Lessons learned from PCB management: opportunities for the new POPs

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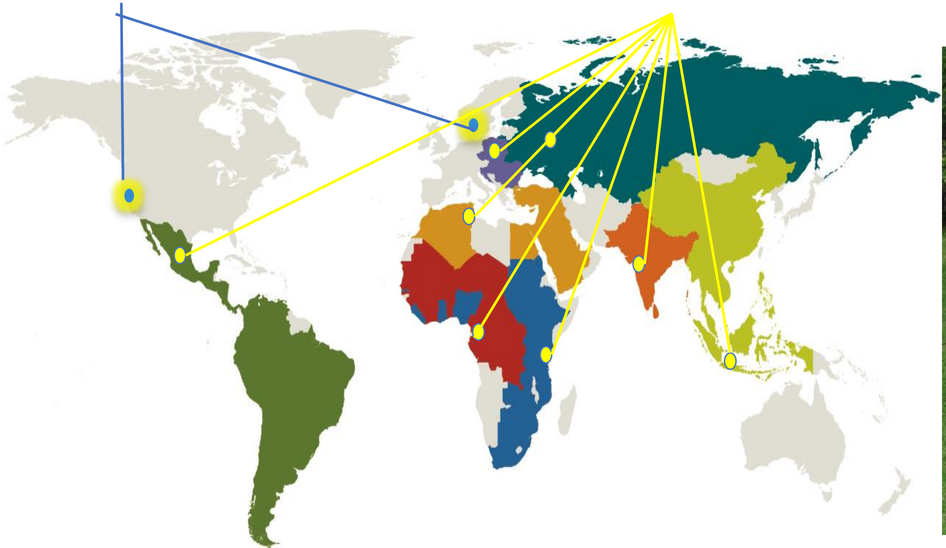
IPEN Mission:

A toxics-free future for all

Global Network of 600+ NGOs in 120 countries

Global & Regionally balanced Leadership

2 Global Offices + 8 IPEN Regional Hubs



IPEN Model

Globalize Local Priorities

Link local constituencies to the global process

Localize Global Policies

Leverage global policies and resources for on-the-ground change

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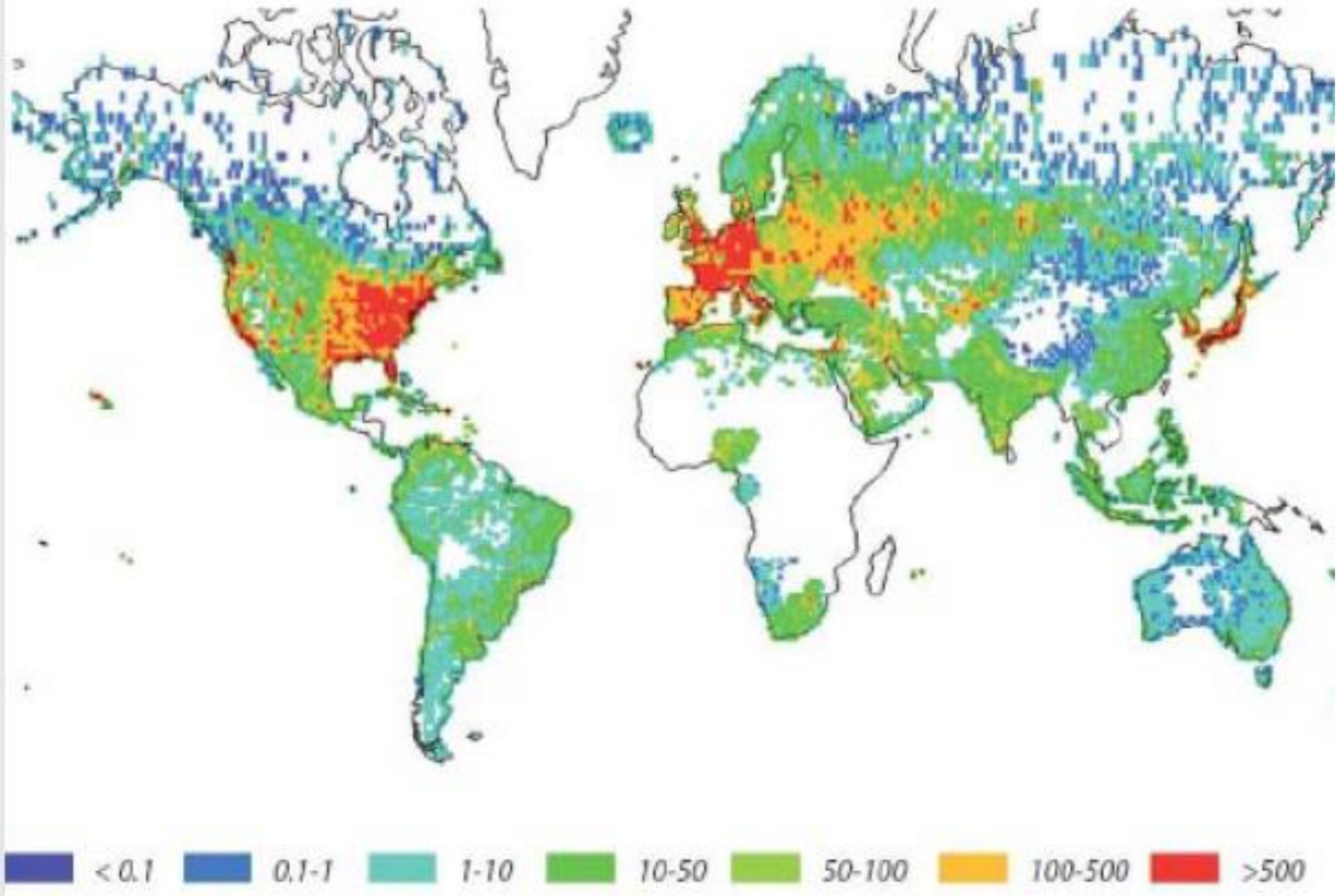
Polychlorinated biphenyls (PCB) Production

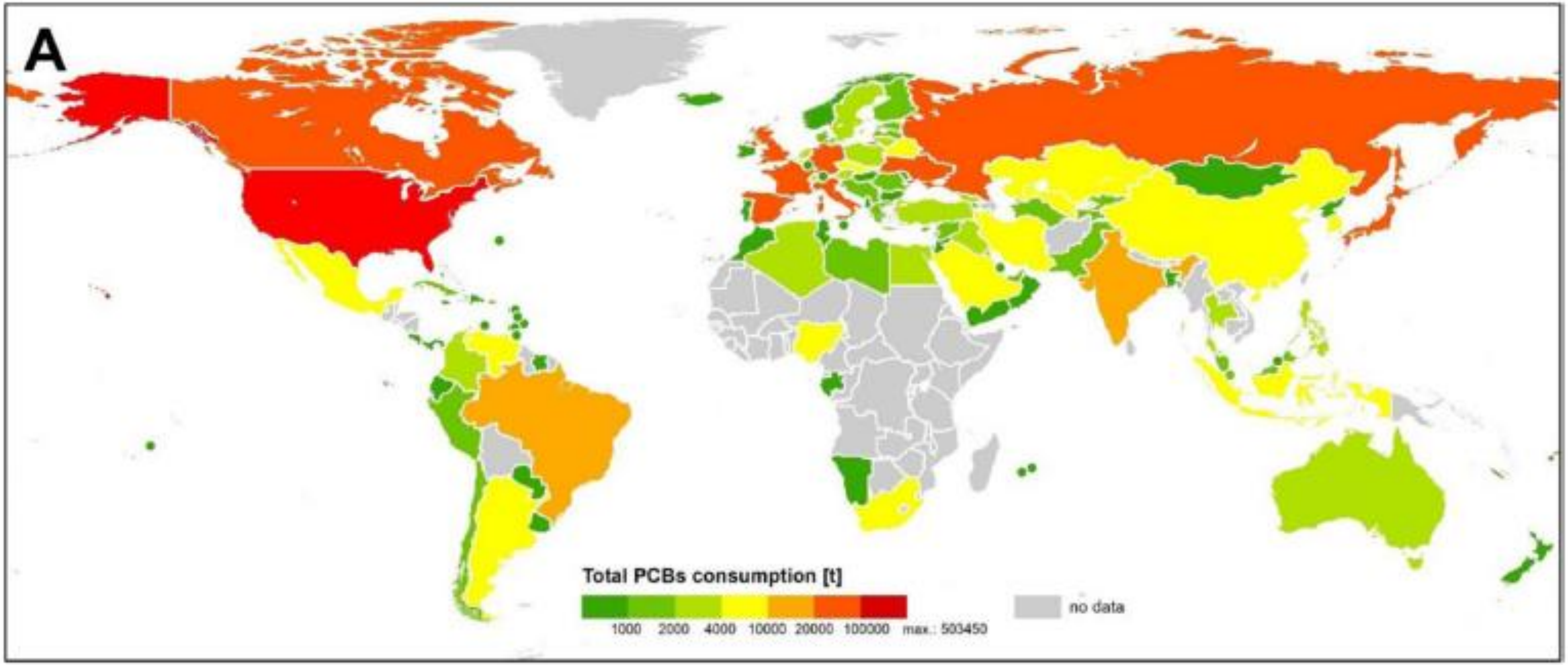
- Manufactured since the 1930’s in at least 10 countries
- Mainly USA, West Germany, USSR and France.
- Exported to 114 countries
- 1.3 million tonnes of pure PCB were produced
- However, the pure PCB was diluted in oils and later spread through products and wastes resulting in 17 million tonnes of PCB waste globally.
- The Stockholm Convention targets are for PCBs to be phased out from use in equipment by 2025 and stockpiles to be eliminated by 2028.

Export destination of PCB and related equipment in tonnes



Source: PCB Inventory Guidance, pg. 11

Total PCB consumption (tonnes)



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Applications of PCBs

Closed applications:

- Primarily dielectric fluid to prevent fires and explosions in electrical capacitors and transformers.
- Electric motors, light ballasts.

Partially open applications:

- Hydraulic fluid, switches, electrical cables etc

Open applications:

- Paints, caulking/sealants, flame retardants, insulation, dyes

Source: Photo by Anil Sookdeo / Global Environment Facility

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Mobility and persistence

The mobility and persistence of PCBs has resulted in their contamination of soil and aquatic life from the high Arctic and Antarctic to the Mariana Trench in the deep Pacific Ocean.

The first signs of the environmental persistence, mobility and toxicity of PCBs were detected in the Baltic Sea in the 1960s and 1970s.

However, Monsanto, the company that manufactured over 50% of all PCB globally, were aware of the toxicity of PCBs since shortly after they began mass manufacture in the 1930's. They argued the risk was minimal due to their use in closed applications.

Bioaccumulation

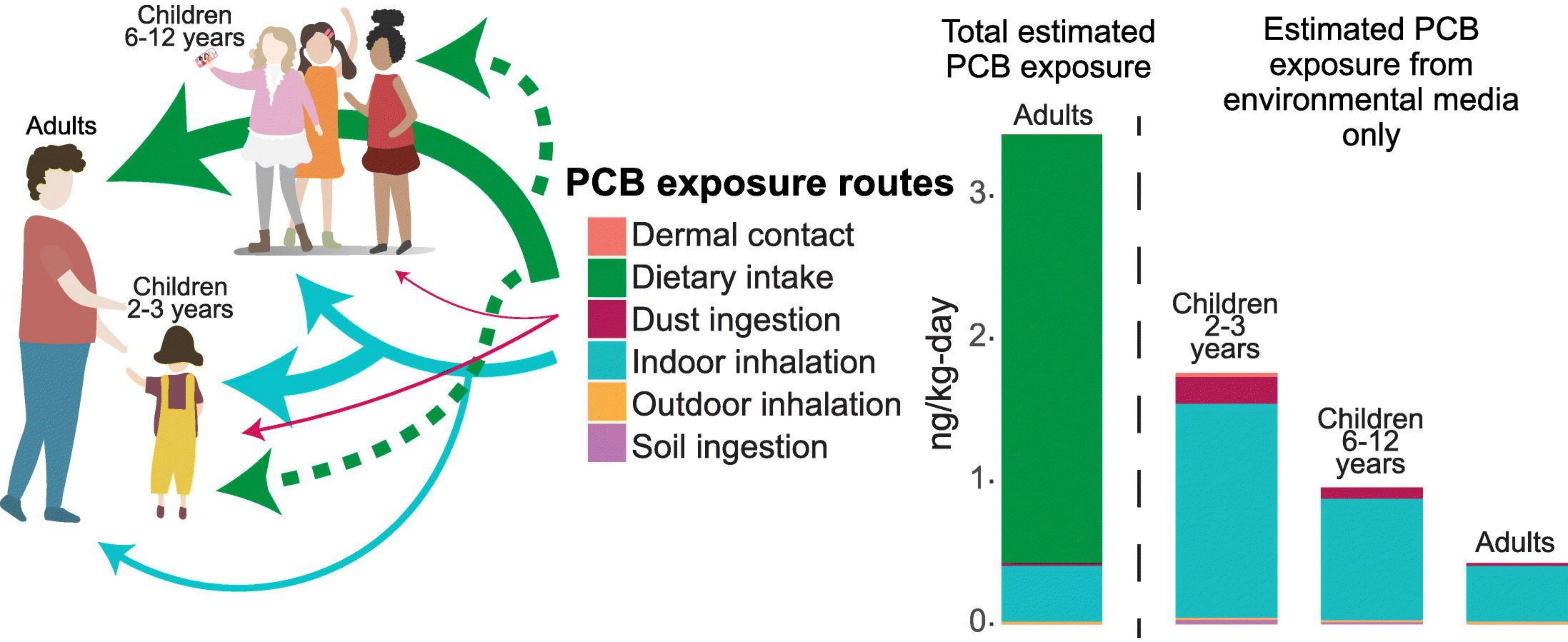
- Lulu the killer Whale (UK) was found to have massive levels of PCB in her body. PCBs in Lulu’s body were 100 times higher than the minimum toxic level. Like many chlorinated POPs, PCBs are lipophilic or attracted to fats. For high trophic levels predators such as killer whales this results in PCB lodging in body fat or blubber of predators after accumulating through the food web on which feed.
- It is now estimate that PCBs may be the cause of the demise of up to 50% of global killer whales, lowering immune systems and impacting reproductive ability.

Toxicity

- PCBs have significant toxicity in the case of human exposure and has been associated with:
- Neurodevelopmental toxicity leading to learning, behavioural or developmental or intellectual problems in children.
- PCB exposure has also been linked to suppressed immunological function, auditory deficits and central nervous system disorders with Parkinson disease like symptoms.
- In whales, dolphins and porpoises PCBs accumulated from prey can lead to suppressed immune systems, disruption of the endocrine system and impaired reproduction. Tuna and sharks are also impacted. Some Orcas are predicted to die out within a generation due to PCB contaminant levels

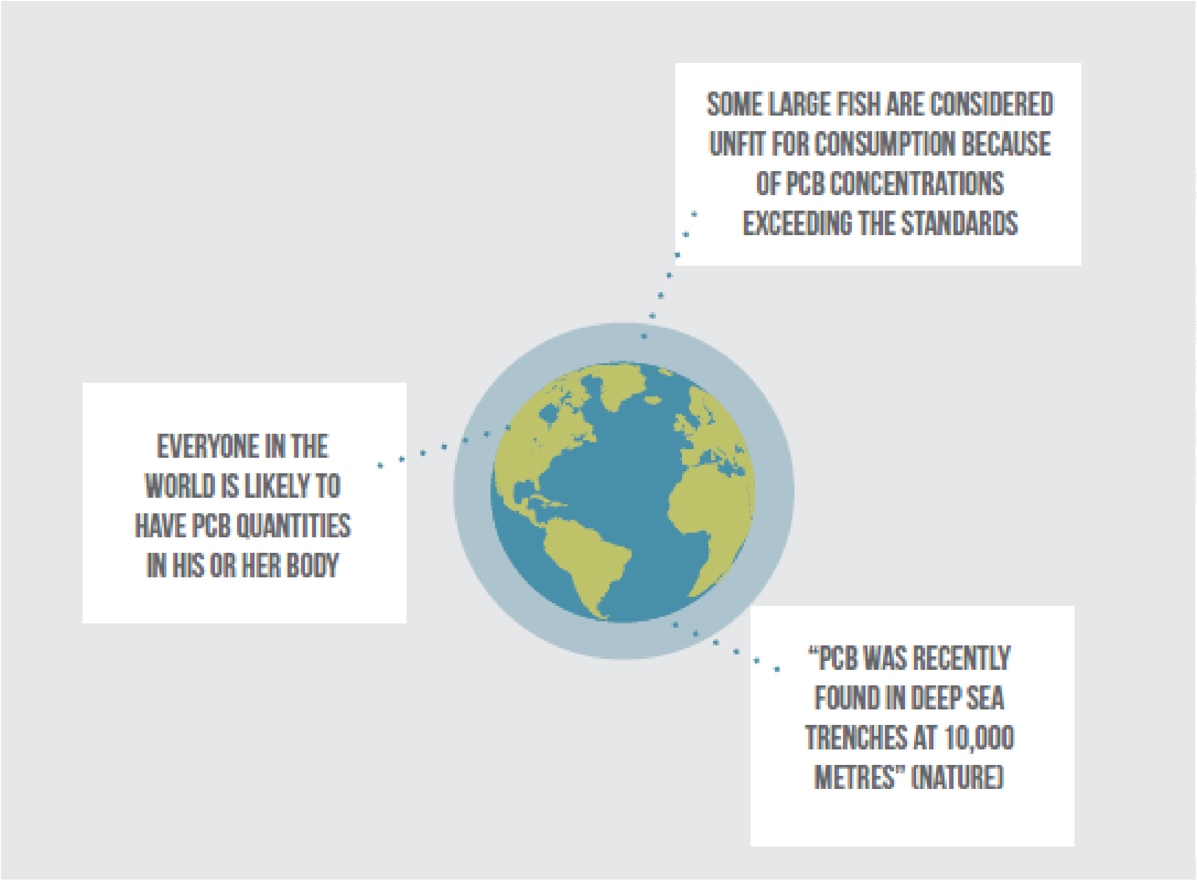
Human exposure to PCB

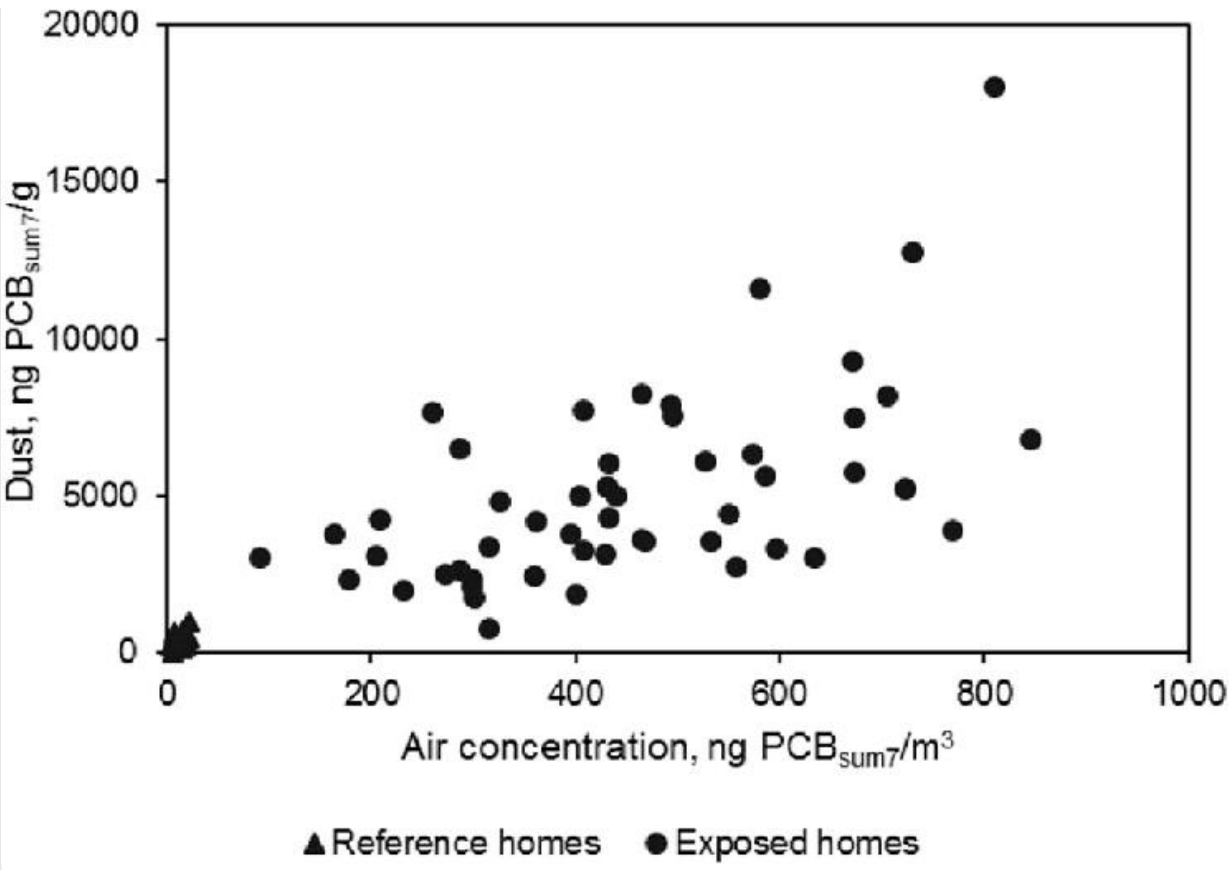
- Open applications (paint and caulking/sealants)
- Semi open applications
- Dietary
- Emissions and waste
- Indoor air and dust
- Soil ingestion (children's pica behaviour)



Weitekamp et al (2021)

PCB contamination: global and local





Anderson et al., 2020

Closed applications – poor management

- Transformers, capacitors and lighting ballast.
- Less exposure in use but problems arise when they leak, degrade or the oil is repurposed despite regulations.

Documented cases of:

- PCB transformer oil being drained into the ground in Malawi just before testing.
- In Dominican Republic PCB transformer oils progressively diluted with mineral oil by shop owners to avoid disposal regulations, PCB oil sold to illegal foundries.
- Reports from Ghana note PCB oil used to make beauty creams and used for domestic sewing machine lubrication
- Montenegro factory workers used PCB oils to wash hands and took it home to burn for heating.

(Melymuk et al., 2022)

The legacy of open application: exposed schoolchildren across the US.

- Between 12, 960 to 25, 920 schools contaminated in the US with sealants and paints containing PCB.
- Field and laboratory studies have demonstrated that PCBs from both interior and exterior caulking can be the source of elevated PCB air concentrations in these buildings, at levels that exceed health-based PCB exposure guidelines for building occupants.
- Replacing PCB sealant with non-PCB sealant can result in the 'clean' sealant becoming contaminated with PCB due to residual PCB.
- Air sampling can reveal wide ranging levels, even within the same room at different times.

(Herrick et al., 2016)

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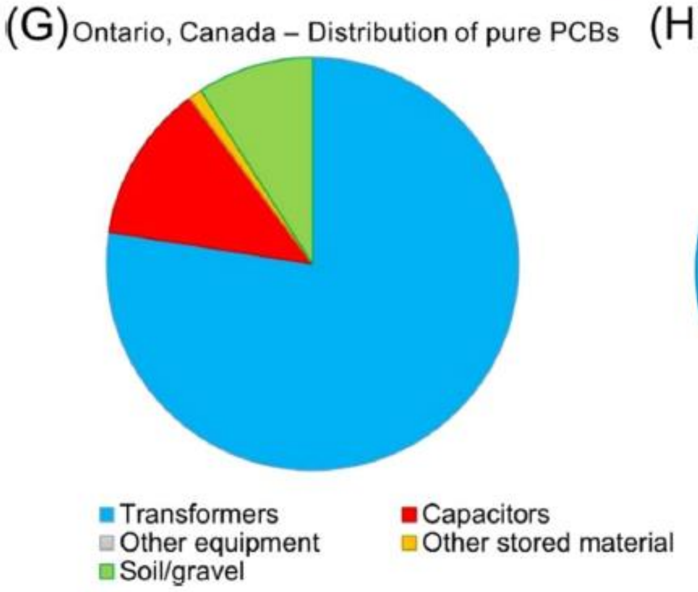
Vermont schools sue Monsanto over toxic PCB contamination.

More than 90 school districts filed the complaint on Friday in federal court. They're seeking to recover costs and damages because, under Vermont’s law, schools with high-enough contamination levels must reduce exposure. Removing the PCBs will be expensive, and certain districts may have to demolish buildings and replace them with new ones — which in total could cost them "hundreds of millions, if not billions, of dollars,” the lawsuit says.

In October 2022 a jury awarded $275M to 13 children and their families who attended a PCB-contaminated school.
(Hornbuckle 2022)

Soils and wastes

- The contribution of PCB contaminated soil and gravels to an inventory can be substantial but most national reports only refer to oil and equipment.
- As an example, Ontario, Canada, did include the contribution from soil and gravel (see below) which is a significant portion of the 12,200 tonnes of PCB waste (>50 mg/kg) in its inventory.



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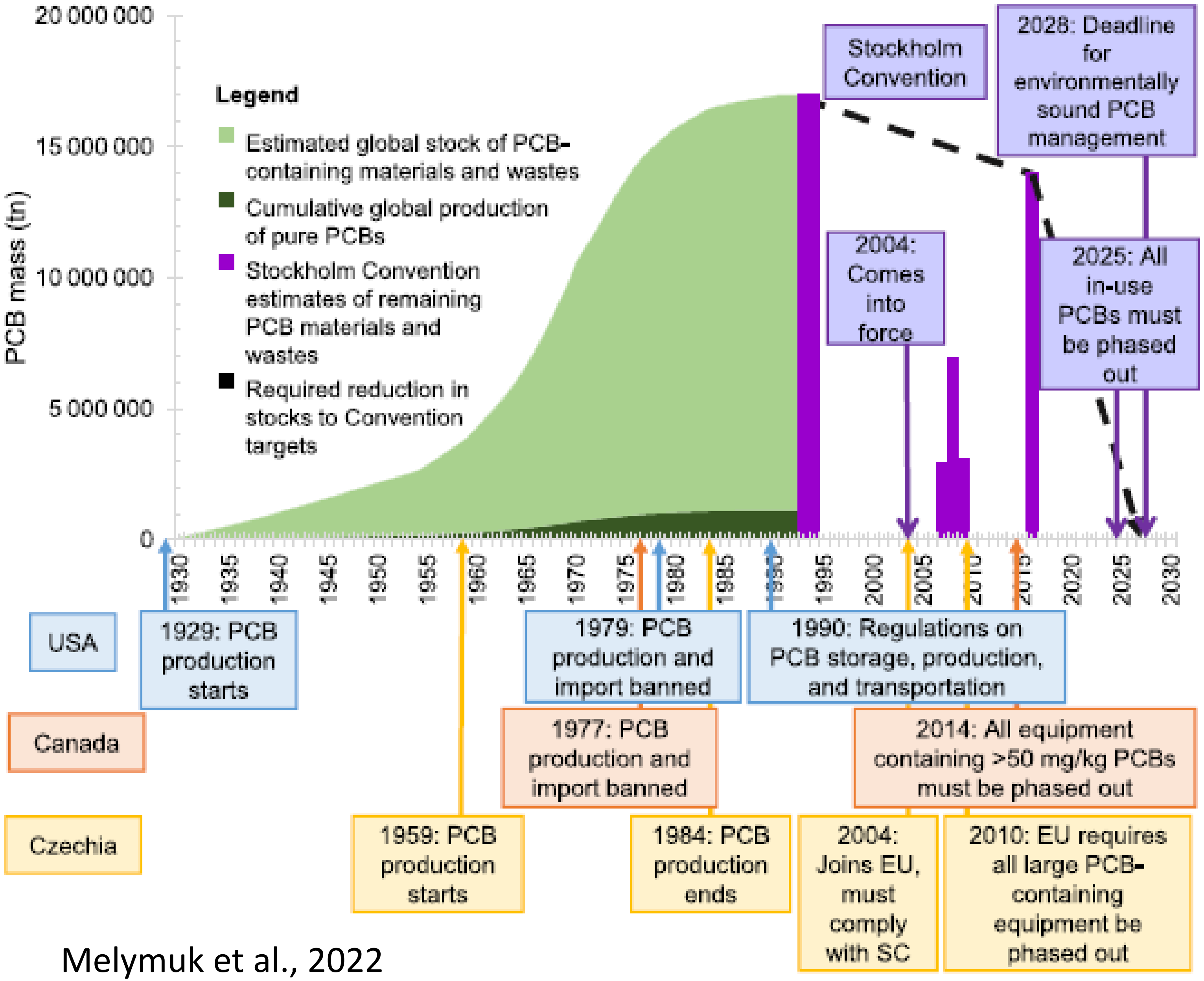
Regulation

- Started in the 1970's with production and import banned in US and Canada.
- Use and marketing heavily restricted in EU from 1985
- Stockholm Convention agreed in 1995 and entered into force in 2004 listing PCB
- Article 6 of the SC requires destruction or irreversible transformation of POPs waste (PCB waste > 50 mg/kg low POP content)



Melymuk et al., 2022

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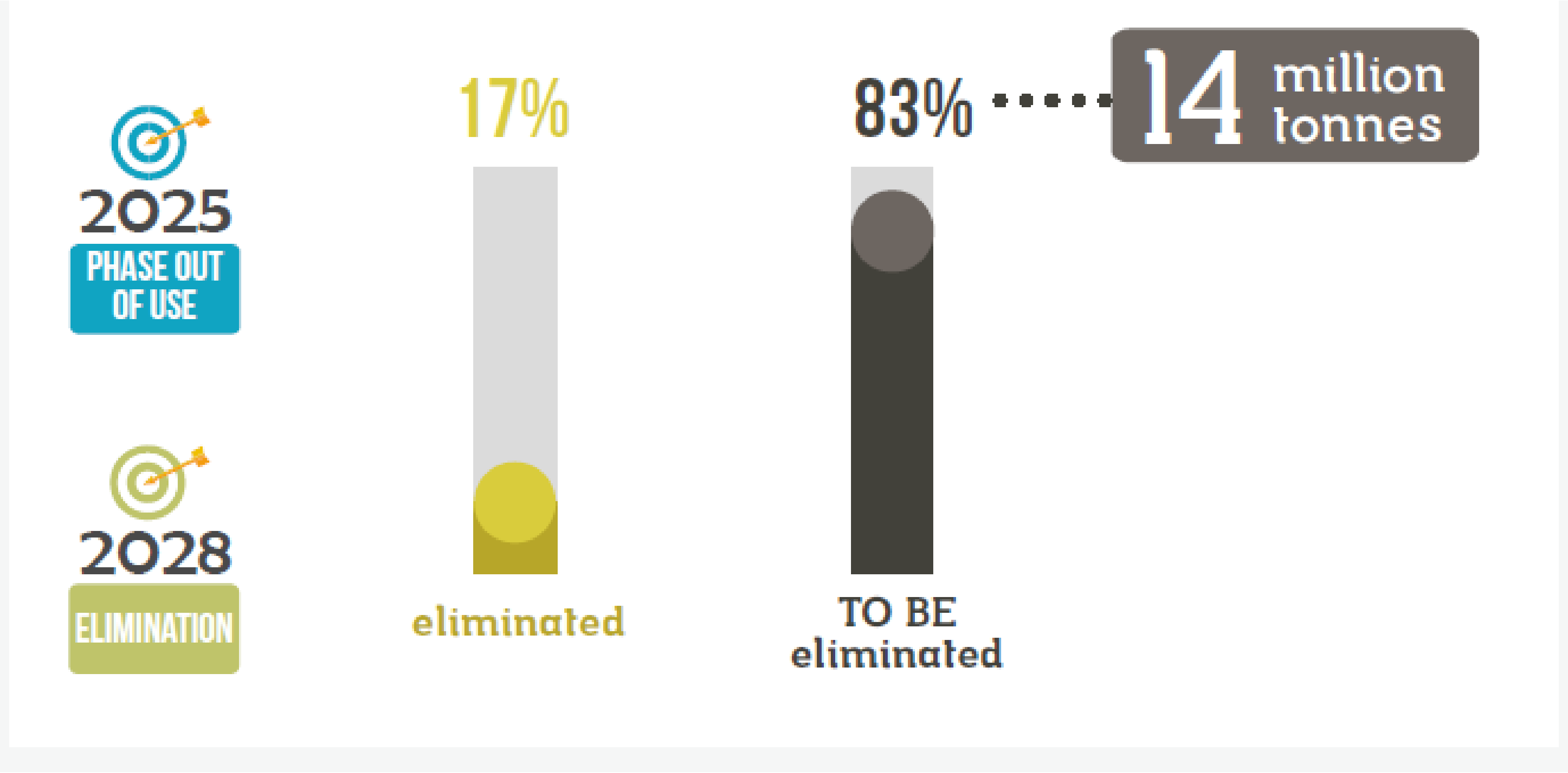
1 million tonnes a year need to be destroyed to meet the 2028 deadline



Based on 2016 UNEP data

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Global PCB destruction well behind schedule

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Stockholm Convention on Persistent Organic Pollutants

Report on progress towards the elimination of polychlorinated biphenyls

Table 6. Summary of quantitative global information on PCB reported under the Stockholm Convention and Basel Convention national reports.

	Production (t)	PCB waste eliminated (Local destruction + exports) (t)	Inventoried PCB (t)
Global information reported under SC and BC	1,046,000 – 1,512,000	593,260	639,057

1. As previously explained, a higher amount of total PCB waste to be disposed is expected since liquids represent an average of 30% of the total weight of electrical equipment and pure PCB has been diluted by cross contamination, among other issues.

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Inventories and reporting under Stockholm Convention

- Inventories of PCB waste are critical for the environmentally sound management and destruction of PCBs and tracking elimination progress.
- Reporting under Stockholm is the main database of PCB waste.
- National reporting under the Stockholm Convention has been fragmented and incomplete.
- There has been a lack of uniformity in SC reporting of units (kg, tonnes, equipment, oil) leading to high levels of uncertainty in estimates.
- Soil and sediment contamination volumes are rarely recorded.

Non-parties – The USA

- The US, with 50% of all historical PCB production is not a party to SC and does not report PCB inventories to the convention.
- It does have a *PCB transformer registration database* and the *PCB Cleanup and Disposal Program.*
- The transformer database is self-reporting and does not include concentrations of PCB.
- US does not have a deadline for PCB destruction.
- The US has no inventory for capacitors, ballasts other electrical equipment, and contaminated soi
- PCB in the US are legally allowed to be disposed of by methods not considered ESM by the Stockholm Convention such as landfill.
- It is estimated the US has at least 26 million cubic meters of soils contaminated with PCBs and 350 PCB contaminated sites.

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Parties- Not enough accurate reporting

- Of the 184 ratifying parties of the Stockholm Convention, 10 have not submitted any implementation plan.
- Of the 174 Parties that have submitted reports, 72 national PCB inventories (42%) are partial or preliminary.
- Many inventories are only of transformers which account for around 50% of PCB use thereby seriously underestimating other waste.
- 23 countries (13%) reported complete PCB inventories but no capacity to achieve ESM, while 11 countries had inventories and capacity to manage PCBs but had made no significant progress toward ESM.
- Only 18% of parties (34%) are moving toward ESM of PCB
- Only 23 countries (13%) have achieved ESM of PCB and nearly all are high income parties.

(Melymuk et al 2022)

Destruction technologies outdated and concentrated in the global north

- Incineration and cement kilns form the majority of destruction techniques but generate UPOP emissions and contaminated ash and Cement Kiln Dust with an enormous carbon footprint.
- BAT BEP techniques must be employed to reduce elevated dioxin emissions – often not available in the global south.
- Limited regional destruction capacity results in risky shipping operations over long distances. Insurance costs may exceed destruction costs.

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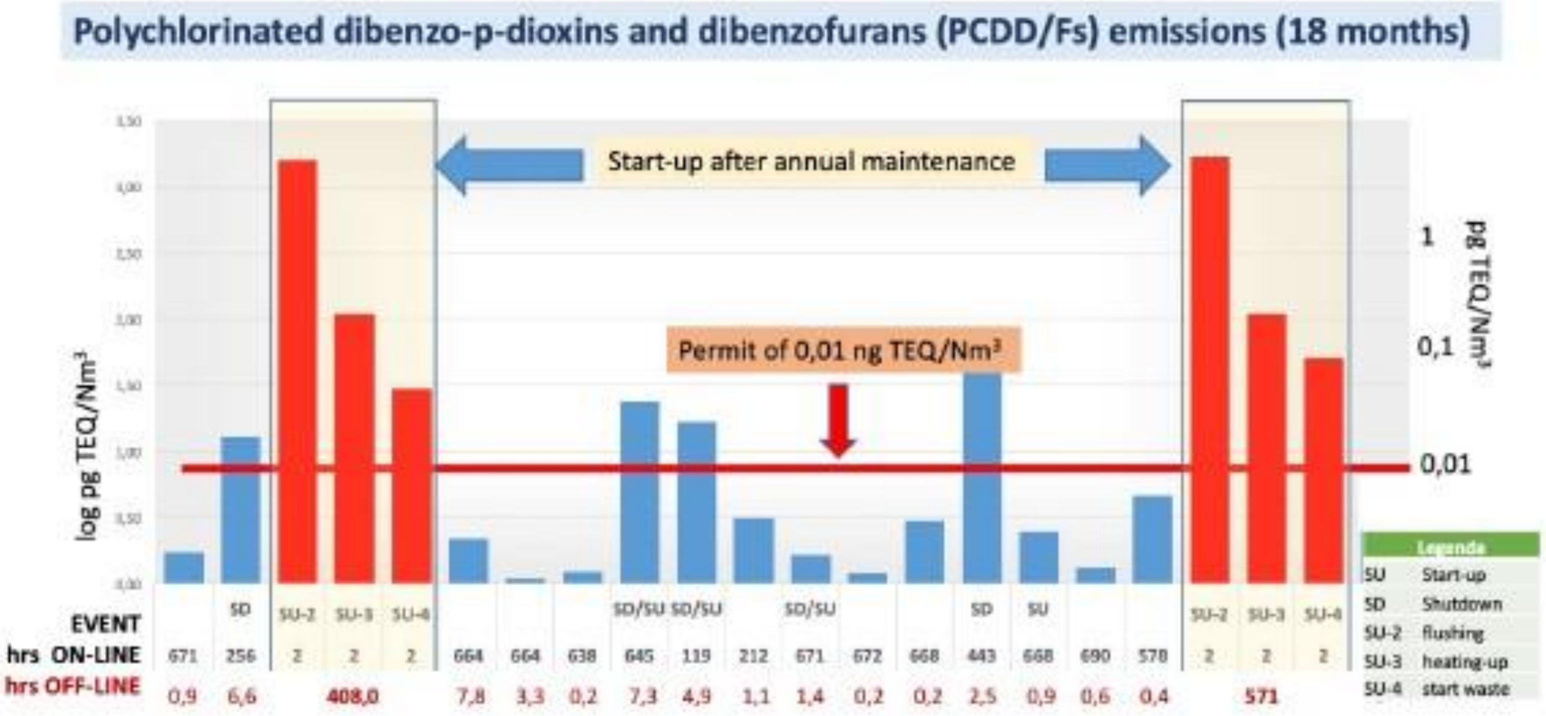
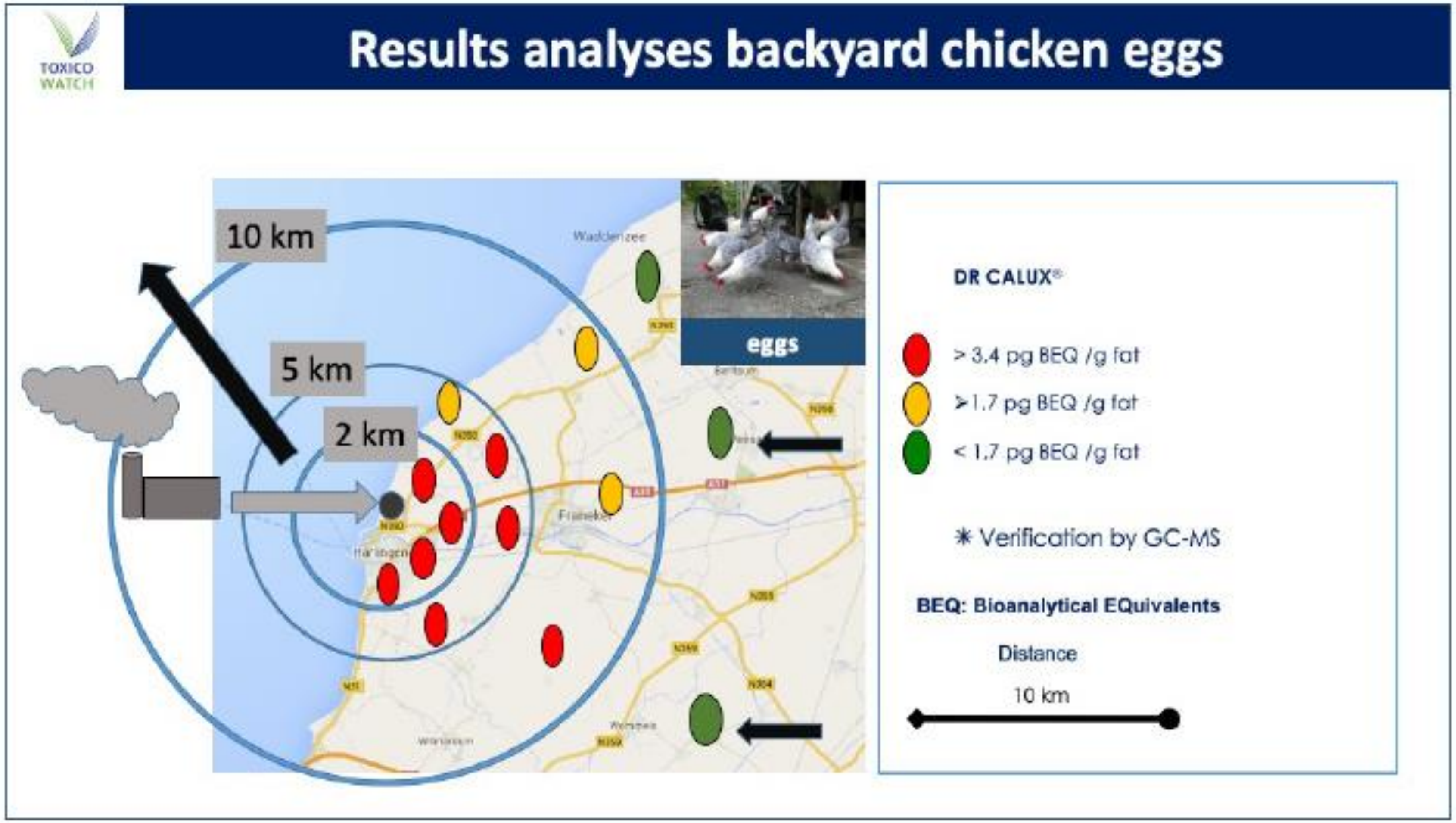
Long-term versus short-term dioxin sampling



Long-term sampling with an uptime of > 95%, could measure under ideal condition emission levels of 0,2 pg TEQ PCDD/F /Nm³ (794 hours). However, during start-ups levels of dioxins were found to be much higher: 1,7 ng TEQ/Nm³. In the figure above levels of PCDD/Fs are shown during the different stages of start-up (red) of flushing (SU-2), heating-up (SU-3) and start waste feed (SU-4). High PCDD/F levels are observed, when without waste combustion cleaning operation are performed and no air pollution control devices are obliged.

Source: Toxico Watch Netherlands

Dioxin in the food chain - Netherlands



Break the POPs cycle with non-combustion technologies for new POPs waste destruction

- Decades of POP waste incineration have led to ongoing unintentional POP emissions and releases – even when operating to BAT BEP standards.
- Incineration BAT BEP measures have a tendency to move dioxin and other UPOPs into the fly ash and bottom ash as scrubber systems capture more UPOPs.
- Studies have demonstrated that even with the latest and best run incinerators dioxin emissions during start up, shut down, cleaning operations (flashing) can still lead to dioxin bioaccumulation in the food chain at unacceptable levels

Stack flashing – Harlingen incinerator, Netherlands.
Source Toxico Watch

Non-combustion technologies under-utilised for PCB destruction

- Non-combustion technologies such as:
- Gas Phase Chemical Reduction (GPCR)
- Super-Critical Water Oxidation (SCWO)
- Base Catalysed Decomposition (BCD) and
- Mechano-Chemical Destruction (MCD)…

Do not generate UPOPs such as dioxins in emissions or ash and break the POPs cycle.

Gas Phase Chemical Reduction (GPCR) destroyed the entire PCB stockpile of Western Australia (2000 tonnes).

Decentralising POP destruction to accelerate the elimination process

- IPEN has developed resources on non-combustion technologies for POP waste destruction.
- Some technologies can destroy all POPs and some are specific to individual POPs.
- Some technologies are modular and mobile allowing the technology to be taken to the stockpile instead of shipping stockpiles overseas.
- The Global Environment Facility (GEF) has a programme to fund POPs waste destruction projects using non-combustion technology.
- These funds can be accessed by parties to the Stockholm Convention.

- For more information

https://ipen.dev.clerestory.com/documents/non-combustion-technology-pops-waste-destruction

Major challenges in PCB elimination

- Too much time allowed to pass between identifying the threat of PCB and prohibiting use and production allowing contamination to spread and open applications to proliferate without records.
- Poor record keeping and national reporting of PCB equipment, products and contaminated sites.
- Only a few European countries have inventories of open applications with ranges between hundreds and thousands of tonnes
- Insufficient resources for inventory development and reporting
- Insufficient resources and capacity for destruction

Major challenges in PCB elimination

- Lack of regional destruction capacity leading to high-risk shipping and elevated insurance costs – undermines proximity principle
- Combustion destruction methods lead to UPOP formation (PCDD/DF and dl PCB)
- Not enough non-combustion techniques utilised.
- Weak enforcement and illegal disposal in some countries
- Open applications very difficult and expensive to inventory and manage.
- Lack of polluter pays enforcement to generate resources for cleanup and destruction
- Regrettable substitutions with other chemicals that have since been identified as POPs (e.g. Short Chain Chlorinated Paraffins)

Lessons learned and opportunities for new POPs: Some general principles

- *Prevention*: Need to assess chemicals of concern BEFORE they enter production and use. Onus on producers to demonstrate safety.
- Critical need to prevent chemicals with POPs characteristics entering the market as management solutions and limited and exposure impacts low-income countries most.
- *Precaution*: Where one chemical of a family exhibits POP characteristics the rest of the family should be assessed as a priority and restrictions applied to the whole group (e.g. PFAS, chlorinated paraffins, phenolic benzotriazoles like UV-328)
- *Polluter pays* – establish EPR schemes that provide the resources for inventory and elimination while the production companies are still solvent.
- Avoid regrettable substitution such as SCCPs for PCBs.

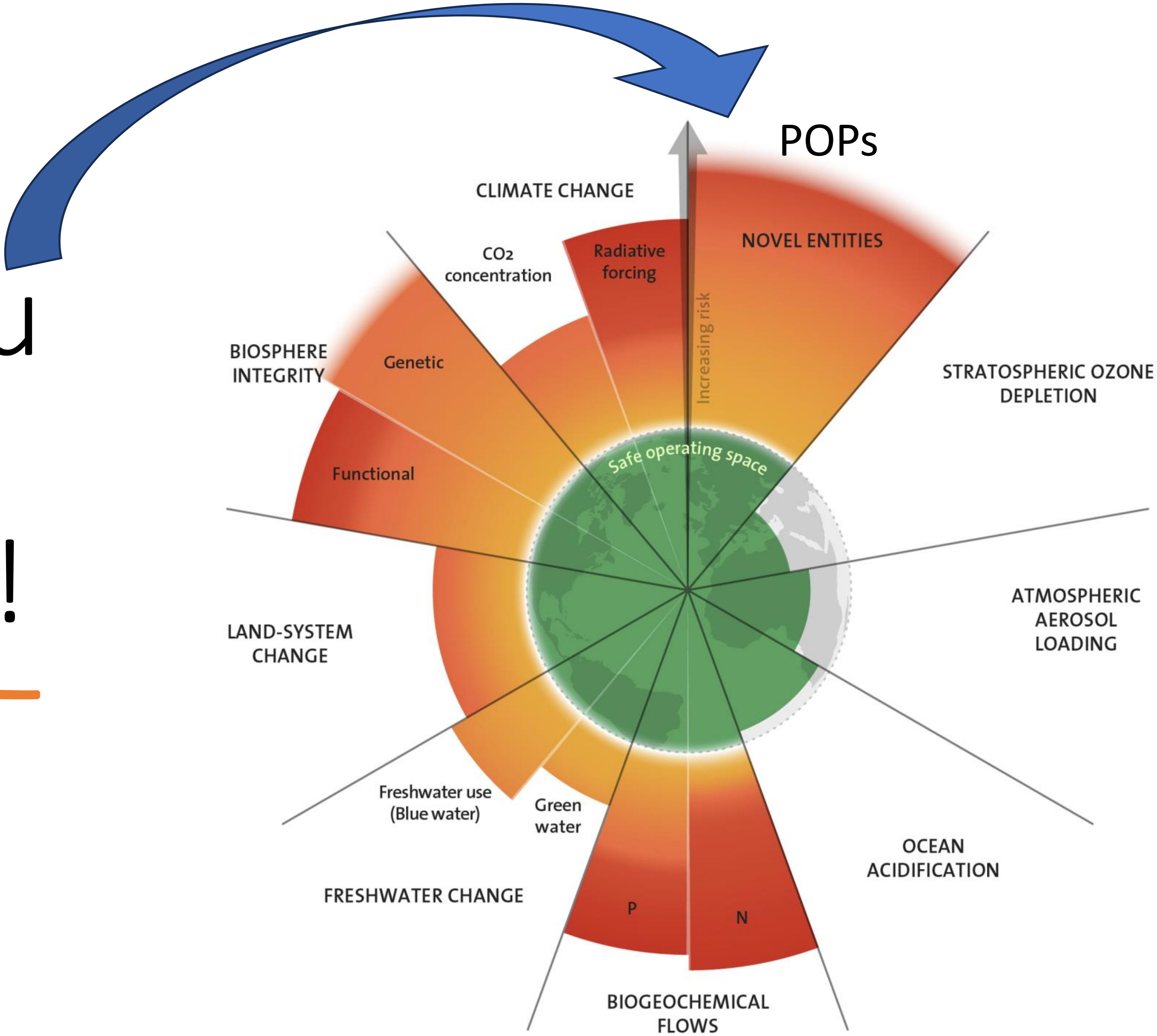
Specific strategies to consider

- Target open application control measures early for products and wastes containing new POPs.
- Resource countries to identify, label and track new POP wastes so they can inventory and report accurately.
- Regional harmonisation of regulatory frameworks to identify, inventory and stockpile PCB waste ahead of elimination.
- Ensuring adequate analytical capacity to identify POP waste.
- Developing risk management and communication frameworks to ensure POP waste holders understand the risk associated with POP waste and need for ESM.
- Develop adequate training programmes for regulators and industry to ensure ESM of POPs waste.
- Promote destruction technologies that break the POPs cycle and do not contribute to it via UPOPs.

POP PFAS - Making PCB management look easy.

- PCB: Trade was limited, most was used in closed items like transformers and most stocks were held by large companies requires to inventory and report them (with exception of open applications).
- PFAS: primarily open applications held by millions of people, highly mobile in water, limited remedial and destruction methods available.
- High human exposure with food packaging, products, furnishing and clothes treated with PFAS substances.
- Traditional destruction methods unsuitable with new studies showing PFAS in emissions, ash, and other flue gas residues as PFAS are resistant to thermal degradation. (Bjorklund et al 2023)

Thank you for your attention!



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