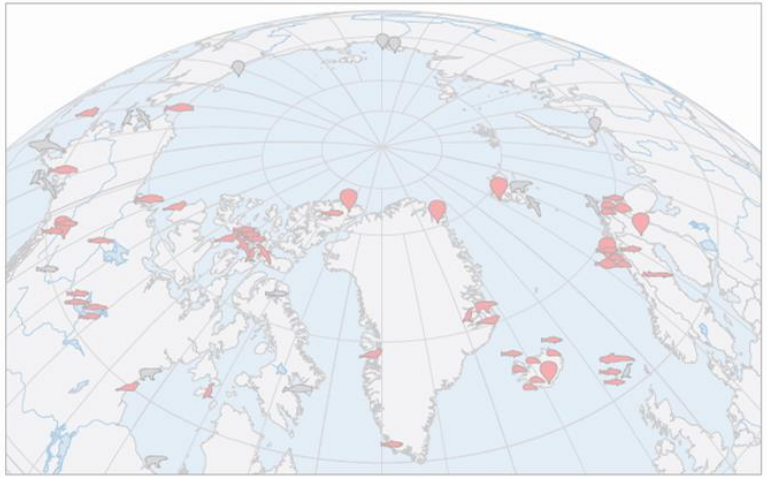


Experiences on BFR management in Finland

Timo Seppälä
Senior adviser
Finnish Environment Institute

2nd International Seminar about
Persistent Organic Pollutants
5 November, 2020

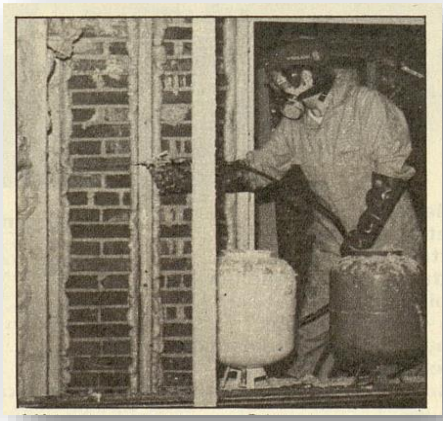
SYKE

Contents

- BFR chemicals restrictions
- WEEE and ELV recycling drivers
- Stockholm Convention Article 6 waste management provisions and the Low POP Content
- Implementing Low POP Content in waste management

SYKE

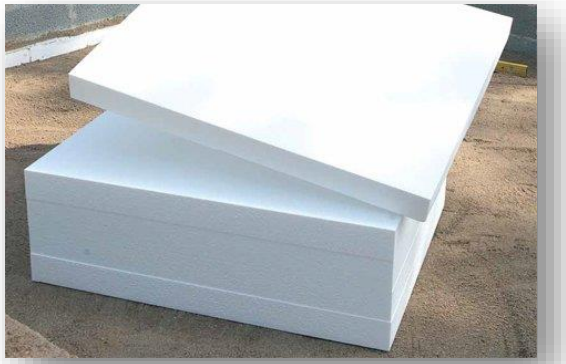
Brominated Flame Retardants 1



- Penta and Octa-BDE
  - OctaBDE was commercialized sometime in the mid 70's
  - PU foam and ABS plastics, FR textiles, thermoplastics in electronics, vehicles etc
  - RoHS Directive (2002/95/EC) (recast Directive 2011/65/EU in 2013)
    - To reduce the hazardous content in electric and electronic appliances
    - required heavy metals such as lead, mercury, cadmium, and hexavalent chromium and flame retardants such as polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE) to be substituted by safer alternatives.
  - Prohibition in the EU in 2004
    - placing on the market and use in concentrations higher than 0.1 %
  - Recycling was not separately considered

SYKE

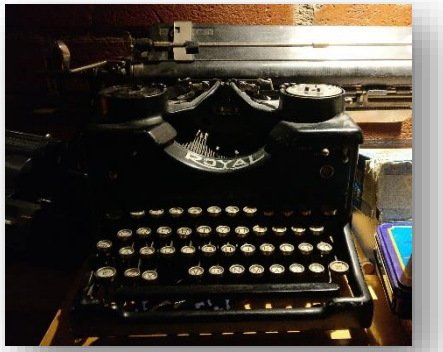
Brominated Flame Retardants 2



- HBCD
  - Use began in large scale in 1980's
  - Mainly in EPS, XPS insulation and packaging, some electronics and textiles
  - Listing in Stockholm Convention in 2009
  - Prohibition in the EU in 2017
  - Use only by authorisation since 2015
- Deca-BDE
  - Directive 2011/65/EU (ROHS Directive) restricted the use of decabromodiphenyl ether in electrical and electronic equipment
  - Prohibition in 2019, with exemptions for automotive and aviation
    - placing on the market and use in concentrations higher than 0.1 %
  - Plastics/polymers/composites, textiles, adhesives, sealants, coatings and inks. DecaBDE containing plastics are used in **housings of computers and TVs, wires and cables, pipes and carpets**.

SYKE

History of WEEE recycling in Finland (EU)



- WEEE Directive (2002/96/EC) (recast Directive 2012/19/EU in 2014)
  - Prevent WEEE formation and support reuse
  - Collection rate: 4 kg/year per person from households
  - Must be collected separately from other waste
  - Users responsible for delivering the appliances to separate collection

- Respective national legislation in 2004
  - Producers must collect all WEEE from users irrespective of the target
  - Estimates made in 2003: 23 kg/year WEEE per person
  - Focus in metal recycling
  - In 2007 the most common disposal for WEEE plastics was landfilling
  - Recovering plastics had to be developed to meet the WEEE recycling targets

SYKE

2008 Review of Directive 2002/96 on Waste Electrical and Electronic Equipment

- *2005 data, EU average*

#	Treatment category	Current % collected of WEEE Arising
1A	Large Household Appliances	16.3%
1B	Cooling and freezing	27.3%
1C	Large Household Appliances (smaller items)	40.0%
2,5A,8	Small Household Appliances, Lighting equipment – Luminaires and 'domestic' Medical devices	26.6%
3A	IT and Telecom excl. CRT's	27.8%
3B	CRT monitors	35.3%
3C	LCD monitors	40.5%
4A	Consumer Electronics excl. CRT's	40.1%
4B	CRT TV's	29.9%
4C	Flat Panel TV's	40.5%
5B	Lighting equipment – Lamps	27.9%
6	Electrical and electronic tools	20.8%
7	Toys, leisure and sports equipment	24.3%
8	Medical devices	49.7%
9	Monitoring and control instruments	65.2%
10	Automatic dispensers	59.4%

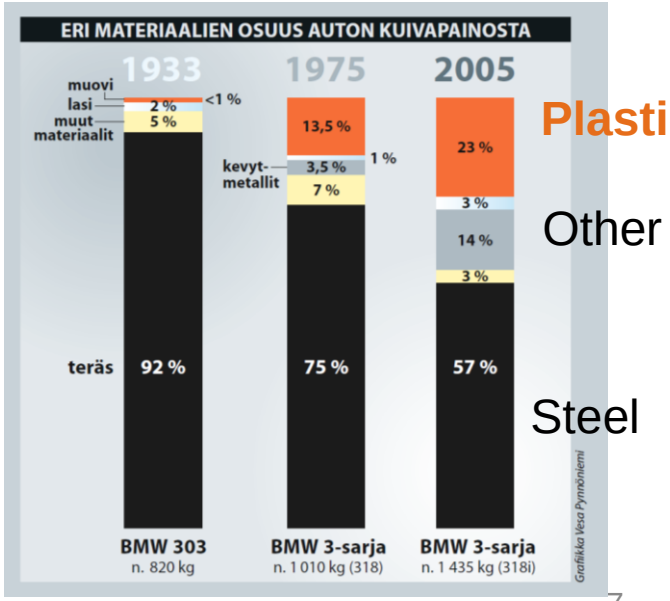
Table i: Current amount of WEEE collected & treated as percentage of WEEE Arising

SYKE

History of end-of-life vehicles (ELV) recycling

- Old cars have always been recycled to some extent
- Many operators all over the country

- ELV directive (2000/53/EC) entered into force in 2007
  - Producers must ensure ELV management
  - Recycling targets: 85 % in 2006 and 95 % in 2015
    - Increases need more and more plastics
- FI: 70 000 – 80 000 vehicles recycled annually
  - Now: 275 collection points
  - Average age 21 years
    - Appproaching the time when PBDEs phase out started



STATE OF THE ART VEHICLE RECYCLING (IN INDUSTRIALLISED COUNTRIES)

ACEA European Automobile Manufacturers Association

- Applying several typical processes, a car can be recycled and legal quota of 85% for Recycling and 95% for Recovery can be achieved

Recycling Quota: ∑ ≈ 85 %

Recycling and Recovery Quota: ∑ ≈ 95 %

SYKE

POPs and recycling

- Penta- and Octa-BDE listed in Stockholm Convention in 2009
- Waste management was discussed
  - It was not clear whether recycling of materials containing BDEs would be possible and in accordance with the Convention
    - a ban with a limit value and no exemption for recycling
    - a ban with a recycling exemption
    - exemption for imported articles
- No recycling exemption for HBCD or Deca-BDE

- What does this mean in practice?

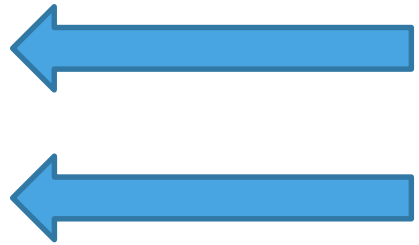
SYKE

Article 6(1)d of the Stockholm Convention

(d) Take appropriate measures so that such wastes, including products and articles upon becoming wastes, are:

(i) Handled, collected, transported and stored in an environmentally sound manner;

(ii) Disposed of in such a way that the persistent organic pollutant content is destroyed or irreversibly transformed so that they do not exhibit the characteristics of persistent organic pollutants or otherwise disposed of in an environmentally sound manner when destruction or irreversible transformation does not represent the environmentally preferable option or the persistent organic pollutant content is low, taking into account international rules, standards, and guidelines, including those that may be developed pursuant to paragraph 2, and relevant global and regional regimes governing the management of hazardous wastes;



(iii) Not permitted to be subjected to disposal operations that may lead to recovery, recycling, reclamation, direct reuse or alternative uses of persistent organic pollutants; and

SYKE

Low POP Content by Basel Convention

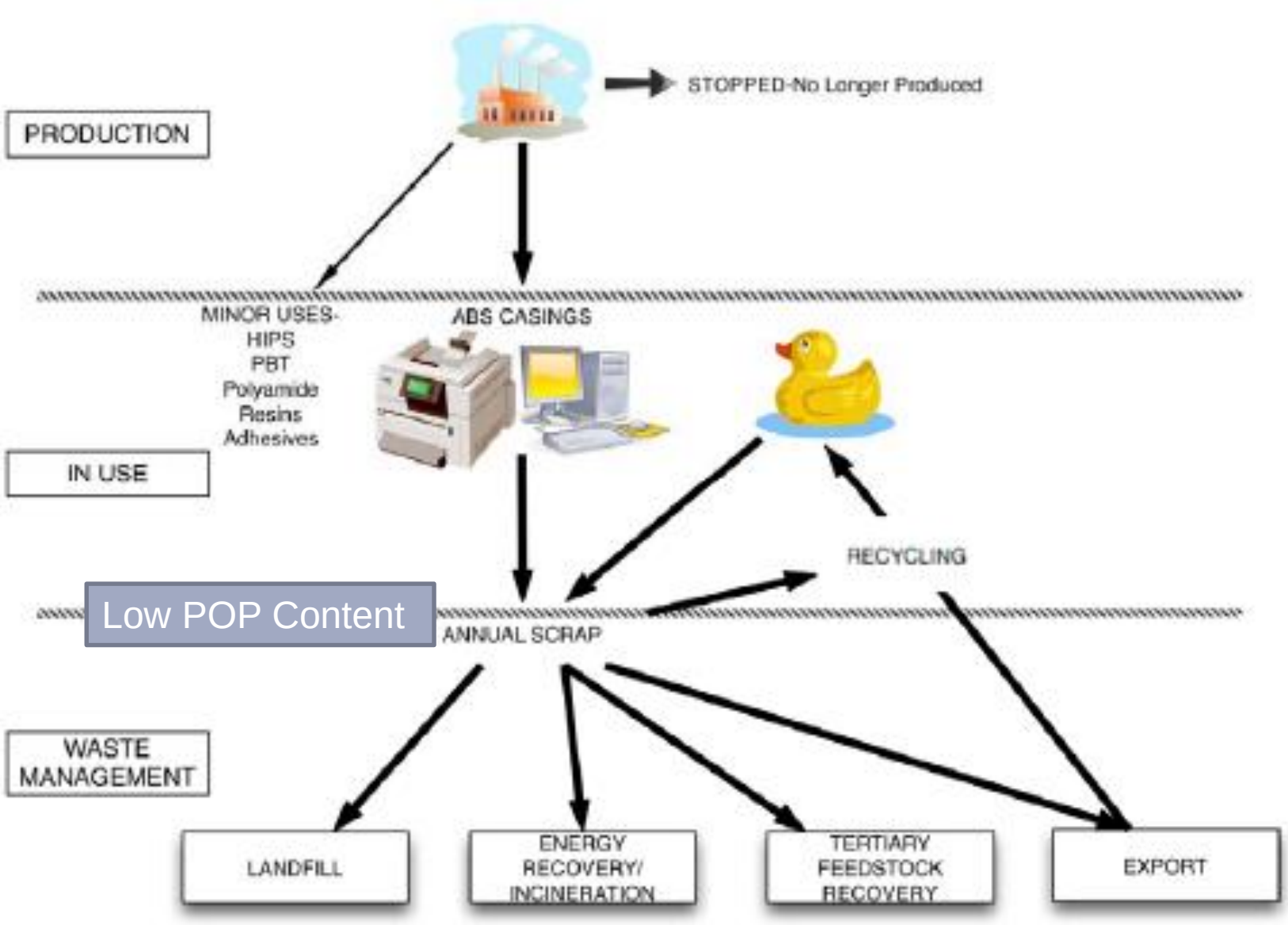
UNEP/CHW/OEWG.12/INF/7

Table 2: Provisional definitions of low POP content[6]

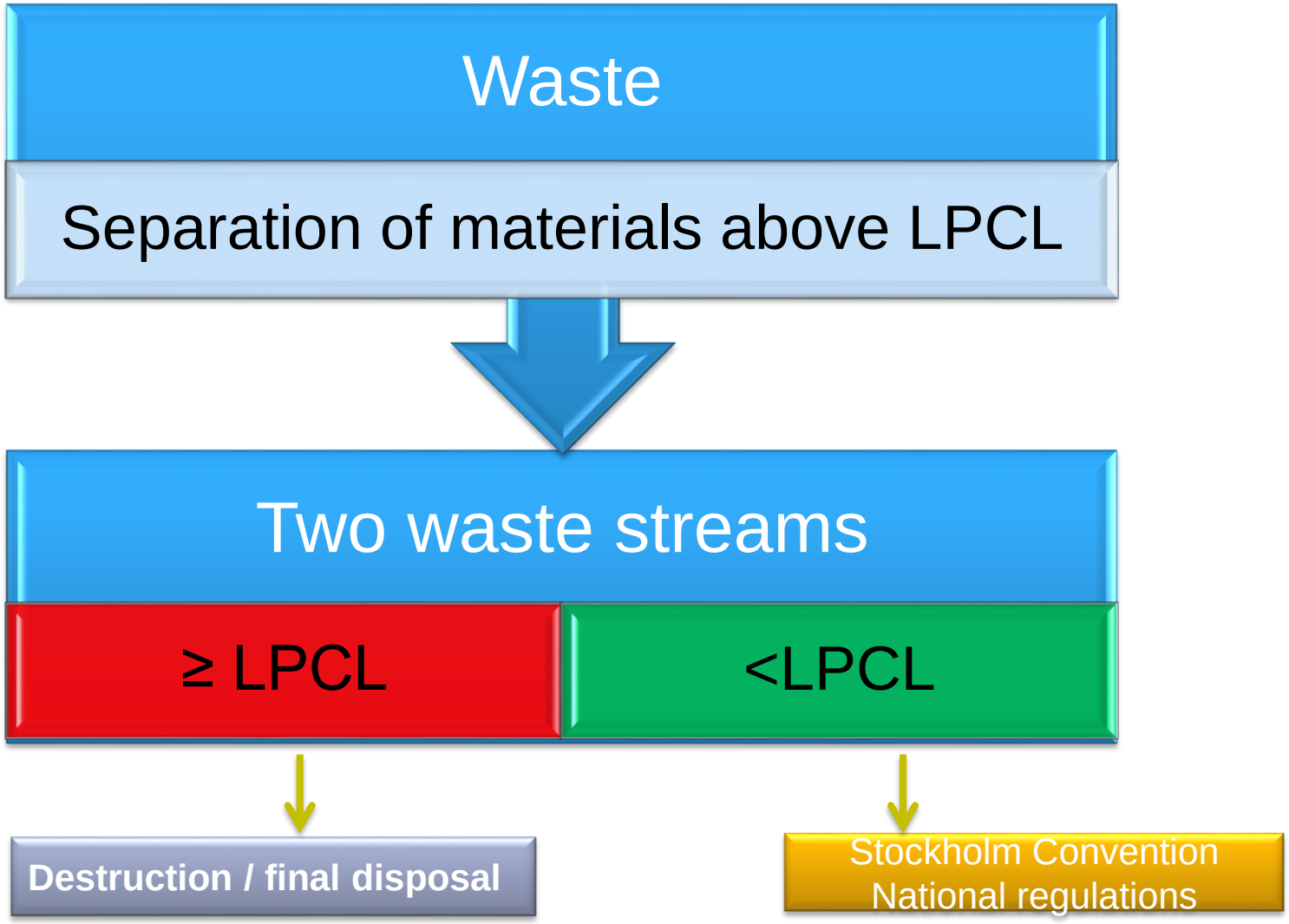
POP	Low POP content
Aldrin	50 mg/kg
Alpha-HCH, beta-HCH and lindane	50 mg/kg as a sum[7]
Chlordane	50 mg/kg
Chlordecone	50 mg/kg
DDT	50 mg/kg
Dieldrin	50 mg/kg
Endrin	50 mg/kg
HBB	50 mg/kg
HBCD	100 mg/kg or 1000 mg/kg
HCB	50 mg/kg
HCBD	100 mg/kg
Heptachlor	50 mg/kg
Hexabromodiphenyl ether and heptabromodiphenyl ether and tetrabromodiphenyl ether and pentabromodiphenyl ether	50 mg/kg or 1000 mg/kg as a sum[8]
[Hexabromodiphenyl ether and heptabromodiphenyl ether and tetrabromodiphenyl ether and pentabromodiphenyl ether and decabromodiphenyl ether (BDE-209) present in commercial decabromodiphenyl ether]	[[50 mg/kg] [500 mg/kg] [1000 mg/kg] as a sum[9]]
Mirex	50 mg/kg
PCBs	50 mg/kg
PCDDs and PCDFs[10]	1 µg TEQ/kg or 15 µg TEQ/kg

SYKE

When do you apply LPCL?

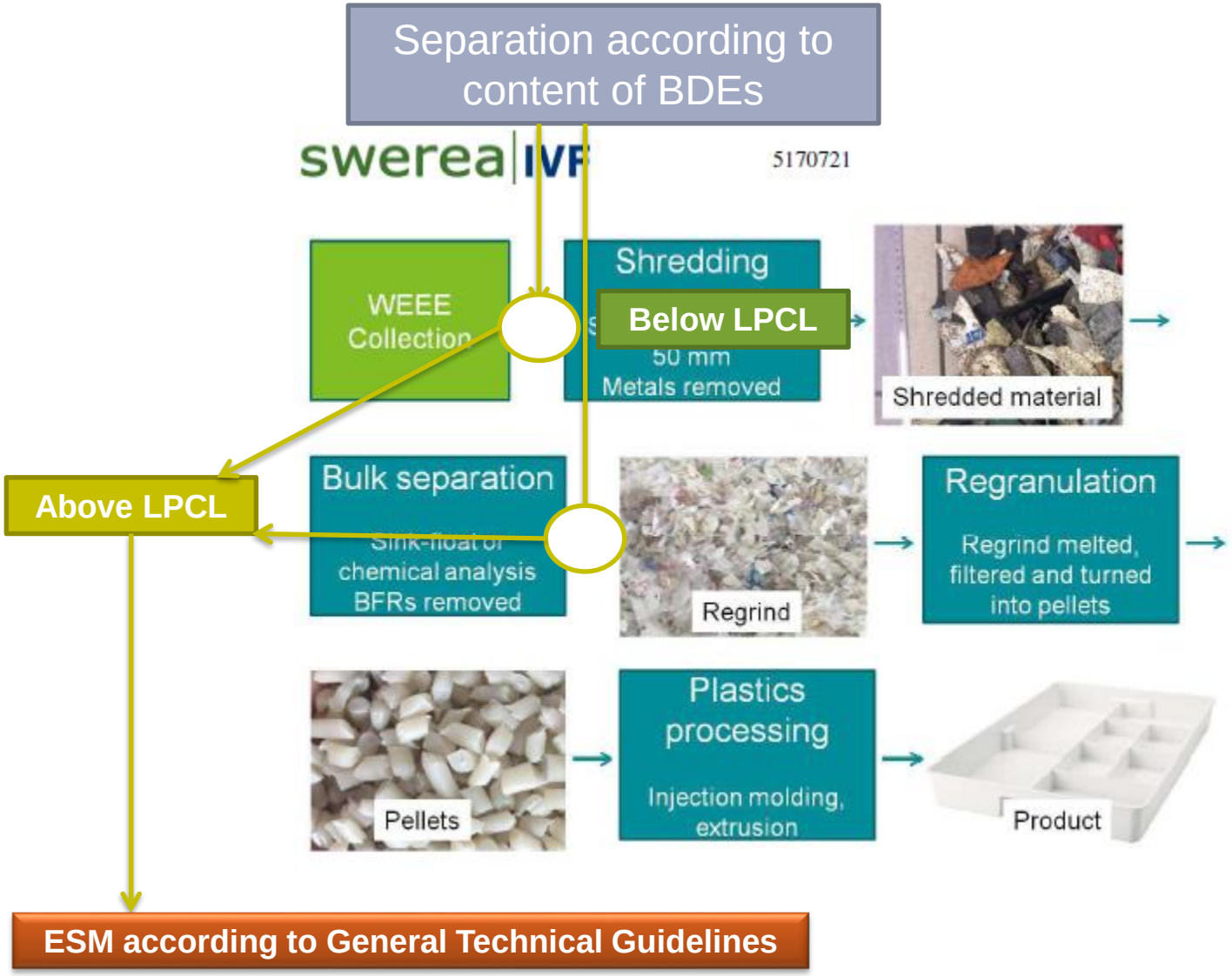


In simple terms



SYKE

In practice


Separation according to content of BDEs
swerea IVF
5170721
WEEE Collection
Shredding
50 mm
Metals removed
Below LPCL
Shredded material
Above LPCL
Bulk separation
chemical analysis
BFRs removed
Regrind
Regranulation
Regrind melted, filtered and turned into pellets
Pellets
Plastics processing
Injection molding, extrusion
Product
ESM according to General Technical Guidelines

Example HBCD

- EPS insulation board 6700 mg/kg HBCD
- Low POP Content in the EU 1000 mg/kg
- In the EU a limit value set for ”unintentional trace contamination” UTC 100 mg/kg

  - EPS board will be POP waste when disposed of (>LPCL)
  - POP content must be destroyed according to Article 6
    - Either remove the BFR in the insulation board or destroy the board in an environmentally sound manner (according to ESM guideline of the Basel Convention)

SYKE

HBCD in EPS- ja XPS plastics in Finland

- Large scale use since 1980's
- Use ended by 2017 (in the whole EU)
- 10% of the EPS insulation flame retardant in Finland
    - Source: Finnish insulation industry association
  - Ground frost insulation has traditionally been the biggest EPS application – non-FR
  - EPS for walls and and floors must be flame-retardant
- Historical use (i.e. more than 15 years ago) unknown!
- In the renovation you will likely find both FR and non-FR grade EPS/XPS
  - POPs waste must be separated on site for destruction
  - If not → 670 mg/kg

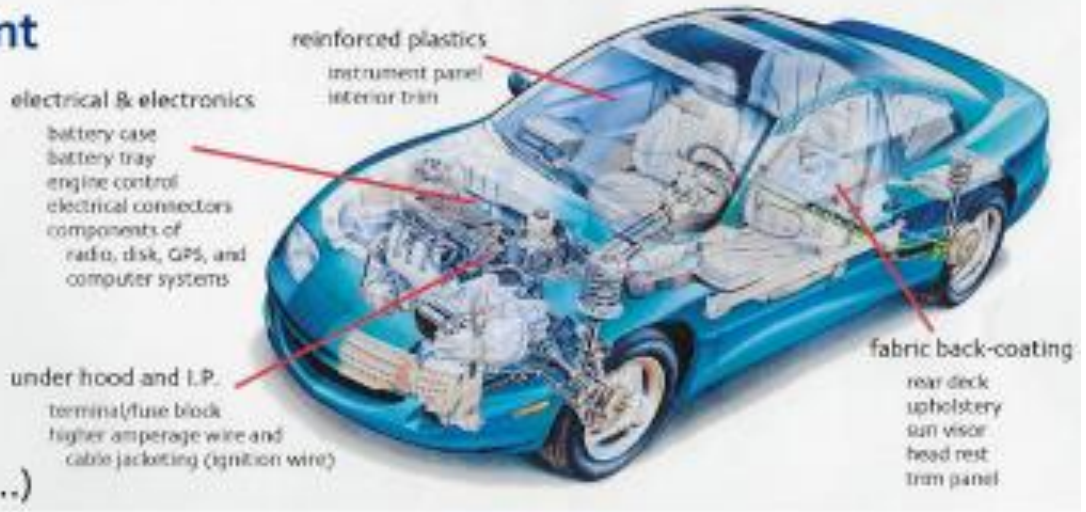
This will go on for the next 100 years

SYKE

POSSIBLE USES OF DECA-BDE IN CAR PARTS

Possible DecaBDE applications are widely distributed in vehicles

- **In the passenger compartment**
  - Seats and head rests
  - Dashboard
  - Sound deadening parts
  - Door sealing gaskets
  - Door trims
- **Wires and cables :**
  - Under the hood (engine, battery,…)
  - In the passenger compartment (inside airbag systems, headliner lights, dashboard,…)
- **In the heating, ventilation, air conditioning system pipes**
- **In the fuel circuit (pipes, tank)**
- **Others (locks, rear-view mirrors,…)**

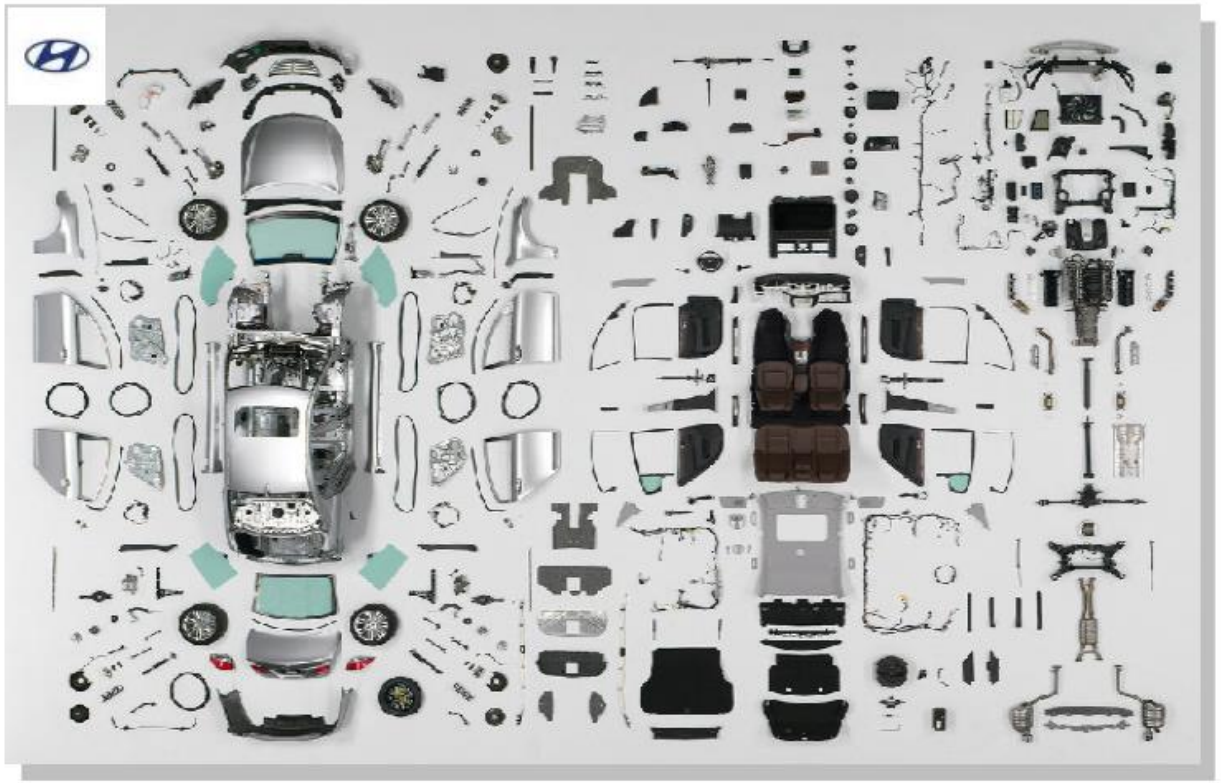


➡ A complete dismantling is not possible!

How many parts a vehicle contains?

- Depending on the complexity, there are between 4.000 & 9.000 different main components contained in a vehicle platform (without multiple entries for one specific part).
  - e.g. The vehicle platform of one OEM contains 8.400 components (=28.000 incl. common parts) from 1.800 suppliers!
  - Up to 75% of a car are pre-manufactured by supply chain

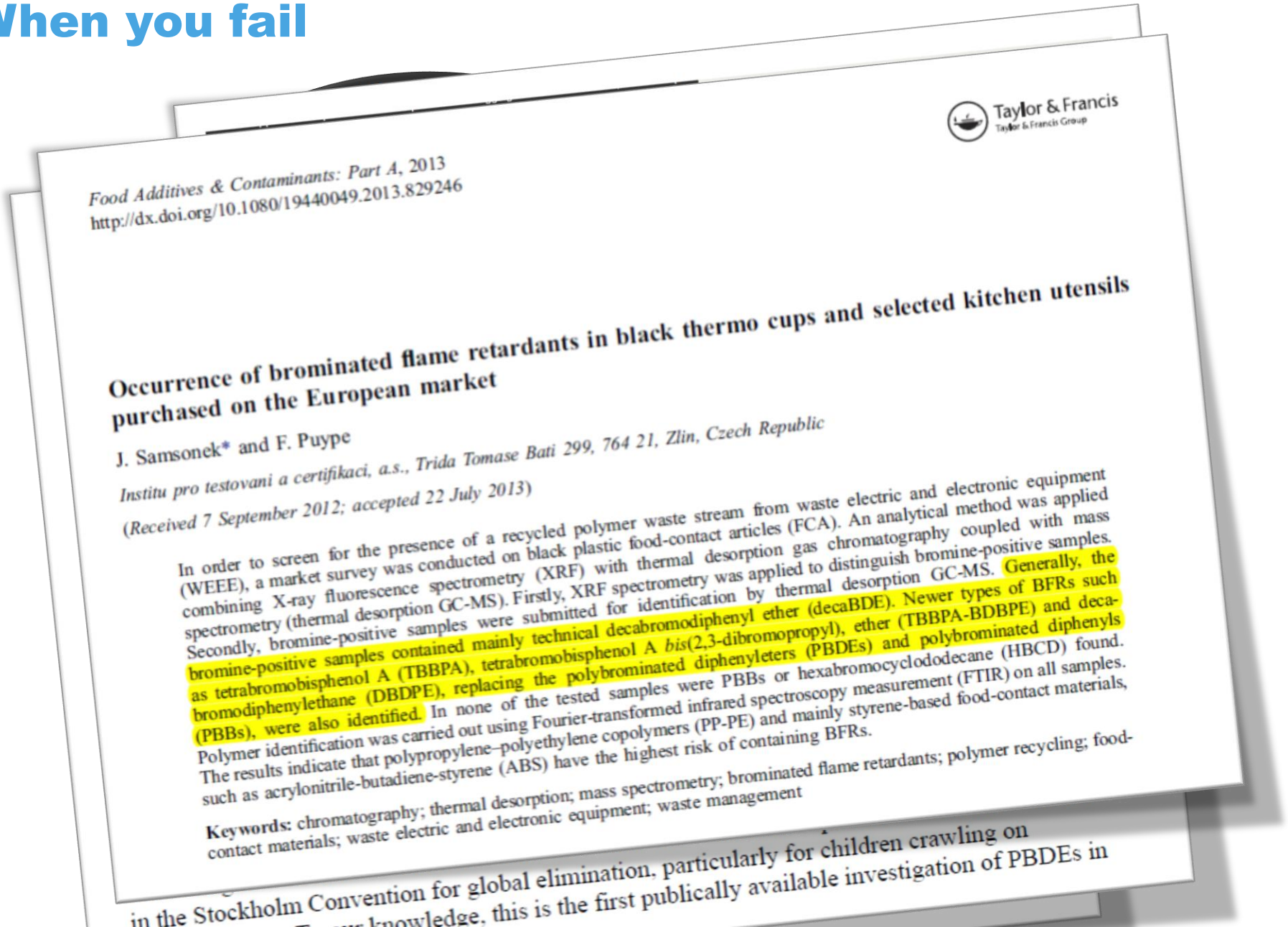
Total number of components assembled to one vehicle: up to 28.000 (example: 1 tire = 1 part reference number; number of tires per vehicle = 4)



Products from other industries may be even more complex! (e.g. aerospace, engineering industry)

SYKE

When you fail



Food Additives & Contaminants: Part A, 2013
http://dx.doi.org/10.1080/19440049.2013.829246

Taylor & Francis
Taylor & Francis Group

Occurrence of brominated flame retardants in black thermo cups and selected kitchen utensils purchased on the European market

J. Samsonek* and F. Puype

Institu pro testovani a certifikaci, a.s., Trida Tomase Bati 299, 764 21, Zlin, Czech Republic

(*Received 7 September 2012; accepted 22 July 2013*)

In order to screen for the presence of a recycled polymer waste stream from waste electric and electronic equipment (WEEE), a market survey was conducted on black plastic food-contact articles (FCA). An analytical method was applied combining X-ray fluorescence spectrometry (XRF) with thermal desorption gas chromatography coupled with mass spectrometry (thermal desorption GC-MS). Firstly, XRF spectrometry was applied to distinguish bromine-positive samples. Secondly, bromine-positive samples were submitted for identification by thermal desorption GC-MS. Generally, the bromine-positive samples contained mainly technical decabromodiphenyl ether (decaBDE). Newer types of BFRs such as tetrabromobisphenol A (TBBPA), tetrabromobisphenol A *bis*(2,3-dibromopropyl), ether (TBBPA-BDBPE) and deca-bromodiphenylethane (DBDPE), replacing the polybrominated diphenyleters (PBDEs) and polybrominated diphenyls (PBBs), were also identified. In none of the tested samples were PBBs or hexabromocyclododecane (HBCD) found. Polymer identification was carried out using Fourier-transformed infrared spectroscopy measurement (FTIR) on all samples. The results indicate that polypropylene–polyethylene copolymers (PP-PE) and mainly styrene-based food-contact materials, such as acrylonitrile-butadiene-styrene (ABS) have the highest risk of containing BFRs.

Keywords: chromatography; thermal desorption; mass spectrometry; brominated flame retardants; polymer recycling; food-contact materials; waste electric and electronic equipment; waste management

in the Stockholm Convention for global elimination, particularly for children crawling on

knowledge, this is the first publically available investigation of PBDEs in

SYKE


Gracias!