive data on the total amounts of equipment and materials manufactured with PCB are lacking. Information on historical consumption is scarce. In most cases, it is difficult to get data on historical imports and exports; even in the Western Europe and Others Group (WEOG). It has been estimated that 48 % of the PCB production used for transformer oil, 21 % for small capacitors, 10 % for other closed systems; 21 % open uses[45]. Thus, transformers usually represent the single largest source of PCB[46]. More generally, electrical equipment can be considered as the main destination for PCB.

[42] For example at 1 million t (UNEP 2002c); more than 1 million t (UNEP, 2002g; WHO, 1992); 1.2 million t (Holoubek, 2000); 1,3 million t (Breivik et al., 2007); 1,5 million t (Ivanov and Sandell, 1992; Rantanen, 1992.

[43] Democratic People's Republic of Korea, 2008.

[44] UNEP Chemicals, 2004.

[45] Urs Wagner in the PEN Magazine (Secretariat of the Stockholm Convention, 2010).

[46] Also see for example UNEP, 2002j.

Table 1: Overview of estimated total production of PCB[47]

Country	Start of production		End of production		Amount (1,000 t)		Sources
	Earliest estimate	Latest estimate	Earliest estimate	Latest estimate	Lowest estimate	Highest estimate	
Korea (DPR)	1960s	1960s	2006	>2006[48]	25	30	Democratic People's Republic of Korea, 2008
Soviet Union/Russian Federation	1938	1939	1993	1993	180	180	AMAP, 2000; GEF, 2012; Ministry of Environment and Water of Bulgaria, 2012; UNEP, 2002g
Spain	1930	1955	1984	1986	25	29	Bletchly as cited in WHO, 1993; de Voogt and Brinkman (1989) in Breivik *et al*. 2007; Ministerio de Medio Ambiente y Medio Rural y Marino of Spain, 2004; OECD as cited in Holoubek, 2001
Czechoslovakia	1959	1959	1984	1984	21	21	OECD as cited in Holoubek, 2001; Schlosserova in Breivik *et al*., 2007; Slovak Environmental Agency, 2006
West Germany	1930	1950	1983	1983	59	300	Bletchly as cited in WHO, 1993; de Voogt and Brinkman as cited in Breivik *et al*., 2007; Federal Ministry for the Environment and Nature Conservation of Germany, 2010; OECD as cited in Holoubek, 2001
Italy	1958	1958	1983	1983	24	31	Bletchly as cited in WHO, 1993; de Voogt and Brinkman as cited in Breivik *et al*., 2007; OECD as cited in Holoubek, 2001
France	1930	1930	1980	1984	102	135	Bletchly as cited in WHO, 1993; de Voogt and Brinkman as cited in Breivik *et al*., 2007.; Ministère des Affaires Etrangères of France, 2004 ; OECD as cited in Holoubek, 2001
Poland	1966	1966	1977	1977	2	2	Faladysz and Zulkovski *et al*. as cited in Breivik *et al*., 2007
USA	1929	1930	1975	1977	476	648	Bletchly as cited in WHO, 1993; Canadian Council of Resource and Environmental Ministers as cited in Holoubek, 2001; de Voogt and Brinkman as cited in Breivik *et al*., 2007; Holoubek, 2001; OECD as cited in Holoubek, 2001 ; UNEP, 2002b
China	1960	1965	1974	1983	7	10	Jiang *et al*. as cited in Breivik *et al*., 2007; Li as cited in UNEP, 2002g; Ministry of Environmental Protection of China, 2007; People's Republic of China, 2007; Wong, 1999 as cited in Fiedler, 2001; World Bank, 2005
Japan	1952	1954	1972	1972	59	59	Bletchly as cited in WHO, 1993; Breivik *et al*.; Ministry of Foreign Affairs of Japan, 2010; Hiraoko as cited in 2002g; OECD as cited in Holoubek, 2001
UK	1951	1954	1965	1977	66	67	Bletchly as cited in WHO, 1993; Breivik *et al*.; Department of Environment, Food and Rural Affairs of the United Kingdom, 2007, 2010; OECD as cited in Holoubek, 2001
Total					**1,046**	**1,512**	

[47] Sorted by the earliest estimate of the end of production.

[48] Information received during the fifth meeting of the Advisory Committee of the PEN, held on 26-27 November 2014 in Geneva, Switzerland, suggests that production in the DPRK is ongoing. This needs to be verified.

3.2. Amounts Eliminated to Date

3.2.1. Amounts Eliminated According to the National Reports

As outlined in the mandate, this evaluation has to be based on the third national reports on progress in eliminating PCB submitted by Parties. The total mass of equipment and material containing or contaminated with PCB at concentrations greater than 0.005 % destroyed according to the data provided in the first, second and third national reports[49] amounts to *ca*. 591 thousand tonnes. **Figure 1** illustrates how much has been reported as destroyed in each of the respective national reporting cycles.

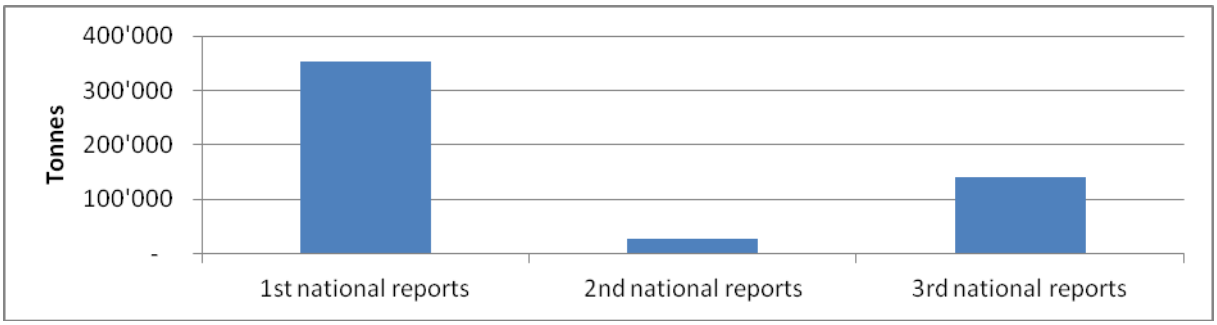

Figure 1: Total mass of PCB destroyed as reported in the first, second and third national reports under the Stockholm Convention[50]

As can be seen, the largest mass was reported as destroyed in the first national reports, at more than 350 thousand tonnes. The mass reported in the second round only amounts to *ca.* 295 tonnes. The data reported in the third round add *ca.* four thousand tonnes. The explanation for the relatively large amount reported for the first report can be explained by the fact that many countries used this opportunity to report accumulated amounts destroyed in the past. Moreover, it should be noted that efforts have been undertaken for the purpose of this report to avoid double-counting values. A lot of the data reported in the second and third national reports have already been reported in the first report. Thus, the mass quoted for the second and third national reports only represents what has been destroyed in the preceding five-year period.

Little significance should be attached to the total numbers quoted here, given their non-comprehensive character (also see section 2.4). However, it may be possible to identify a trend: The mass of PCB destroyed within the period covered by the third national reports is significantly higher than the mass for the period covered by the second national reports, although the number of reports submitted to date is much lower. This increase may be interpreted as an indication that progress is being made towards accelerating the elimination of PCB. An alternative explanation is that reporting improved.

3.2.2. Amounts Eliminated According to All Sources of Information

As noted, the data available in the national reports provide only limited insights into the question of how much progress has been made towards eliminating PCB. It is therefore necessary to include the additional sources cited in section 2.1.

Data on the elimination of PCB equipment and materials are reported in three different formats: In units, total mass and/or oil equivalent. Most countries report the total mass, possibly together with the number of units (where applicable) and the corresponding mass of oil contained in the

[49] Secretariat of the Basel, Rotterdam and Stockholm Conventions, 2014a

[50] Data gathered from *ibid*.

equipment or material. However, as outlined above, in a number of instances only the units and/or the oil equivalent have been reported. Table 2 shows the amounts reported in the various configurations, with 'n.a.' indicating where no data are available.

Table 2: Reported units, total mass and oil equivalent of eliminated PCB equipment and material (all values rounded)[51]

Row	Units	Total mass (t)	Oil equivalent (t)
1	1,999	879	318
2	50,569	28,547	n.a.
3	n.a.	2,969	10,582
4	1,235,208	n.a.	151,750
5	158,664	n.a.	n.a.
6	n.a.	1,347,073	n.a.
7	n.a.	n.a.	873
Total		**?**	

Of most concern is the total mass of equipment and materials containing or contaminated with PCB that has been destroyed; while also of interest, we will not be concerned with estimating the missing number of units and oil equivalent. In order to be able to fill the cells marked in red, the following steps were taken: First, the average ratio between units and total mass was calculated (*ca*. 1.24) based on those instances where both variables were reported in conjunction. This factor was then used to estimate a possible value for the total mass in rows 4 and 5. Second, the average ratio between the oil equivalent and the mass was calculated (*ca*. 0.44) in order to provide an alternative estimate for the total mass in row 4 as well as to calculate an estimate for the total mass in row 7. Finally, the total masses were summed (see Table 3).

Table 3: Estimated total mass destroyed to date (note: all values rounded)[52]

Row	Units	Total mass (t)	Oil equivalent (t)
1	1,999	879	318
2	50,569	28,547	n.a.
3	n.a.	2,969	10,582
4	1,235,208	66,268 – 1,530,438	151,750
5	158,664	196,587	n.a.
6	n.a.	1,347,073	n.a.
7	n.a.	381	873
Total		**1,642,324 – 3,106,494**	

The estimated total mass of equipment and material containing or contaminated with PCB at concentrations greater than 0.005% destroyed to date is thus estimated at between approximately 1.6 million tonnes and 3.1 million tonnes. The middle value lies at *ca*. 2.4 million tonnes. The large ranges given are an indication of the degree of uncertainty that applies to the estimate.

[51] Calculated based on Secretariat of the Basel, Rotterdam and Stockholm Conventions, 2014a, 2014b; Secretariat of the Basel, Rotterdam and Stockholm Conventions, 2009, 2010, 2011; GEF, 2014; UN, 2014; UNEP, 2003; UNEP, 2002a, 2002b, 2002c, 2002d, 2002e, 2002f, 2002g, 2002h, 2002i, 2002j, 2002k, 2002l; Basel Convention Regional Centre for French-speaking countries in Africa in Senegal, 2007; Secretariat of the Basel, Rotterdam and Stockholm Conventions, 2014c; Chemical Legislation European Enforcement Network, 2005a, 2005b; CEC, 2006; UNEP Chemicals Branch, 2014

[52] Ibid.

Considered in the light of existing destruction capacity[53], this estimate appears conceivable. Several observations suggest that this estimate may be too high. While efforts were made to avoid any double counting of data from different sources, this possibility cannot be entirely excluded. This is especially due to the fact that in many instances countries report that PCB waste has been imported/exported without specifying the country of origin/destination. Interestingly, most of the data are only recorded from one of the trading partners, making it difficult to validate the provided data through a second source.

Meanwhile, other deliberations suggest that the estimate may in fact be too low and these likely outweigh the amounts that were double counted. It can be assumed with almost absolute certainty that countries have not reported all amounts that have actually been destroyed. In many instances, countries noted that waste has been eliminated without giving any quantitative data. For others, no information was available at all. The additional sources of information have not been sufficient to achieve a complete overview. For instance, trade data from the reporting under the Basel Convention were only available for the years between 2009 and 2011.

3.2.3. Amounts Eliminated Between 1990 and 2014

Figure 2Figure 2: Mass destroyed by year shows the mass destroyed for each year between 1990 and 2014. In order to provide a simplified picture, no range is presented for the respective years.

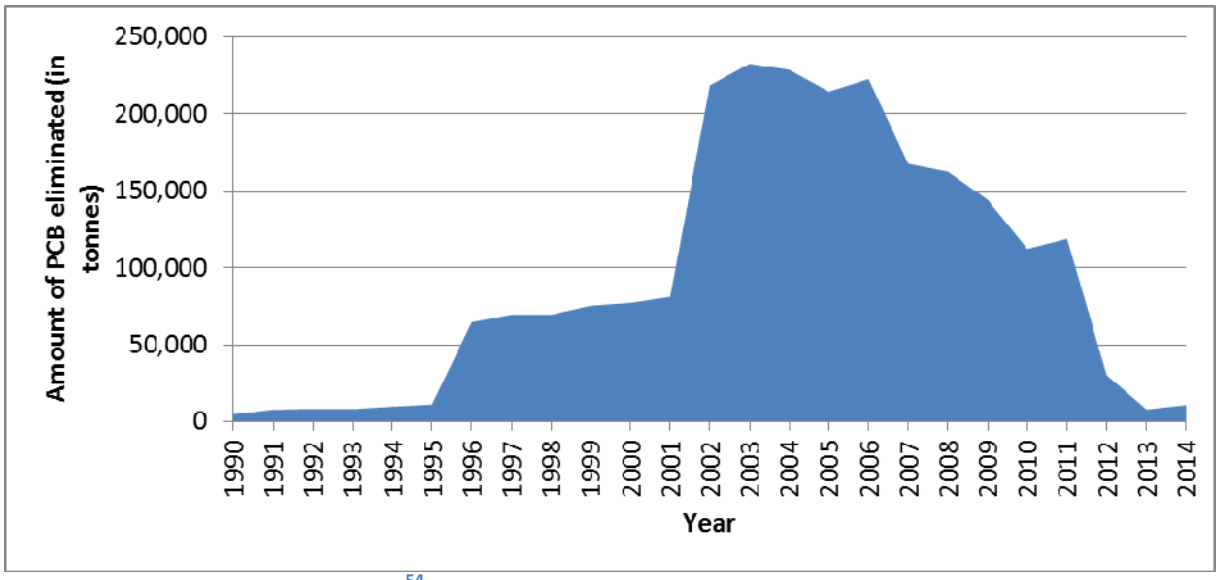

Figure 2: Mass destroyed by year[54]

Available data suggest that there were two major boosts in the amount of PCB destroyed per year, namely in 1996 and 2002. The second, being far more significant, could be interpreted as a pre-emptive consequence of the Stockholm Convention: While it entered into force in 2004, negotiations on the text were concluded in 2000 and delegates adopted the Convention at the Conference of the Plenipotentiaries in May 2001. The data should be viewed with caution: Improved reporting in the years following the adoption of the text is likely responsible: For the majority of countries, reporting started to cover information around this period. However, this can only in part explain such a drastic

[53] See for instance UNEP Chemicals Branch, 2004

[54] Calculated based on Secretariat of the Basel, Rotterdam and Stockholm Conventions, 2014a, 2014b; Secretariat of the Basel, Rotterdam and Stockholm Conventions, 2009, 2010, 2011; GEF, 2014; UN, 2014; UNEP, 2003; UNEP, 2002a, 2002b, 2002c, 2002d, 2002e, 2002f, 2002g, 2002h, 2002i, 2002j, 2002k, 2002l; Basel Convention Regional Centre for French-speaking countries in Africa in Senegal, 2007; Secretariat of the Basel, Rotterdam and Stockholm Conventions, 2014c; Chemical Legislation European Enforcement Network, 2005a, 2005b; CEC, 2006; UNEP Chemicals Branch, 2014

increase compared with previous years. It is safe to assume that much larger amounts were eliminated in the first decade of the 21st century than in the 1990s.

From 2002 through 2006, elimination rates remained relatively constant, with the largest amount reportedly eliminated in 2003 at *ca*. 230 thousand tonnes. There is a sharp decrease from 2007 onwards. In 2010, only slightly more than 110 thousand tonnes were eliminated, *i.e.* a decrease of more than 50 % compared with 2003. A lack of reporting cannot account for this, since data for these years are in fact more, rather than less comprehensive. This includes for instance the availability of Basel reporting data. Moreover, the second national report, which had the highest response rate, covers this period. A plausible explanation is that countries had already disposed the 'low-hanging fruits', *i.e.*, large obsolete stockpiles that were readily identified.

The primary reason why the amounts for 2012 to 2014 are much lower than those reported for the previous years is that data for this period are often not yet available (*e.g*. the third round of national reporting is still ongoing, Basel Convention reporting data were not available, *etc*.). These figures are thus not informative. One could speculate that the downward trend may have continued; however, this needs to be validated. Overall, it can be concluded that the share eliminated before 2004 is only slightly lower than the share eliminated after 2004.

3.2.4. Trade in Waste Oils Containing PCB According to UN Comtrade

What has been presented so far does not take into consideration the data available from UN Comtrade, according to which imports and exports of waste oils containing polychlorinated biphenyls (PCBs)/polychlorinated terphenyls (PCTs)/polybrominated biphenyls (PBBs) since 2002 (the first year for which data are available) amounted to 262,282 t and 228,168 t, respectively. The distributed across the years for imports and exports are shown in **Figure 3** and **Figure 4**.

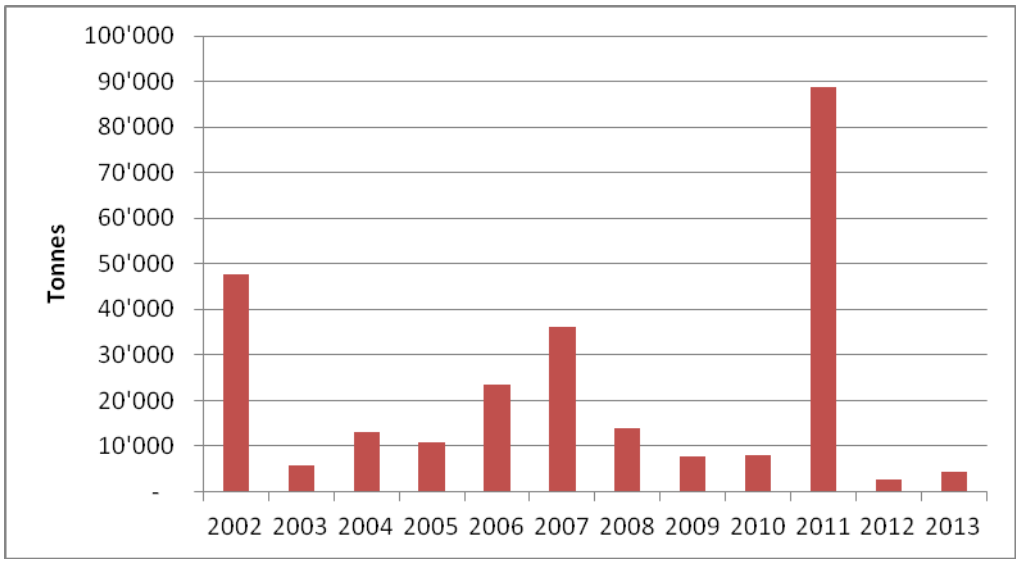

Figure 3 Imports of waste oils containing polychlorinated biphenyls (PCBs)/polychlorinated terphenyls (PCTs)/polybrominated biphenyls (PBBs) as reported under UN Comtrade[55]

[55] United Nations, 2014

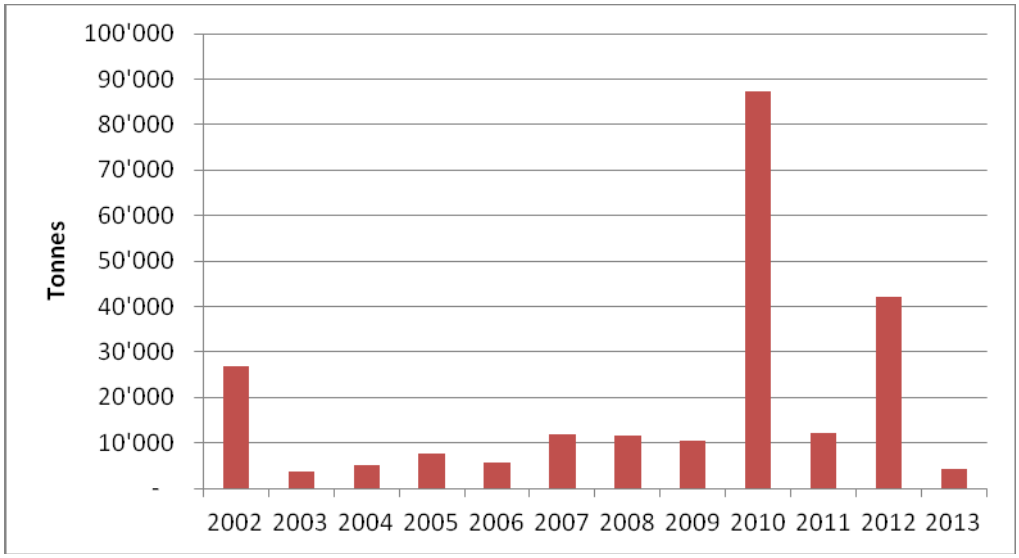

Figure 4: Exports of waste oils containing polychlorinated biphenyls (PCBs)/polychlorinated terphenyls (PCTs)/polybrominated biphenyls (PBBs) as reported under UN Comtrade[56]

It was not possible to include these data in the overall estimate since it is highly divergent from other data sets. It also contains some surprising results: For example: many developing countries report having imported waste oils containing PCB from developed countries. Country reporting of this category under UN Comtrade may therefore need to be clarified.

3.2.5. GEF Projects

As of January 2015, the GEF project database lists a total of 43 PCB projects[57] (40 approved national, of which five are completed, 18 under implementation, and 17 in the preparatory phase; three approved regional PCB projects, of which two are under implementation and one is in the preparatory phase). Total funding allocated by the GEF for these projects amounts to *ca.* USD 164 million. Co-financing of *ca.* USD 414 million has been leveraged. Information on the amounts of PCB (to be) eliminated under these projects has been gathered by UNEP Chemicals Branch and the advisory committee of the PCB Elimination Network. To date, quantitative data are available for 31 of these projects and suggests that *ca.* 15 thousand tonnes have been eliminated, while another 178 thousand tonnes are scheduled for elimination.

3.2.6. Regional Distribution

The progress in eliminating PCB varies considerably across UN regions. Figure 5 shows from where the amounts destroyed to date originate. Thus, exports from one region to another were counted for the exporting region. As can be seen, the largest shares are from the WEOG and the Asia-Pacific Region at *ca*. 40 % and 47 % or about 1.1 million and 0.96 million tonnes, respectively. The CEE Region accounted for approximately eight percent (*ca*. 190 thousand tonnes), the Latin American and Caribbean Group (GRULAC) for ca. five percent (*ca*. 110 thousand tonnes) and the African Region for slightly more than zero percent (*ca*. six thousand tonnes).

[56] Ibid.
[57] It should be noted that there also POPs projects with have PCB-related elements

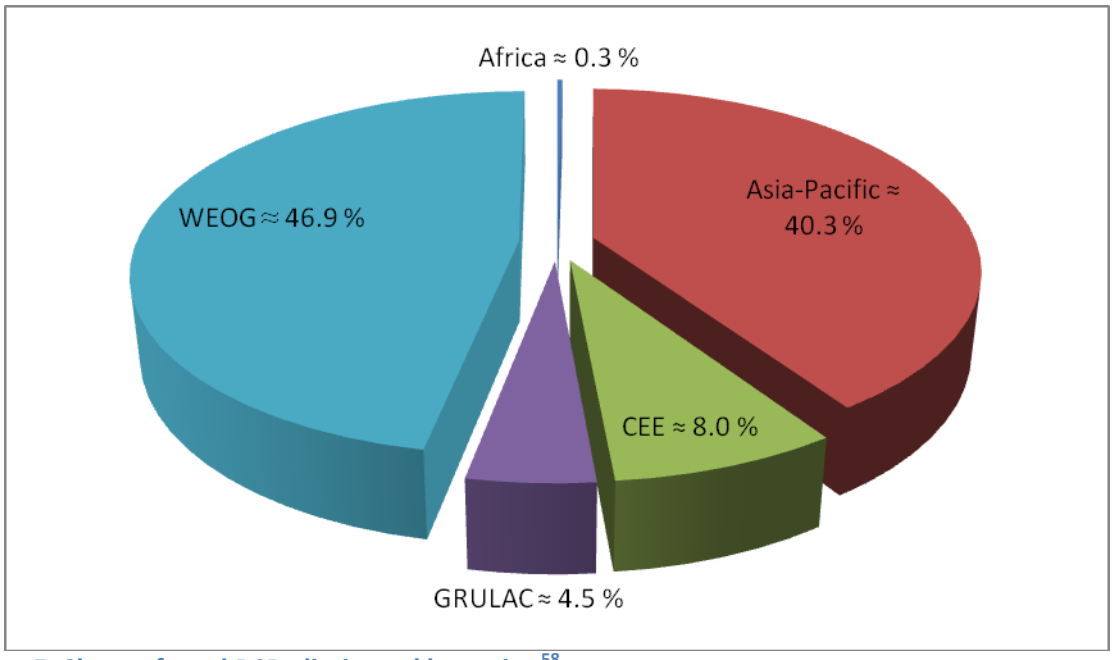

Figure 5: Share of total PCB eliminated by region[58]

As could be expected, the regions also followed different approaches in disposing of PCB wastes: For example, as shown in **Figure 6** more than 50 % of the PCB waste generated in WEOG was disposed of locally. While a significant share of more than ten percent was exported for disposal within the region, a very small share was exported to non-WEOG countries (almost exclusively to the CEE Region). It is safe to assume that the remaining third for which no information was available was likely also destroyed within the region. A similar pattern applies for the Asia-Pacific Region.

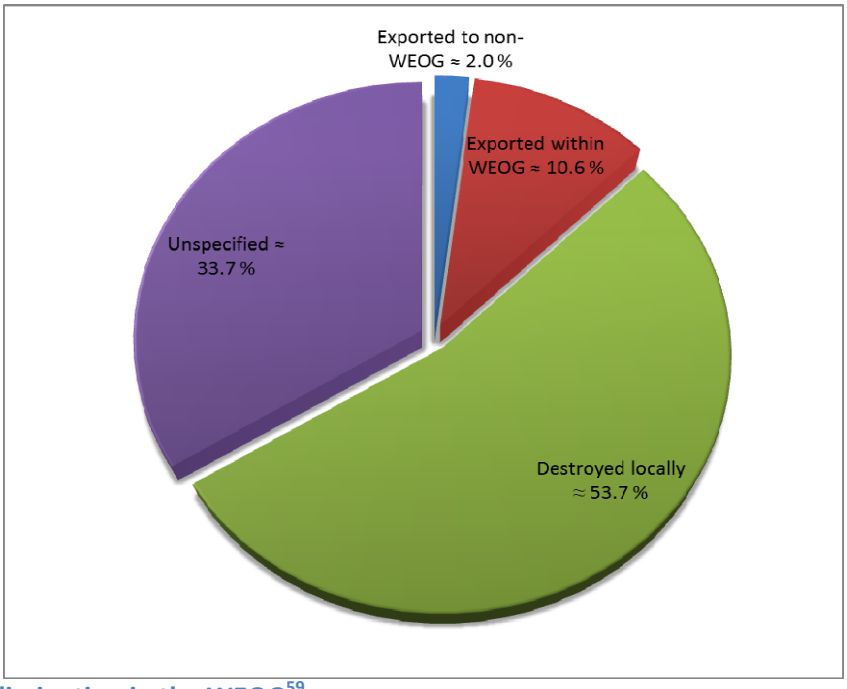

Figure 6: PCB Elimination in the WEOG[59]

[58] Calculated based on Secretariat of the Basel, Rotterdam and Stockholm Conventions, 2014a, 2014b; Secretariat of the Basel, Rotterdam and Stockholm Conventions, 2009, 2010, 2011; GEF, 2014; UN, 2014; UNEP, 2003; UNEP, 2002a, 2002b, 2002c, 2002d, 2002e, 2002f, 2002g, 2002h, 2002i, 2002j, 2002k, 2002l; Basel Convention Regional Centre for French-speaking countries in Africa in Senegal, 2007; Secretariat of the Basel, Rotterdam and Stockholm Conventions, 2014c; Chemical Legislation European Enforcement Network, 2005a, 2005b; CEC, 2006; UNEP Chemicals Branch, 2014

By contrast, as shown in Figure 7, GRULAC exported at least 44 % of its PCB waste for destruction exclusively to WEOG, but also destroyed a significant share locally. In about a third of the cases, no information was available. The CEE Region has a similar pattern.

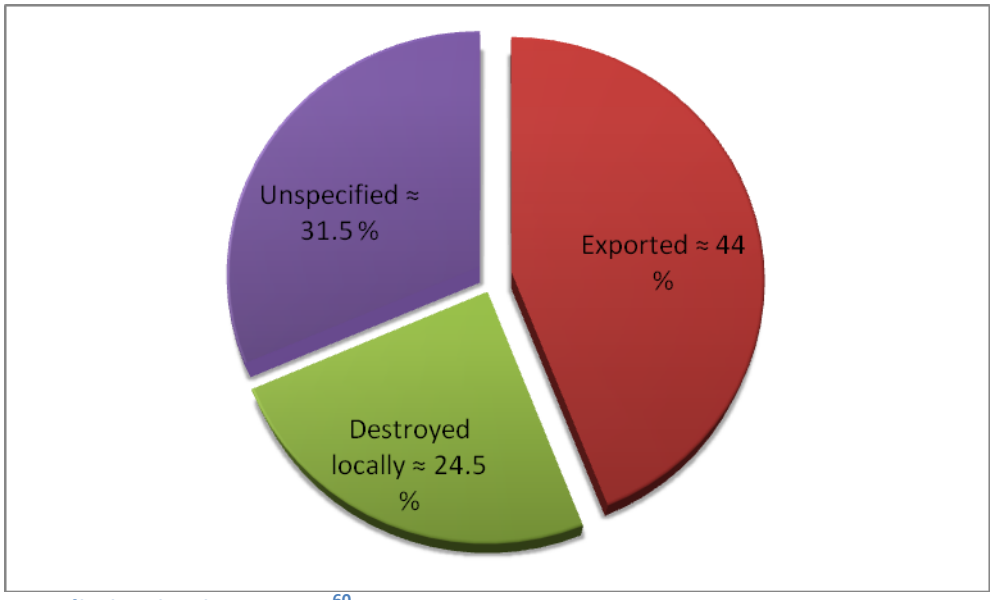

Figure 7: PCB Elimination in GRULAC[60]

3.2.7. Amounts Scheduled for Elimination

In addition to the amounts that have already been destroyed, to the extent possible, information was also gathered on the amounts with clear schedules for elimination. This includes for example stringent national schemes currently under implementation, such as that put in place by the Japanese government[61], GEF projects that are ongoing or in the preparatory phase, and instances where the waste has likely already been disposed of but was not yet reported accordingly as the source of information is outdated.

Using the same methodology explained above, the estimated total mass of equipment and material containing or contaminated with PCB at concentrations greater than 0.005 % scheduled for disposal (or already disposed but not yet confirmed) is thus estimated at between approximately 0.5 million tonnes and 3.7 million tonnes. The middle value lies at *ca*. 2.1 million tonnes. If these disposal activities were carried out, the total amount of PCB waste eliminated would amount to *ca*. 4.5 million tonnes.

3.3. Amounts Still to Be Eliminated

3.3.1. Amounts Still to be Eliminated According to All Sources of Information

The data on PCB in use, stockpiled or waste were organized in many different formats which slightly differ from those used for the amounts eliminated. For some countries data are available for all relevant categories, i.e. the units together with the relevant total mass, solid mass and information on the liquid, including its mass and whether it is 'pure' PCB, contaminated with PCB, or PCB-free. Meanwhile, most countries only report a few or only one of these variables, making it difficult to estimate the total mass that is still in need of elimination. Table 4 shows the values reported in the

[59] *Ibid*.

[60] *Ibid*.

[61] A 'Law Concerning Special measures Against PCB Waste' was formulated in 2001 (Law No. 65) (JESCO, 2015).

various configurations. Note that there is a distinction made for the liquid/oil. The column 'liquid mass' is applicable where there is no information on whether the liquid/oil contains/is contaminated with PCB or not. By contrast, the column 'PCB oil mass' lists the mass of liquid/oil which has been reported as containing/contaminated with PCB.

Table 4: Data reported on equipment and materials containing or contaminated with PCB at concentrations greater than 0.005 % (note: all values rounded)[62]

Row	Units	Total mass (t)	Solid mass (t)	Liquid mass (t)	PCB oil mass (t)
1	12,639	25,249	17,178	6,886	n.a.
2	282,907	92,640	70,475	n.a.	22,734
3	20	29	29	n.a.	
4	64,666	14,776	n.a.	n.a.	n.a.
5	74,020	n.a.	n.a.	4,870	n.a.
6	653,457	n.a.	n.a.	n.a.	59,848
7	10,475,168	n.a.	n.a.	n.a.	n.a.
8	n.a.	65,171	17,948	15,042	n.a.
9	n.a.	151	116	n.a.	35
10	n.a.	12,537	12,537	n.a.	n.a.
11	n.a.	89,633	n.a.	70,009	n.a.
12	n.a.	768,424	n.a.	n.a.	768,424
13	n.a.	934,108	n.a.	n.a.	n.a.
14	n.a.	n.a.	n.a.	2,231	n.a.
15	n.a.	n.a.	n.a.	n.a.	250
Total		**n.a.**			

At this stage, we will not be concerned with the exact PCB content. While the PCB content was reported in a number of cases, the available data were not sufficient to draw any conclusions, *e.g.* in terms of average content. Where accurate information has not been provided, it is assumed to be equipment or material is assumed to contain PCB at concentrations greater than 0.005 %.

In order to estimate how much PCB still has to be disposed, the figure of highest concern is the total mass. However, in a number of instances, the total mass has not been reported (see the cells shaded in red). It is therefore necessary to provide some estimates. When estimating the total mass for row 5, 6 and 7, it is important to keep in mind that the relevant equipment and materials vary strongly in terms of mass. It was therefore necessary to have a closer look at the composition of the relevant cells, so as to determine how large the share is for the different categories. Four main categories were identified: Transformers, capacitors, equipment, and others. Several issues need to be highlighted in this context: The category 'equipment' may in fact include transformers and capacitors; however, the different types are often subsumed under this category. The category 'others' is extremely diverse, meaning that any generalizations about this category have to be interpreted with caution.

In order to obtain a conversion factor for each of these categories, the average ratio between units and mass was calculated taking into consideration all instances where both variables were reported

[62] Calculated based on Secretariat of the Basel, Rotterdam and Stockholm Conventions, 2014a, 2014b; Secretariat of the Basel, Rotterdam and Stockholm Conventions, 2009, 2010, 2011; GEF, 2014; UN, 2014; UNEP, 2003; UNEP, 2002a, 2002b, 2002c, 2002d, 2002e, 2002f, 2002g, 2002h, 2002i, 2002j, 2002k, 2002l; Basel Convention Regional Centre for French-speaking countries in Africa in Senegal, 2007; Secretariat of the Basel, Rotterdam and Stockholm Conventions, 2014c; Chemical Legislation European Enforcement Network, 2005a, 2005b; CEC, 2006; UNEP Chemicals Branch, 2014

in conjunction. This was done for each of the four categories (transformers, capacitors, equipment, others). In line with what was expected, the ratio was highest for transformers and lowest for capacitors. This conversion factor was then multiplied with the number of units reported for each of the categories wherever the corresponding total mass had not been reported. Subsequently, the thus calculated total mass for each of the categories was summed up in order to get an overall estimate for row 5, 6 and 7. As an example, the results for row 5 are shown in Table 5. Again in line with what was expected, the number of capacitors is much larger, while the accumulated mass of transformers far outweighs that of capacitors.

Table 5: Composition of instances where only the units and liquid mass are available (note: all values rounded)[63]

Composition of row 5			
Type	**Units**	**Conversion factor**	**Total mass**
Transformers	4,517	2.851	12,876
Capacitors	64,159	0.054	3,444
Equipment	5,303	1.377	7,301
Others	41	0.166	7
Total	**74,020**	**n.a.**	**23,628**

In order to make the estimate more reliable, alternative conversion factors were calculated for rows 5 and 6, where figures for liquid mass and PCB oil mass were also available. Thus, conversion factors for each of the above mentioned categories (transformers, capacitors, equipment and others) were calculated both to convert liquid mass to total mass and PCB oil mass to total mass. These calculations provided alternative estimates for row 5 and 6, so that a range could be given.

Where only one variable was available, no range could be calculated. This was the case for row 7 (only the number of units available), row 14 (only liquid mass available) and row 15 (only PCB oil mass available). For rows 14 and 15, *i.e.*, where the mass of the liquid/PCB oil has been reported without data on the solid or total mass of the equipment, a similar approach was followed in order to first obtain a conversion factor and to then estimate the total mass. The overall results are shown in Table 6.

[63] Ibid.

Table 6: Total mass of equipment and materials containing or contaminated with PCB (note: all values rounded)[64]

Row	Units	Total mass (t)	Solid mass (t)	Liquid mass (t)	PCB oil mass (t)
1	12,639	25,249	17,178	6,886	n.a.
2	282,907	92,640	70,475	n.a.	22,734
3	20	29	29	n.a.	
4	64,666	14,776	n.a.	n.a.	n.a.
5	74,020	23,628 – 31,856	n.a.	4,870	n.a.
6	653,457	355,503 - - 373,922	n.a.	n.a.	59,848
7	10,475,168	6,853,831	n.a.	n.a.	n.a.
8	n.a.	65,171	17,948	15,042	n.a.
9	n.a.	151	116	n.a.	35
10	n.a.	12,537	12,537	n.a.	n.a.
11	n.a.	89,633	n.a.	70,009	n.a.
12	n.a.	768,424	n.a.	n.a.	768,424
13	n.a.	934,108	n.a.	n.a.	n.a.
14	n.a.	14,840	n.a.	2,231	n.a.
15	n.a.	702	n.a.	n.a.	250
Total		**9,251,222 – 9,277,868**			

Thus, if all sources of information listed above are taken into consideration, the total mass of PCB equipment and materials that still needs to be eliminated is estimated at *ca.* 9.3 million tonnes. Transformers account for the largest share, followed by capacitors. However, this is also due to a reporting bias, whereas other applications have often not been included in the inventories. Quantitative data on open applications were reported only by a few countries.

While this includes all types of equipment and material, the large majority of data reported are based on transformers and capacitors and neglects others closed, semi-closed and, in particular, open applications. Open applications have almost exclusively been reported by a few countries belonging to the WEOG. In Switzerland for example, according to a national survey conducted in 1999-2002, it has been estimated that about 50 t-150 t of PCB were present at that time in joint sealants of existing buildings erected between 1955 and 1975[65].

This estimate is at best indicative, given the many limitations discussed above. A number of reasons suggest that the estimate of *ca.* 9.3 million tonnes may in fact be an underestimation. As noted previously, most inventories are preliminary in nature. They typically do not cover open applications and instead focus on a few 'main' categories (typically transformers), only some regions, and only certain sectors (typically the electricity sector). Where countries reported all equipment, rather than only the share that is suspected to contain PCB, the data were not included. Also taking into account the potential for dilution and cross-contamination, the estimate may thus be plausible. Meanwhile, some figures may be too high, since the often large amounts of equipment that is 'PCB-assumed' are in fact included in the analysis, although its share with a PCB content above 0.005 % is likely relatively small. Yet more importantly, it is highly probable that significant amounts included in this estimate have in fact already been disposed. Even where these are covered in the gathered data on the amounts already eliminated, it was rarely possible to determine in how far these were actually the same ones reported elsewhere as existing stockpiles.

[64] Ibid.

[65] Federal Office for the Environment of Switzerland, 2014

Compared to earlier estimates, the 9.25 million tonnes may be considered a realistic estimate. Prior to the fourth meeting of the COP to the Stockholm Convention, the Secretariat reviewed the data contained in the first NIPs (submitted until December 2008) and came to the conclusion that almost 6.5 million tonnes of PCB contaminated oil together with almost 0.5 million tonnes of contaminated equipment were reported by the Parties. Since inventories are now more comprehensive and because additional sources have been used in this estimate to close some of the gaps, it is not surprising to see that the amount is higher than previously estimated, even though considerable amounts have been destroyed in the meantime. However, another analysis by the Secretariat had indicated that less than 3 million tonnes remain to be eliminated. Further analysis is necessary in order to determine which estimate is more accurate.

3.3.2. Regional Distribution

Figure 8 shows the share of the total mass of 9.3 million tonnes in need of elimination by region. It should again be noted that this figure and the corresponding estimates are based on the data that has been reported, meaning that this may not be an accurate representation of the situation.

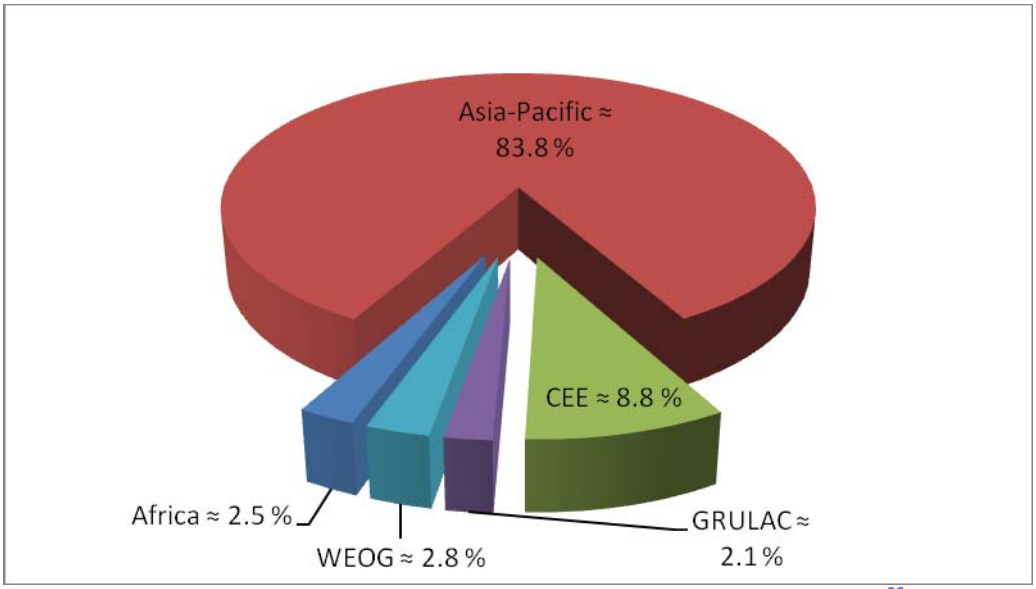

Figure 8: Distribution of the total mass still in need of elimination across regions[66]

Almost 84 % of the total mass of equipment and materials containing or contaminated with PCB has been reported by the Asia-Pacific Region, although only about 5 % of PCB was produced in the Asia-Pacific Region (see section 3.1). One reason may be that a substantial share of the large amounts that have in fact already been eliminated in the Asia-Pacific Region is still included here. The very small amounts reported for the WEOG is in line with the data presented above which suggested that this region also destroyed the largest amounts to date. Open applications are the notable exception but have rarely been reported. In fact, a number of countries from the WEOG report that virtually all equipment with a PCB content greater than 0.005 % have been removed from use and destroyed. Open applications are the notable exception. As regards Africa and GRULAC, historical uses are relatively low.

[66] Calculated based on Secretariat of the Basel, Rotterdam and Stockholm Conventions, 2014a, 2014b; Secretariat of the Basel, Rotterdam and Stockholm Conventions, 2009, 2010, 2011; GEF, 2014; UN, 2014; UNEP, 2003; UNEP, 2002a, 2002b, 2002c, 2002d, 2002e, 2002f, 2002g, 2002h, 2002i, 2002j, 2002k, 2002l; Basel Convention Regional Centre for French-speaking countries in Africa in Senegal, 2007; Secretariat of the Basel, Rotterdam and Stockholm Conventions, 2014c; Chemical Legislation European Enforcement Network, 2005a, 2005b; CEC, 2006; UNEP Chemicals Branch, 2014

Meanwhile, it is evident that the estimates for the African Region and – to a lesser extent – GRULAC are far below the amounts that are in fact still in need of elimination. Inventories are particularly wanting for the African Region. It is also important to keep in mind that capacities to dispose of the remaining amounts vary considerably. For example, Japan has reported large amounts of PCB waste that are still in need of elimination[67], which may in fact be seen as an indication that many other countries reported quantities that are unrealistically low. Yet, the country is well on track towards meeting the goals of the Stockholm Convention. Thus, while the figure may suggest that the Asia-Pacific Region should be prioritized, while GRULAC and the African Region are less of a concern, it can be expected that the situation will look very different in a few years' time, especially if more recent and accurate data become available. Further work also remains for the WEOG, in particular in addressing open applications which have so far largely not been included in inventories.

3.4. Progress toward Eliminating PCB

Adding the 9.3 million tonnes in need of elimination to the 2.4 million tonnes estimated to have been eliminated gives a total of *ca.* 11.7 million tonnes. Accordingly, *ca.* 20% of the total mass of equipment and material containing or contaminated with PCB has already been eliminated. *Ca.* 80% of the total thus remain to be destroyed. Adding the 2.1 million tonnes scheduled for disposal raises the share to almost 40 %.

Table 7 provides an overview of the amounts already eliminated, scheduled to be eliminated, still in need of elimination, and the total across regions.

Table 7: Overview of progress towards eliminating PCB[68]

Region	Eliminated		To be eliminated		Total
	Tonnes	Share (%)	Tonnes	Share (%)	
Africa	5,967	3	231,945	97	237,912
Asia-Pacific	955,970	11	7,751,178	89	8,707,148
CEE	189,139	19	818,563	81	1,007,702
GRULAC	106,350	36	190,196	64	296,546
WEOG	1,112,728	81	259,340	19	1,372,068
All	2,370,154	20	9,264,545	80	11,621,376

Again, region differences are very pronounced. Figure 9 provides an overview of the progress of each region towards elimination of PCB, *i.e.* the share of each region's total that it has already disposed of. Available data suggest that the African Region has the longest way ahead towards achieving the goal of eliminating PCB: *Ca*. 97 % still needs to be eliminated. The approximate shares lie at 89 % for the Asia-Pacific Region, 81 % for the CEE Region, 64 % for GRULAC and 19 % for WEOG.

[67] In its third national report, Japan reported among others ca. 90 thousand tonnes of PCB-contaminated oil, almost six million units of lighting ballasts, ca. 1.7 million pole-mounted transformers, and ca. 1.7 million low-voltage capacitors. (Ministry of Foreign Affairs of Japan, 2014)

[68] *Ibid.*

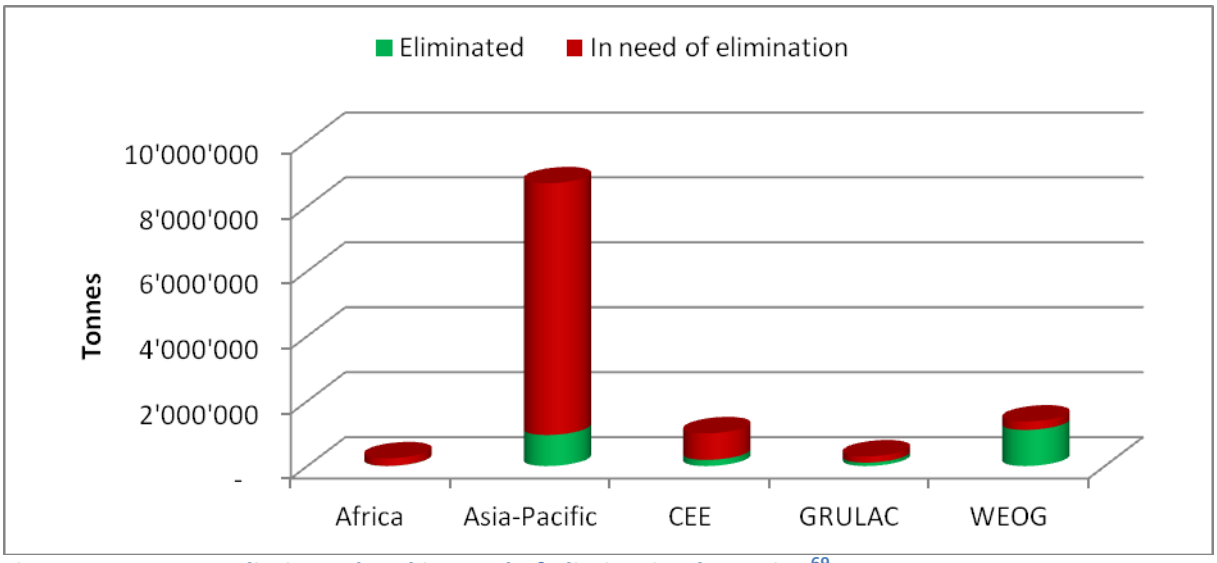

Figure 9: Amounts eliminated and in need of elimination by region[69]

An explanation for the surprisingly small total for the WEOG is that very large amounts have already been eliminated prior to the periods covered by most of the available sources of information. Thus, many of the countries of the WEOG simply reported that material and equipment containing PCB have virtually been disposed.

[69] *Ibid.*

4. Discussion, Conclusions and Recommendations:

Existing data are severely limited and many challenges have been encountered in gathering and evaluating information. It should hence be noted that the numbers presented in this report represent rough estimates, suitable only for identifying larger trends. Further work will be necessary in order to refine the present assessment as well as to incorporate additional information as it becomes available. Such further work would include, among others, a more qualitative reading of the available data and efforts to fill the remaining gaps in cases where inventories are incomplete or non-existent.

It is strongly recommended that steps are taken to ensure that comprehensive, clear, reliable and well-structured data on the amounts of PCB already eliminated and – most importantly – the amounts still to be eliminated are reported. In order to allow for comparability of the data, it is recommended to adjust the reporting format based on the experience from the first three reporting cycles. It needs to be ensured that a unitary reporting format is followed. Accordingly, methodologies for inventories should be streamlined.

Meanwhile, the limited information available is sufficient to highlight the need to expedite and intensify efforts to eliminate PCB to meet the 2025/2028 goals of the Stockholm Convention. While some progress – although difficult to quantify – has been made toward the elimination of PCB, the majority of countries (with some notable exceptions) are currently not on track to achieve the environmentally sound management of PCB by 2028. It is also necessary to confirm whether PCB is still being produced. In the event, steps need to be taken to ensure that the production is phased out as soon as possible. This may need to include technology transfer.

Most national inventories, forming the basis of any action to be taken, are yet preliminary in scope. Even for closed applications, comprehensive data are still lacking. Therefore, PCB inventories need to be harmonized and completed as a basis for reporting accurately and drafting revised national action plans. Inventories need to cover all types of equipment, sectors and geographical areas. For this purpose, countries may need to consider the establishment and periodic updating of a national database.

Such databases should also cover open applications which have so far rarely been given attention despite the provision in Annex A, Part II, para (f) and them being among the main sources of PCB releases to the environment. Most of the countries that have submitted their updated NIPs envisage addressing open applications. It is recommended for other countries to follow this example and to evaluate progress in the next reporting cycle. Sites contaminated with PCB have also not yet received the attention that would be warranted given the large potential for releases to soil and water.

In light of its toxicity and the large quantities of PCB still in use or in stockpiles for disposal, the environmentally sound management and elimination of PCB should be a priority. The basis of any effective action to be is the existence of appropriate regulatory frameworks. Countries should be encouraged to define progressive PCB elimination plans with strict timelines as part of national hazardous waste management plans and to ensure continuous monitoring of progress toward the Stockholm Convention targets.

While technologies and capacities for the destruction or irreversible transformation of PCB are available, with many countries already having eliminated substantial amounts of PCB either domestically or via export, additional financial resources are needed, in particular for developing countries and countries with economies in transition. The relatively small amounts already disposed and scheduled for disposal under GEF projects is very small compared to the estimated total amount still to be eliminated and can thus merely be a starting point. In order to allow for informed decision-

making, it may prove useful to compile information on the costs of elimination (including from completed and ongoing GEF projects) and the cost-effectiveness of available technologies as well as to identify steps that can be taken to reduce such costs or increase financial leverage. Many developing countries may first have to focus on the 'low-hanging fruits', namely to eliminate the main source of PCB, that is large transformers containing high concentrations of PCB.

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Annex A: Reporting template

UNEP Chemicals Branch (2014) | Collection of information | PCB use, storage, trade and destruction

To the extent possible, please fill out where relevant or appplicable; expand cells or rows where necessary. Thank you

Name of party/organisation/institution:
Contact person:
Email:
Telephone:
Date of information (dd/mm/yyyy): 10/13/2014

Amount of PCB destroyed within national boundaries

Country	Site of destruction	Year	Mass (ton)			Number of pieces of equipment	Type of equipment** *	Type of PCB**	PCB content						Technology	Overall costs (USD) ****	Financial assistance?		Project			Contacts		Source of information	Comments
			Equipment	Oil/liquid	Total				>10 % or 100 g/kg	> 0.05 % or 500 mg/kg	> 0.005 % or 50 mg/kg	< 0.005 % or 50 mg/kg	PCB content not known				GEF IA	Other	Identification	Key steps	Major outputs	National	IA		
					0																				
					0																				
					0																				

Amount of PCB exported to foreign country for destruction

Country	Country of export /full country name)	Year	Mass (ton)			Number of pieces of equipment	Type of equipment** *	Type of PCB**	PCB content					Y or A code (Basel Convention)	Technology	Overall costs (USD) ****	Financial assistance?		Project			Contacts		Source of information	Comments
			Equipment	Oil/liquid	Total				>10 % or 100 g/kg	> 0.05 % or 500 mg/kg	> 0.005 % or 50 mg/kg	< 0.005 % or 50 mg/kg	PCB content not known				GEF IA	Other	Identification	Key steps	Major outputs	National	IA		
					0																				
					0																				
					0																				

Amount of PCB imported from foreign country for destruction

Country	Country of import /full country name)	Year	Mass (ton)			Number of pieces of equipment	Type of equipment** *	Type of PCB**	PCB content					Y or A code (Basel Convention)	Technology	Overall costs (USD) ****	Financial assistance?		Project			Contacts		Source of information	Comments
			Equipment	Oil/liquid	Total				>10 % or 100 g/kg	> 0.05 % or 500 mg/kg	> 0.005 % or 50 mg/kg	< 0.005 % or 50 mg/kg	PCB content not known				GEF IA	Other	Identification	Key steps	Major outputs	National	IA		
					0																				
					0																				
					0																				

Amount of PCB stored safely awaiting destruction (domestic or export)

Country	Site of storage	Year	Mass (ton)			Number of pieces of equipment	Type of equipment** *	Type of PCB**	PCB content						Storage arrangement	Overall costs (USD) ****	Financial assistance?		Project			Contacts		Source of information	Comments
			Equipment	Oil/liquid	Total				>10 % or 100 g/kg	> 0.05 % or 500 mg/kg	> 0.005 % or 50 mg/kg	< 0.005 % or 50 mg/kg	PCB content not known				GEF IA	Other	Identification	Key steps	Major outputs	National	IA		
					0																				
					0																				
					0																				

Amount of PCB still available/in use or in need of safe storage/destruction

Country	Owner/holder of PCB	Year	Mass (ton)			Number of pieces of equipment	Type of equipment** *	Type of PCB**	PCB content						Safeguarding measures		Financial assistance?		Project			Contacts		Source of information	Comments
			Equipment	Oil/liquid	Total				>10 % or 100 g/kg	> 0.05 % or 500 mg/kg	> 0.005 % or 50 mg/kg	< 0.005 % or 50 mg/kg	PCB content not known				GEF IA	Other	Identification	Key steps	Major outputs	National	IA		
					0																				
					0																				
					0																				

* 50 mg/kg is equivalent to 0.005% or 50 ppm
** E.g. transformer oil
*** E.g. capacitor
**** Please indicate if transport is included