

# Hazardous chemicals in dust

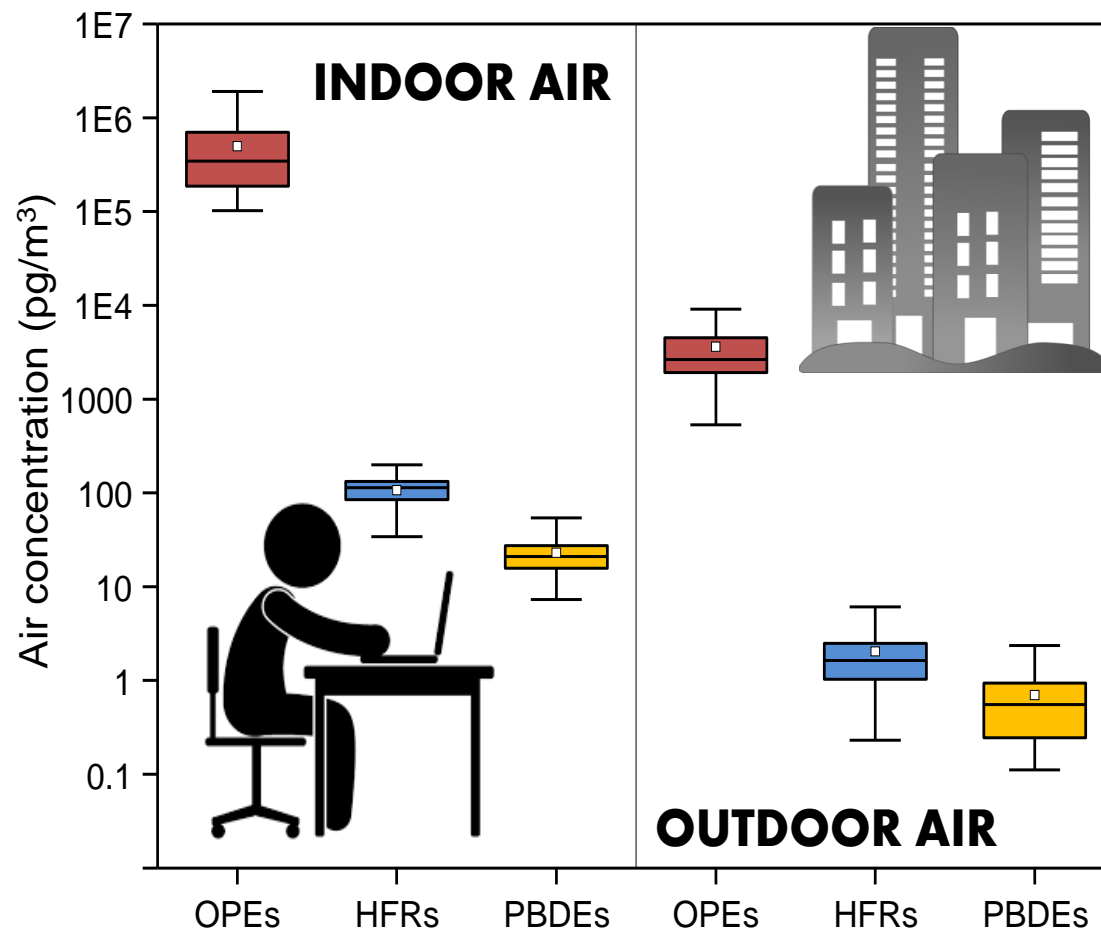
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Stockholms universitet

# Introduction

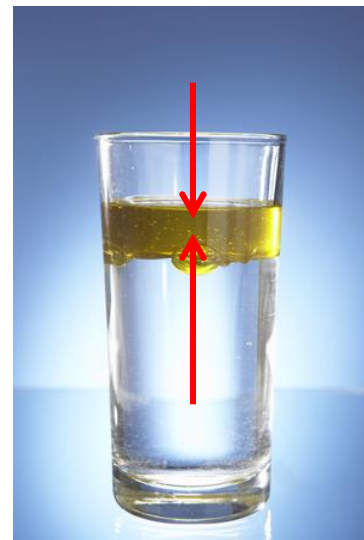
- Previously: natural materials such as wood, stone, plant-based textiles
- Today: many synthetic materials in use in consumer products, building materials found indoors
  - Often based on oil (e.g. plastic)
  - Contain lots of energy (burn very hot) – chemicals added to slow down fires
  - Require additives to improve performance (soften, harden, toughen)
  - New materials with desirable properties (water repellant but breathe, oil repellant, non-stick etc.)
- Many chemicals leach out of products into the indoor environment

# Many chemicals found in higher concentrations indoors than outdoors

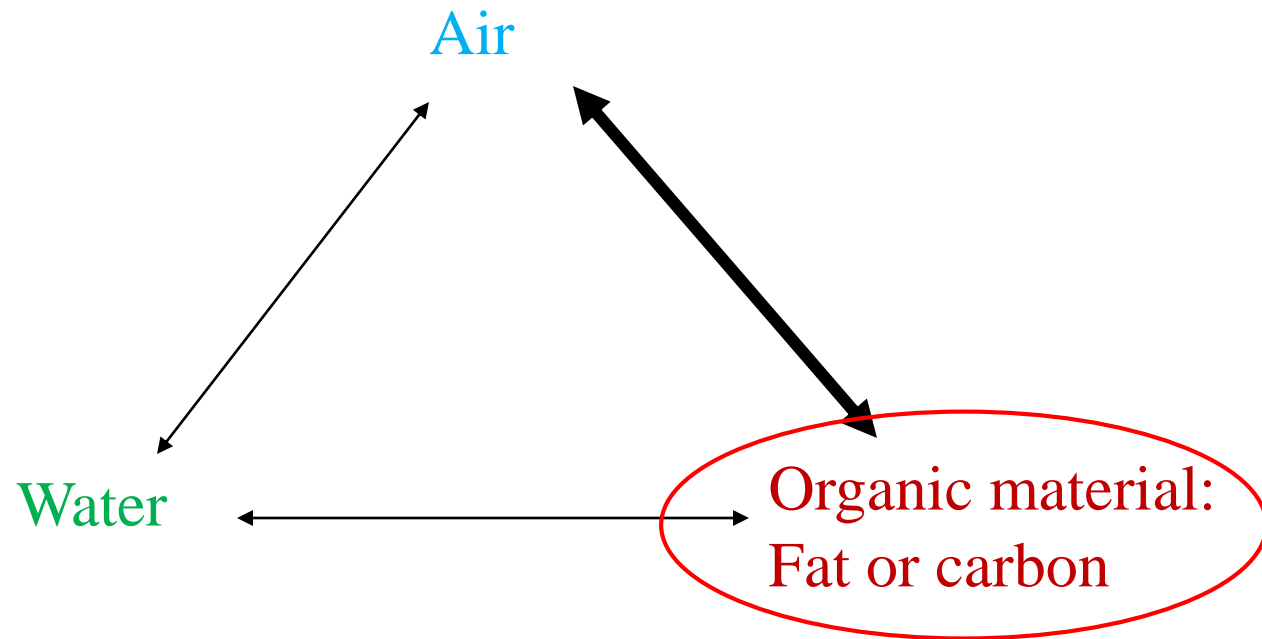


# Semivolatile organic chemicals (SVOCs)

- Hydrophobic (hate water)
  - Dissolve better in organic phases than in water
  - Organic carbon and lipids act as solvents for SVOCs
  - Within SVOC groups, increasing number of rings and/or halogens increases hydrophobicity
- Semivolatile
  - Dissolve better in organic phases than in air
  - Within SVOC groups, increasing number of rings and/or halogens decreases volatility



# Partitioning



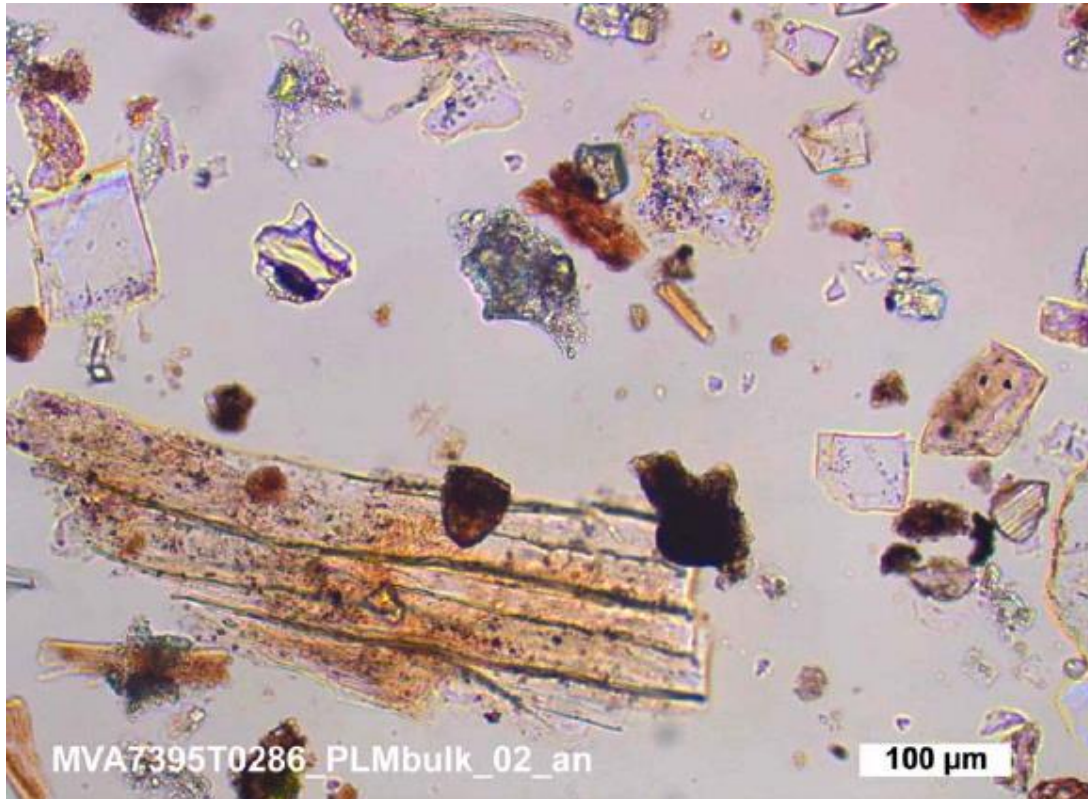
# Which hazardous chemicals (SVOCs) are found in dust?

- PCBs
- PAHs
- Bisphenols
- Phthalate esters/plasticizers
- Flame retardants (BFR, CFR, OPE)
- PFAS
- Pesticides
- And more.....

# PFAS physical-chemical properties differ from other SVOCs

- Some are not volatile at all (e.g. PFOS, PFOA)
- Some are very volatile (e.g. fluorotelomer alcohols (FTOH))
- Hydrophobic and lipophobic
- Many ionize – often found in water

# What is dust?



**Light microscopic image**

|                  |        |
|------------------|--------|
| skin cells       | 1-5%   |
| soil minerals    | 10-20% |
| synthetic fibers | 1-5%   |
| plant fragments  | 40-60% |
| debris*          | 20-40% |

**\* includes clear elastic material**

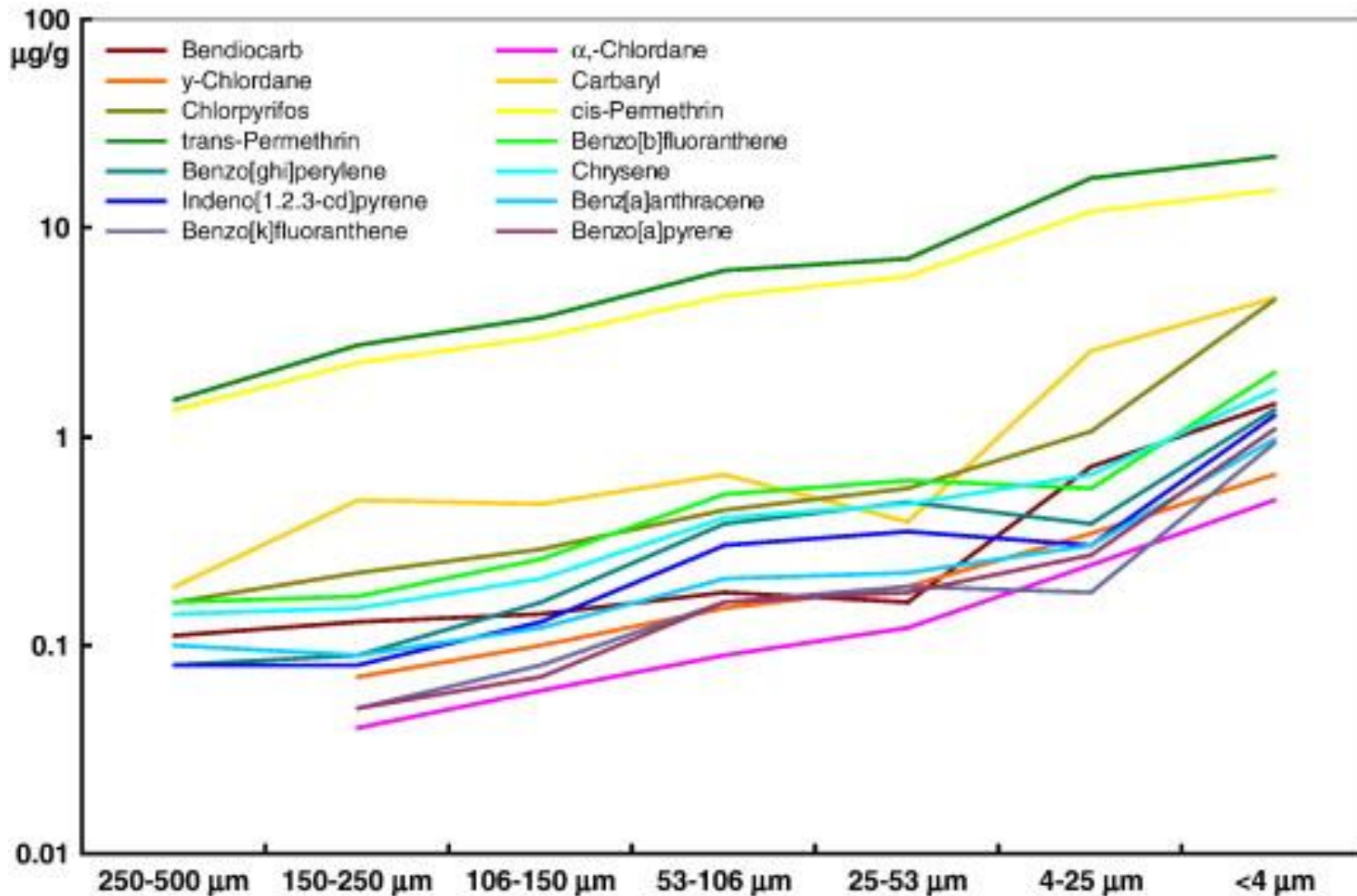


# Partitioning indoors – where will SVOCs go?

- Dust (floor, surfaces)
- Air particulates
- “Personal cloud”
- Organic films
  - Windows
  - Walls, floors and ceiling
  - Skin
- Air (gas phase)



# Dust particle size affects concentrations – surface area/mass ratio

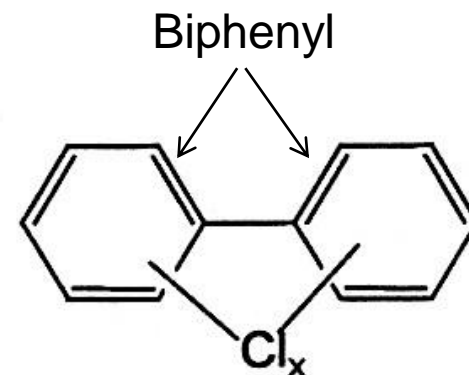


# Where do SVOCs come from?



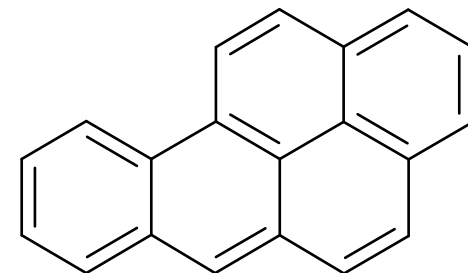
# Polychlorinated biphenyls - PCBs

- Indoor use:
  - Used in paints
  - Plasticizer e.g. building caulking around windows
  - Light ballasts in fluorescent lights
  - Recently found as byproduct in pigments

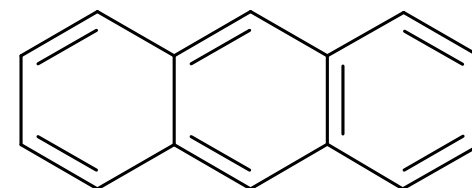


# Polyaromatic hydrocarbons - PAHs

- Indoor sources:
  - Fireplaces
  - Smoking
  - Cooking



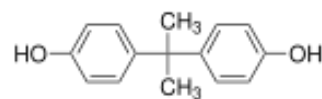
Benzo[a]pyrene



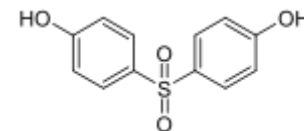
Anthracene

# Bisphenols

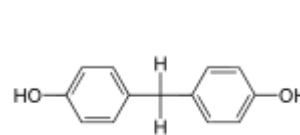
- Uses
  - Production of polycarbonate, epoxy in metal cans, plastic bottles, etc.
  - Thermo paper – receipts, tickets



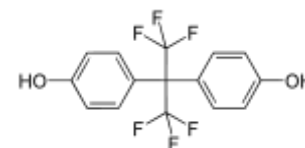
Bisphenol A



Bisphenol S



Bisphenol F



Bisphenol AF



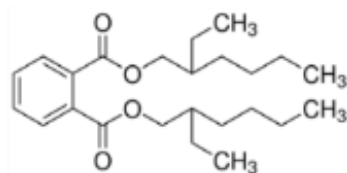
www.promosgift.eu





# Phthalate esters/alternative plasticizers

- Makes plastic soft and long-lived



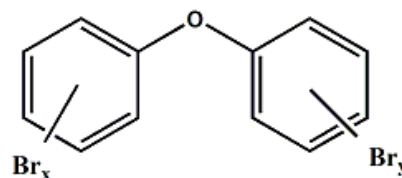
DEHP



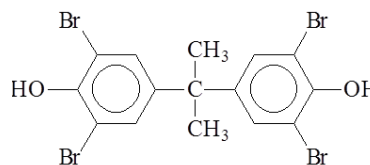
# Brominated flame retardants (BFRs)

- Uses

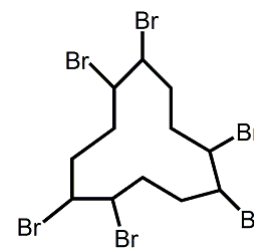
- Polyurethane foam, textiles in furniture etc.
- Plastic casing of computers, TVs, cell phones etc.
- Polystyrene insulation
- Textile backcoating
- Printed circuit boards



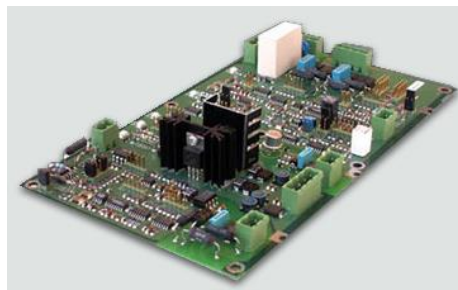
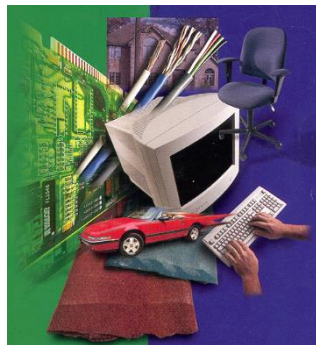
**PBDE**



**TBBPA**

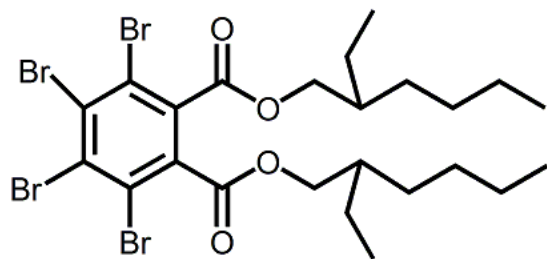


**HBCDD**

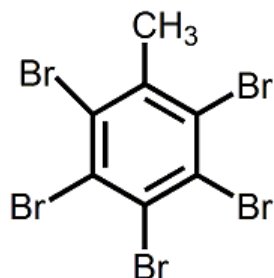




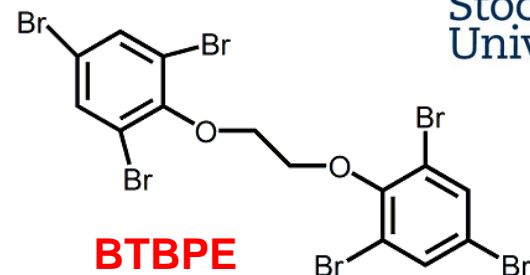
# “Emerging” BFRs – 15-25 ämnen



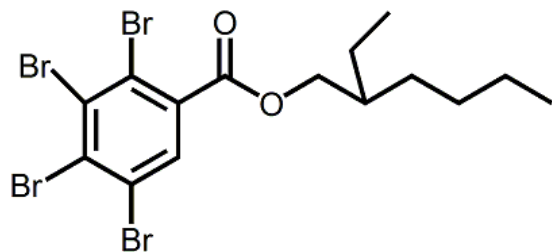
**BEH-TEBP (TBPH)**



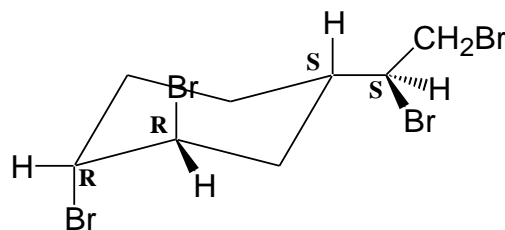
**PBT**



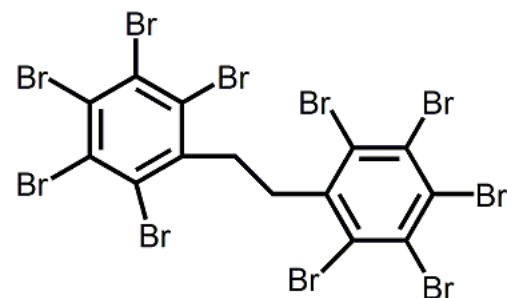
**BTBPE**



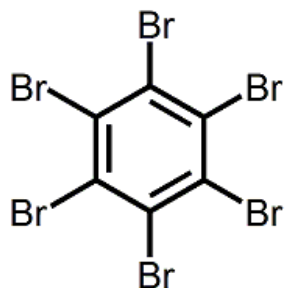
**EH-TBB**



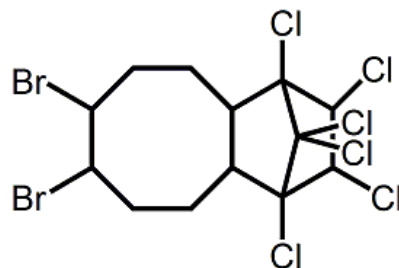
**DBE-DBCH (TBECH)**



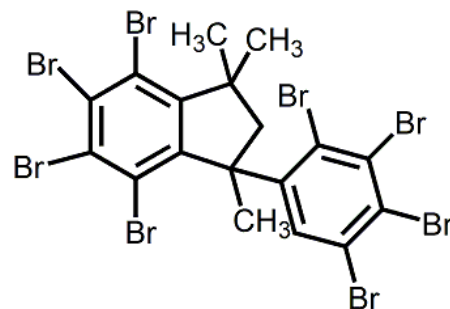
**DBDPE**



**HBB**



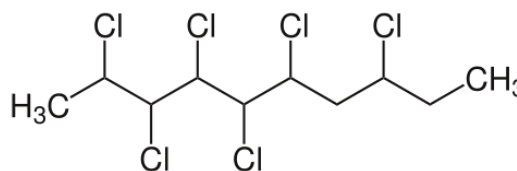
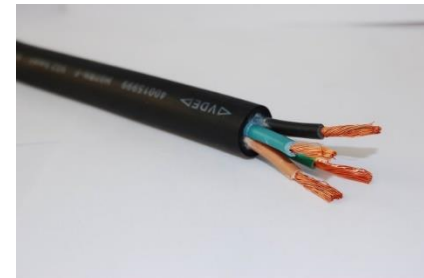
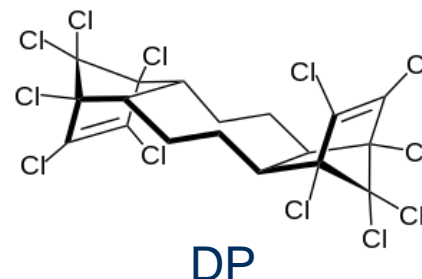
**DBHCTD  
(HCDBCO)**



**OBTMPI**

# Chlorinated flame retardants

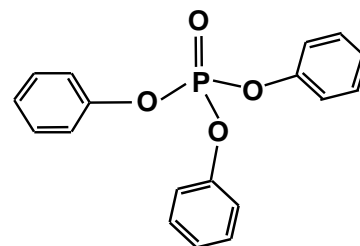
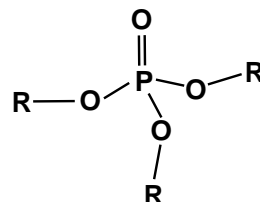
- Dechlorane Plus (DP)
  - Rubber around electrical cables
- Short chain chlorinated paraffins (SCCP)(100s-1000s of compounds)
- CPs also used in
  - Sealants
  - Paints
  - Coatings
  - Plasticizer



SCCP



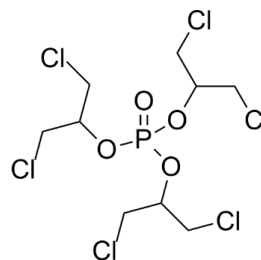
# Organophosphate esters (OPEs)



## • Uses

- Flame retardants in furniture foam, textiles, plastic (replace BFRs)
- Plasticizers
- Floor polish

Triphenyl phosphate TPP

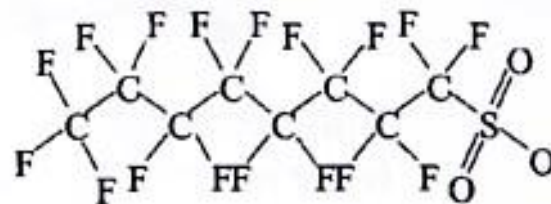


Tris-dichloropropylphosphate TDCPP



# Per- and polyfluorinated alkyl substances (PFAS)

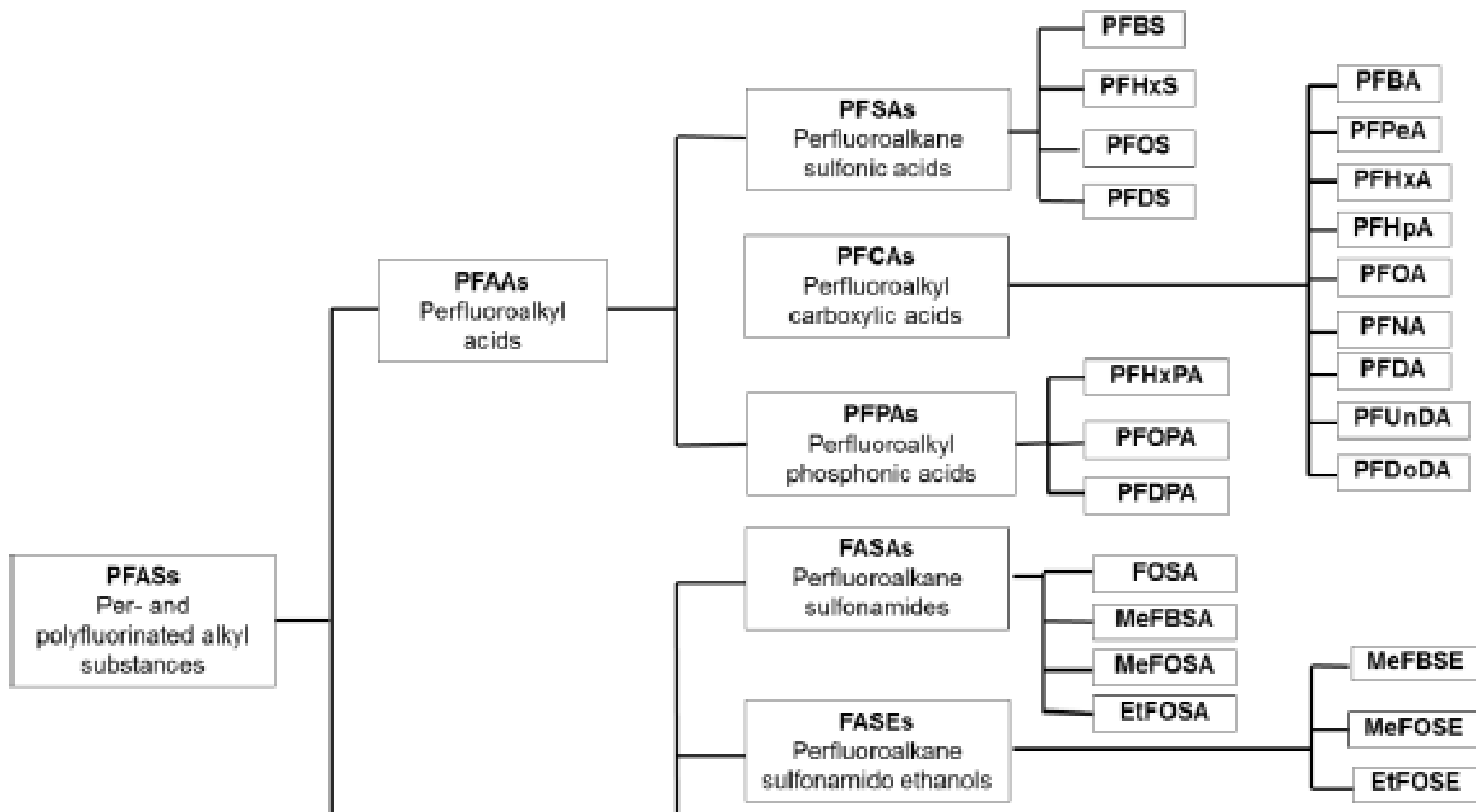
- Perfluorosulfonates (PFOS)
  - Surface treatment of clothing, textiles, paper – repels water, oil and dirt
  - Fire extinguishing foam
- Perfluorocarboxylic acids (PFOA)
  - Used in production of other PFAS and polymers such as Teflon, Gore-tex



PFOS



# PFAS – a growing chemical family

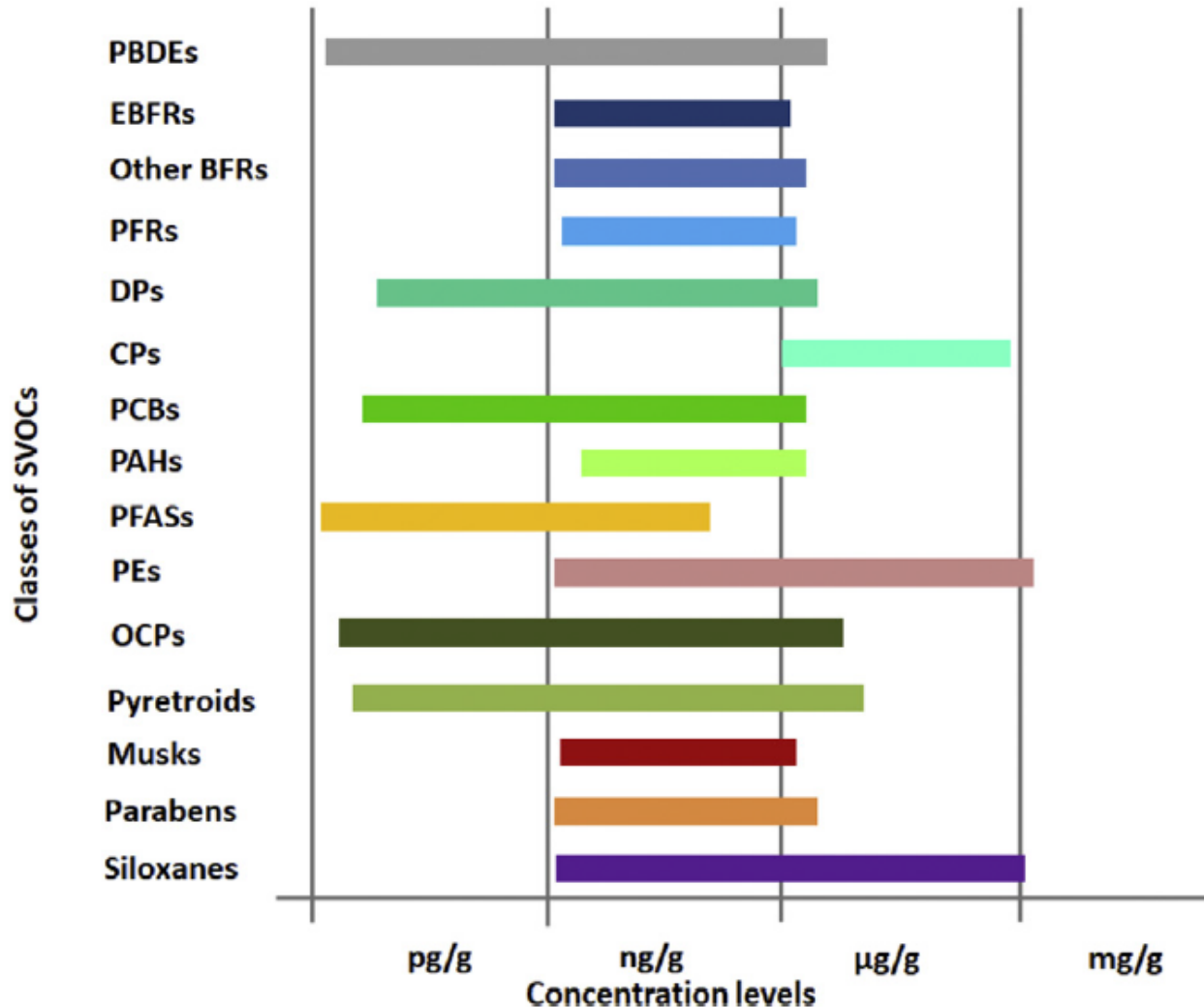


# Overview of products containing hazardous chemicals

| Class of chemicals    | Carpets, textiles & clothing | Electronics | Furniture | Building materials/flooring | Cleaning products | Health/personal care products & cosmetics |
|-----------------------|------------------------------|-------------|-----------|-----------------------------|-------------------|---|
| PBDEs                 | Green                        | Green       | Green     | Green                       | White             | White                                     |
| EBFRs                 | Green                        | Green       | White     | Green                       | White             | White                                     |
| Other BFRs            | Green                        | Green       | White     | Green                       | White             | White                                     |
| OPEs                  | Green                        | Green       | Green     | Green                       | White             | Green                                     |
| PFASs                 | Green                        | Green       | Green     | Green                       | Green             | Green                                     |
| PEs                   | Green                        | Green       | Yellow    | Green                       | Green             | Green                                     |
| PCBs                  | White                        | Green       | White     | Green                       | White             | White                                     |
| PAHs                  | White                        | White       | White     | Yellow                      | White             | White                                     |
| Pesticides            | Yellow                       | White       | White     | White                       | White             | White                                     |
| Synthetic musks       | White                        | White       | White     | White                       | Green             | Green                                     |
| Chlorinated paraffins | Yellow                       | Green       | Yellow    | Yellow                      | White             | White                                     |
| Siloxanes             | Yellow                       | Yellow      | Yellow    | Green                       | Yellow            | Green                                     |
| Parabens              | White                        | White       | White     | White                       | Yellow            | Green                                     |
| Dechlorane plus       | White                        | Green       | White     | Yellow                      | White             | White                                     |

green-conc available, yellow-present but no concentration, white-no information

# International overview of SVOC levels in dust

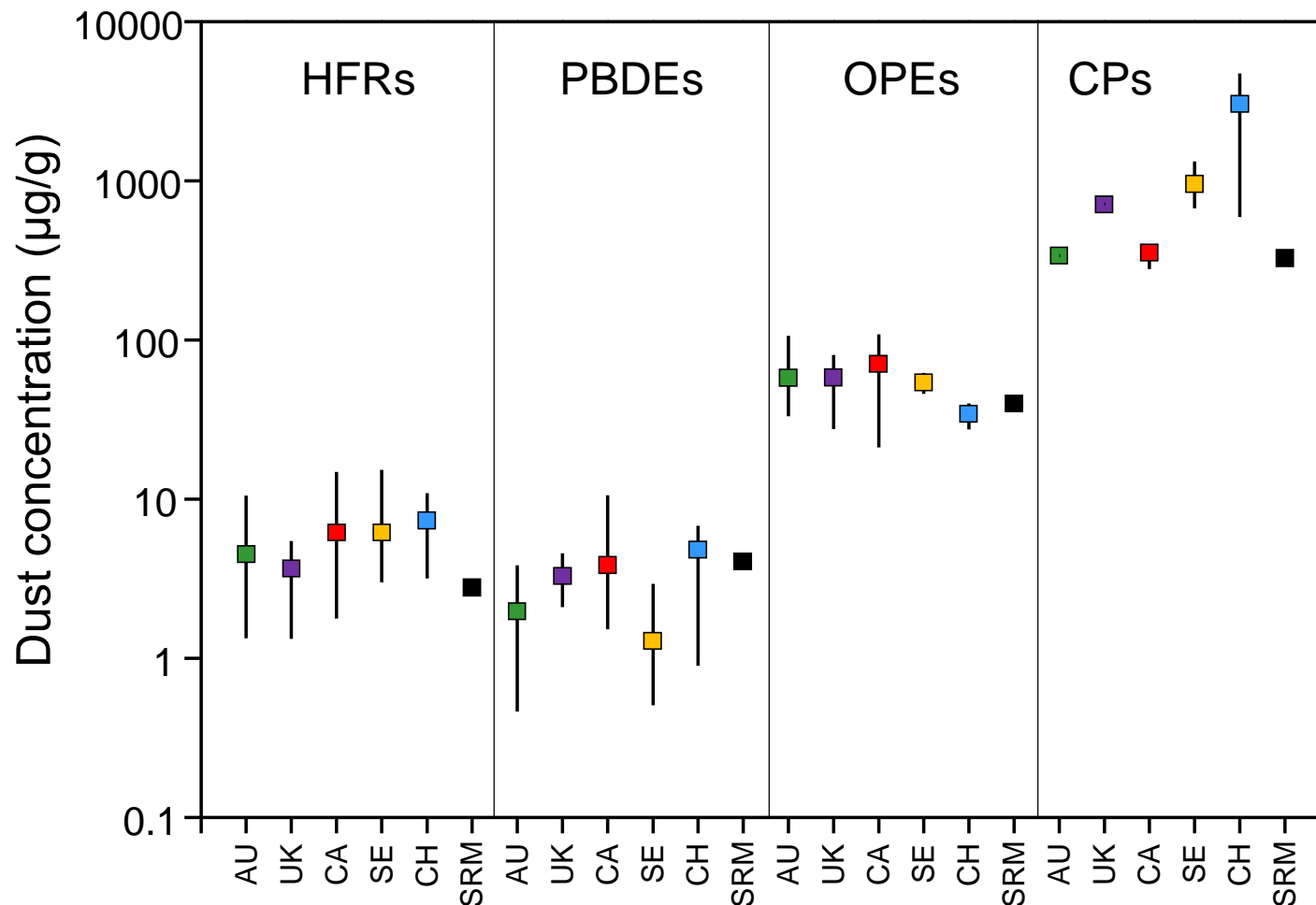


**Fig. 4.** Ranges of concentrations of the selected SVOCs in indoor dust.

Lucattini et al.  
2018  
Chemosphere  
201:466



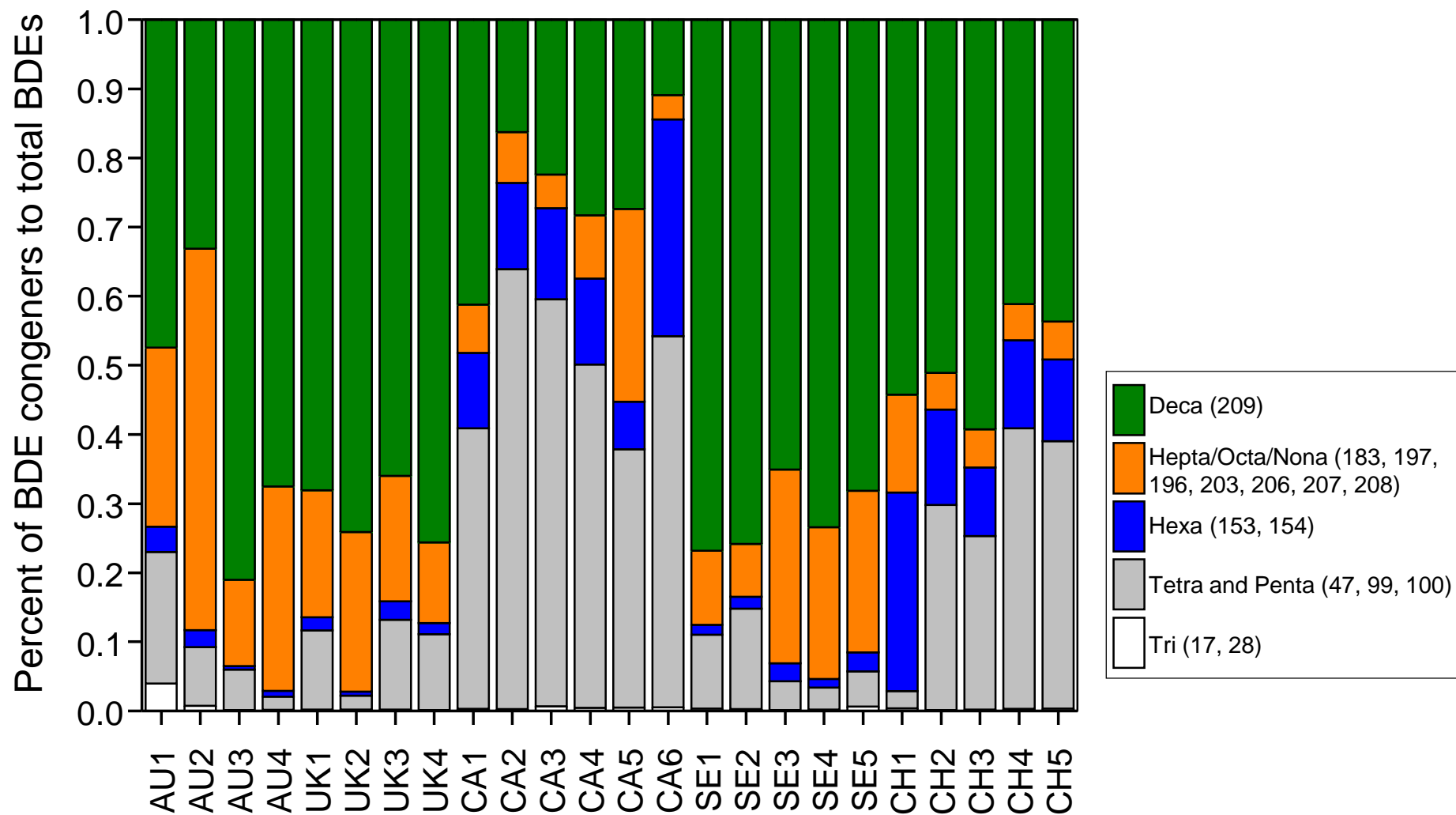
# FR levels in different countries



AU = Australia; UK = The United Kingdom; CA = Canada;  
SE = Sweden; CH = China; SRM = NIST2585 (USA)



# PBDE composition in different countries



# What happens to dust?



Local  
environment



Wastewater  
treatment plant

# What happens to dust?



Local  
environment



Landfill?  
Incineration?

# Conclusions

- Dust is a sink for organic contaminants (SVOCs) in the indoor environment
- Dust may reflect the usage pattern of SVOCs in a country
- Dust (and indoor air!) are sources of hazardous chemicals to the urban environment

# Questions?

