American Chemistry Council | North American Flame Retardant Alliance

NO IGNITION, NO FIRE!

Chemicals, Electronics, and Circularity –

Drivers for Decision Making

Thursday, November 3, 2022

Introductions & Background

Moderator & Panelists

➢ Moderator

- **Ben Gann** – Director, American Chemistry Council

➢ Panelists

- **Jay Illingworth** – Harmonization Director, Electronic Products Recycling Association
- **Chris Slijkhuis** – Recycling Consultant
- **Lein Tange** – Director of Sustainability, ICL Industrial Products

Agenda

01

EPR FOR ELECTRONICS IN CANADA

02

WEEE PLASTICS & RECYCLING CHALLENGES

03

NEW TECH FOR MORE EFFICIENT RECYCLING

04

QUESTIONS & DISCUSSION

About NAFRA

- **ACC's North American Flame Retardant Alliance (NAFRA)**
  - Represents leading producers of flame retardants used in industrial and consumer applications
- **Engaged in public policy advocacy to promote the benefits of FRs as part of an overall approach to fire safety**
- **Members include Albemarle, LANXESS, and ICL Industrial Products**

Case Study: Safer Products for Washington

- **Department of Ecology proposing regulations for OFRs in casings and enclosures for electronic & electrical equipment**
  - Restrictions for indoor products
  - Reporting requirement for outdoor products
- **Formal regulatory proposal to be released in December 2022**
  - 45-day comment period is expected
  - Public sessions to be held in January 2023
- **Need for value chain input and engagement**
- **Contact NAFRA for more information and to coordinate**

Why are flame retardants are used in products?

- Increased use of electronics & electrical equipment in homes and businesses
- Polymers/plastics enhance design & performance
- Changing energy sources & output of electronics – and increased use of plastics – increases fire risk
- End of life becoming an increasing public policy challenge for product designers

Key Factors in FR Selection for Use in Products

- Physical Properties
- Ease of Compounding
- Adequate Thermal Stability
- Corrosivity Issues
- Compatibility
- Health & Environmental Toxicity
- Appearance
- UV Stability
- Electrical Properties
- Combustion Products
- Efficiency/Cost
- Circularity & End of Life

INDUSTRY-LED EPR FOR ELECTRONICS IN CANADA

UL PROSPECTOR WEBINAR:
CHEMICALS, ELECTRONICS, AND CIRCULARITY DRIVERS FOR DECISION MAKING
AMERICAN CHEMISTRY COUNCIL

NOVEMBER 2022

EPRA Confidential

Who Is EPRA?

- ✓ Stewards = 7,800
- ✓ Tonnage = 1.2M tonnes
- ✓ Collection Sites = 2,500
- ✓ Coverage = Regulated Programs in 9 of 10 Provinces
- ✓ Public Awareness = 78% of Canadians are aware of their local electronics recycling program.

As an award-winning, industry-led, not-for-profit organization, EPRA has been setting the standard for safe, secure electronics recycling in Canada for more than a decade.

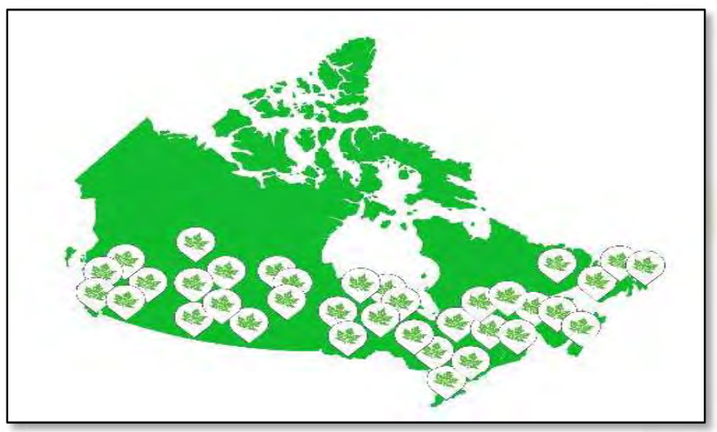
Through our network of qualified processors, transporters and drop-off locations, EPRA provides secure and accessible recycling for consumers and businesses alike, diverting electronics from landfills.

On our journey to a circular economy we will share with you the progress we have made at EPRA.

Regulated Programs in Canada

Electronic Products Recycling Association operates regulated recycling programs in nine provinces across Canada.
Please select your province to find out more about electronics recycling near you.

Accessibility & Awareness



Accessibility:

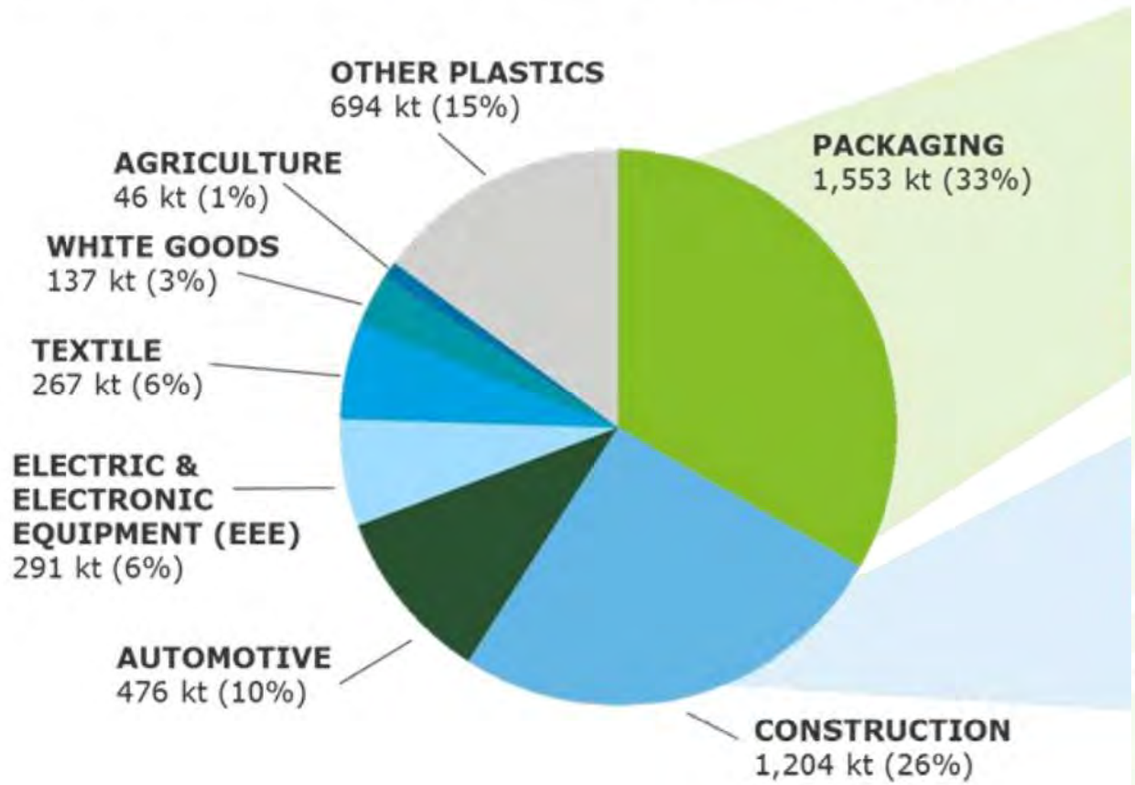
- **Over 2,500 authorized drop-off locations across the nation, coast to coast to coast.**
- Approximately, 97% of the Canadian population are within 30 mins (or 25 km) of an EPRA drop-off center.

Awareness:

- **Program awareness rivals most major brands. Over 78% of the Canadian population are aware of the e-recycling program in their province.**
- EPRA's mobile-friendly websites and web-based applications make it easy for residents, regardless of where they live in the country, to find out what and where they can recycle through the Recycle My Electronics network of drop-off locations.

ELECTRONICS REPRESENTS…

Figure 18: End-use markets for plastic products in Canada (kt, 2016)



Electronics contain 360k tonnes of plastic products produced for Canadian consumption, of which 140k tonnes is discarded as plastic waste.

Electric and electronic equipment made up 6% of all plastics used in Canada and 3% of plastic waste generated

HTTPS://PUBLICATIONS.GC.CA/COLLECTIONS/COLLECTION_2019/ECCC/EN4-366-1-2019-ENG.PDF

ECCC PERSPECTIVE ON EEE PLASTICS

EEE

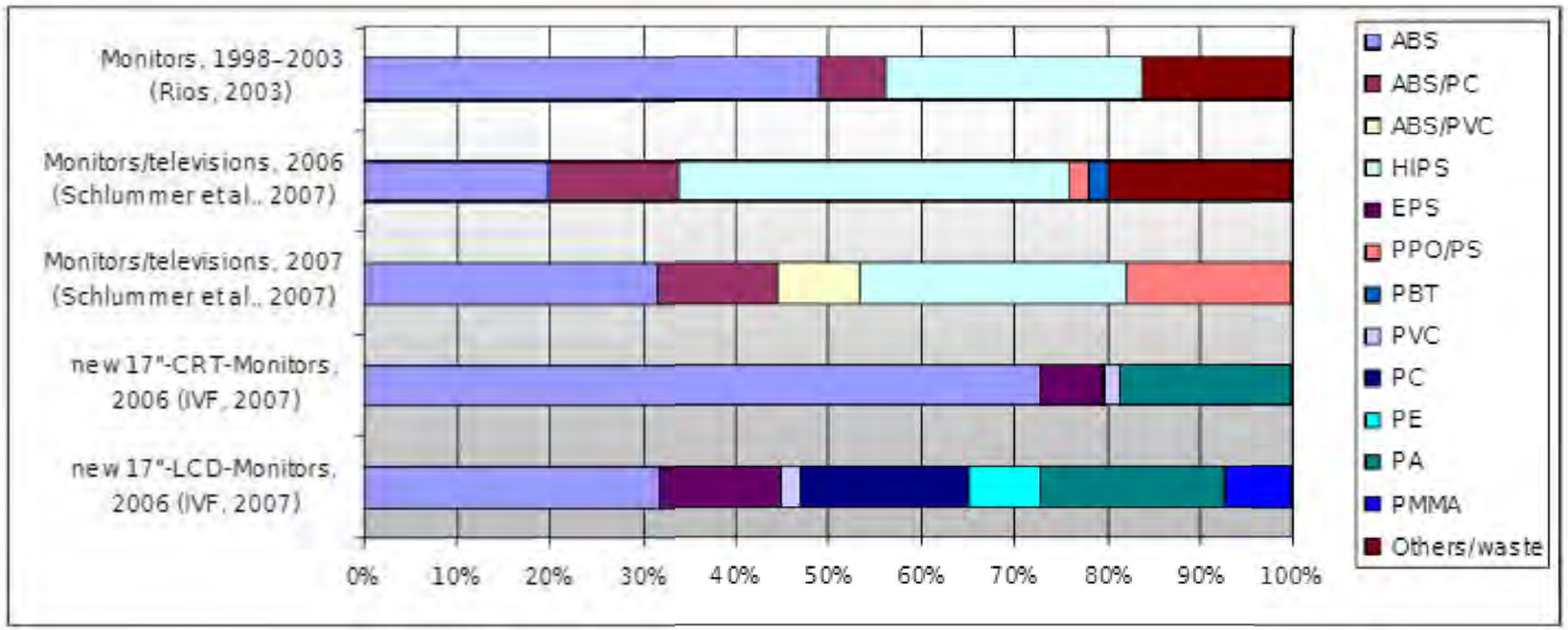
- Half of plastics from EEE waste are targeted by a nationwide EPR system
- Value recovery rate: 15% (29% for EEE products targeted by EPR system)
- Pros: EPR system in place, wide access rate
- Cons: 33% diversion rate, low quality recycled plastics (shredded mixed material), shrinking end-market (Asia)

PLASTICS FROM EOLE A CHALLENGE

- Plastics from End-of-Life Electronics (EOLE) are continuing to be collected and processed
- Primary challenges with EOLE plastics are the number and variety of polymers in use
- Various options for EOLE plastic exist but, there is no single solution, and all are largely dependent upon primary handling and separation processes
- Some local plastics processing is already in place
- Shredded, mixed plastics are the most challenging materials to manage

PLASTICS IN PC MONITORS

The challenge of separating plastics by type:



Source: ***Recycling of Plastics from Waste Electrical and Electronic Equipment (WEEE) - Tentative Results of a Swiss Study***

SHREDDED PLASTICS

Government of Canada regulating Plastics…

As part of Canada's Zero Plastic Waste Agenda, Environment and Climate Change Canada (ECCC) is developing targets, standards and regulations to eliminate plastic waste in Canada.

In June 2022 ECCC published the Single-use Plastics Prohibition Regulations and is developing a regulation to mandate minimum recycled content for certain plastic items and to strengthen the recycling and composting of plastics through accurate labelling.

In the Fall of 2022 a discussion paper released by ECCC on the development of a proposed Federal registry which could require producers and EPR programs (among others) to report on the type of plastic products placed on the market across Canada; what happens to plastic products after the end of their useful life, including the quantity going to landfill and the quantity undergoing value recovery for new applications through reuse, remanufacture, and recycling and their import and export from Canada.

The RQO: Safe & Secure Processing

- EPRA only works with recyclers who have been verified under the national **Electronics Recycling Standard (ERS)**, which was designed by the electronics industry to ensure that EOLE are managed in a safe and environmentally-sound manner.

- The **Recycler Qualification Office (RQO)** audits the recyclers against the ERS requirements with third-party certification by the internationally recognized ***R2 standard*** as the first step in verification.

- EPRA requires that all recyclers actively process material and maintain appropriate environmental, health, safety and security controls for properly handling all materials. The ERS and audit processes promote:
    * sound environmental management practices
    * worker health and safety controls
    * robust data security measures; and
    * downstream processing accountability.

RQO & Plastics Processing

- The RQO have always requested to have the state of the plastic described, that detail is included on the recycler's downstream flow.
- The RQO team treats plastic as a Focus Material even though it is not defined as one under the R2 standard. This includes on-site visits for the plastic recycler to verify the processing and the outputs generated, including the disposition of those outputs.

RQO and International Processing of Plastics…

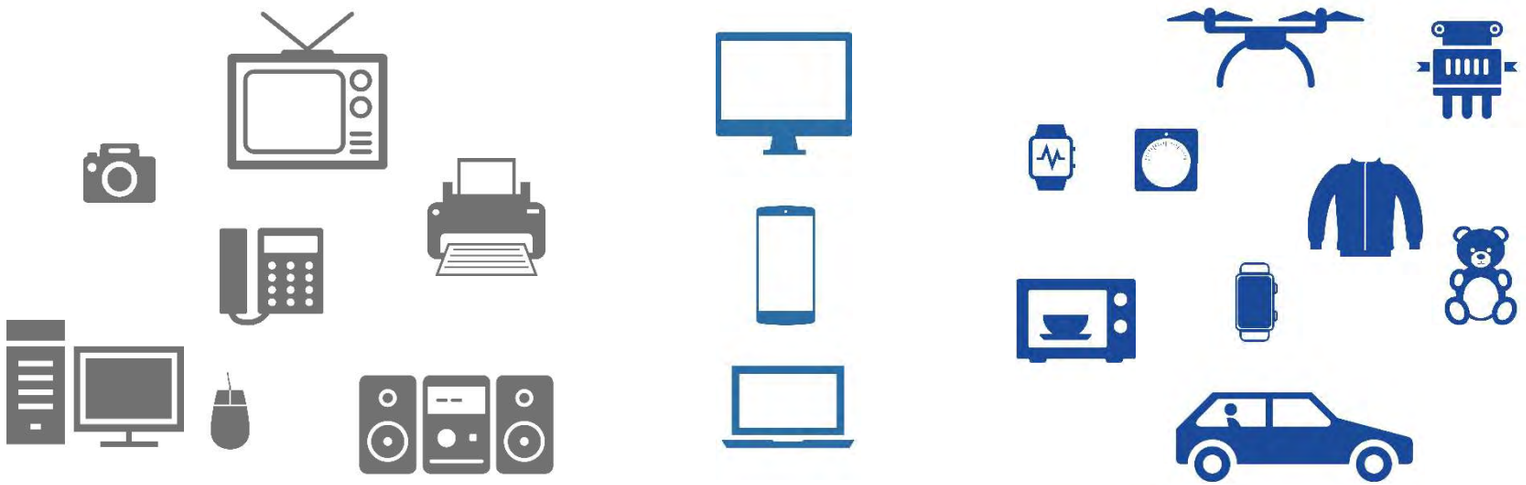
- With revisions to the Basel Convention Rules related to the transboundary movement of plastic, the RQO has changed our process to request export permits to receiving countries for plastic.

- As the US is not a signatory to the Basel Convention, the RQO will monitor and request export permits for those US companies that receive plastic and are shipping the plastic further downstream. i.e. Malaysia.

- We request the Primary Recycler who is shipping to the US, be responsible for ensuring that Canada's regulatory requirements are met

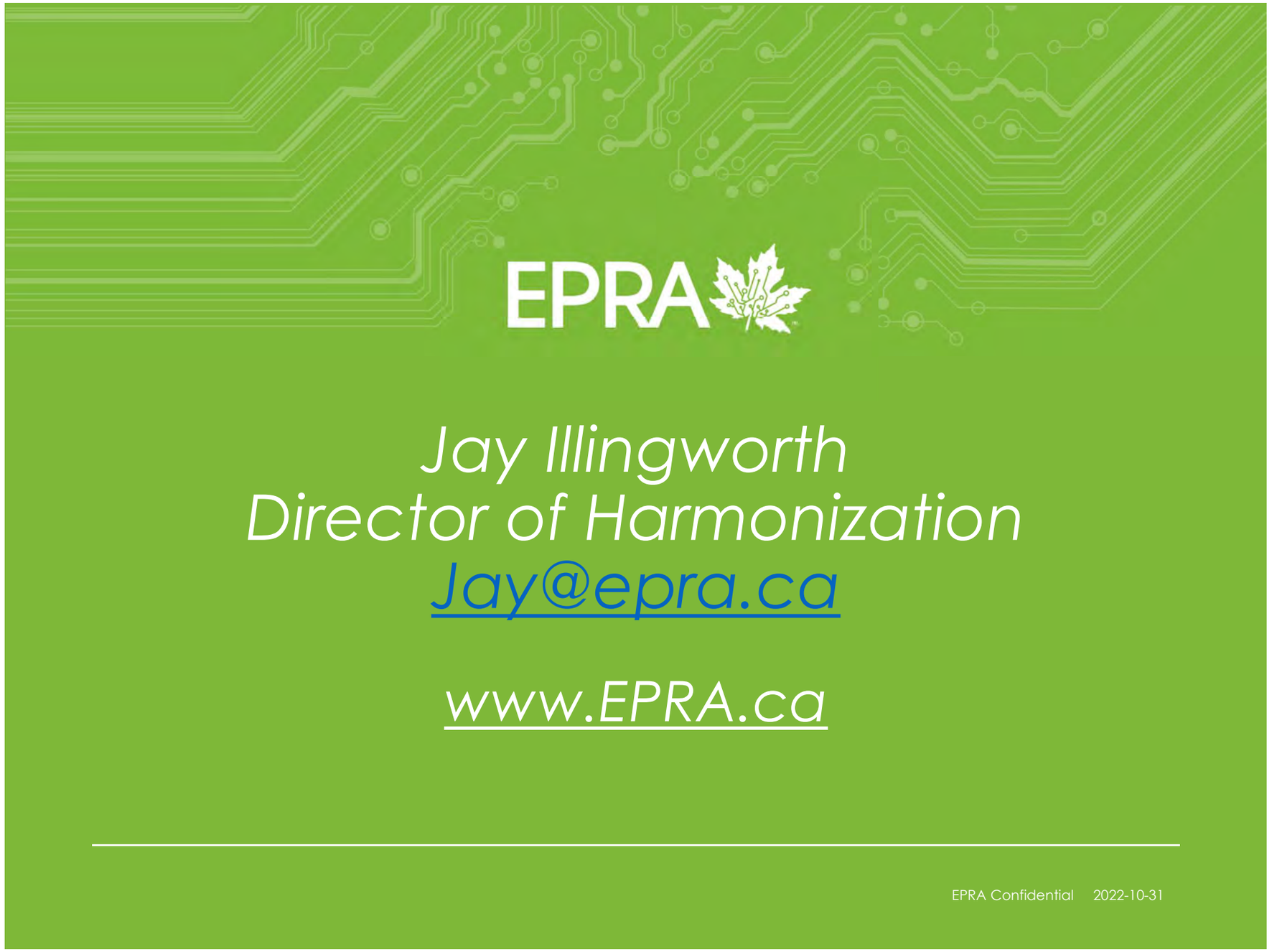
FOCUS ON A “POST-CRT WORLD”…

Electronics Evolution



Product weight
Product size
Precious metal content

Diversity of products
Integration of components
Personally identifiable information



Jay Illingworth
Director of Harmonization
Jay@epra.ca

www.EPRA.ca

PROSPECTOR®

Webinar November 3, 2022

The challenges of converting the supply chain into a supply cycle for WEEE plastics

Chris Slijkhuis
Retired General Manager MGG Polymers
www.mgg-polymers.com

What are the challenges……

- The WEEE Plastics Technology Challenge
- The Circular Economy Canyon Challenge
- The POP Challenge
- The Waste Ever Given Challenge
- The Sheer Lack of Legal Harmonization Challenge

Compliant recyclers solve environmental problems and reduce risks

What are the challenges……

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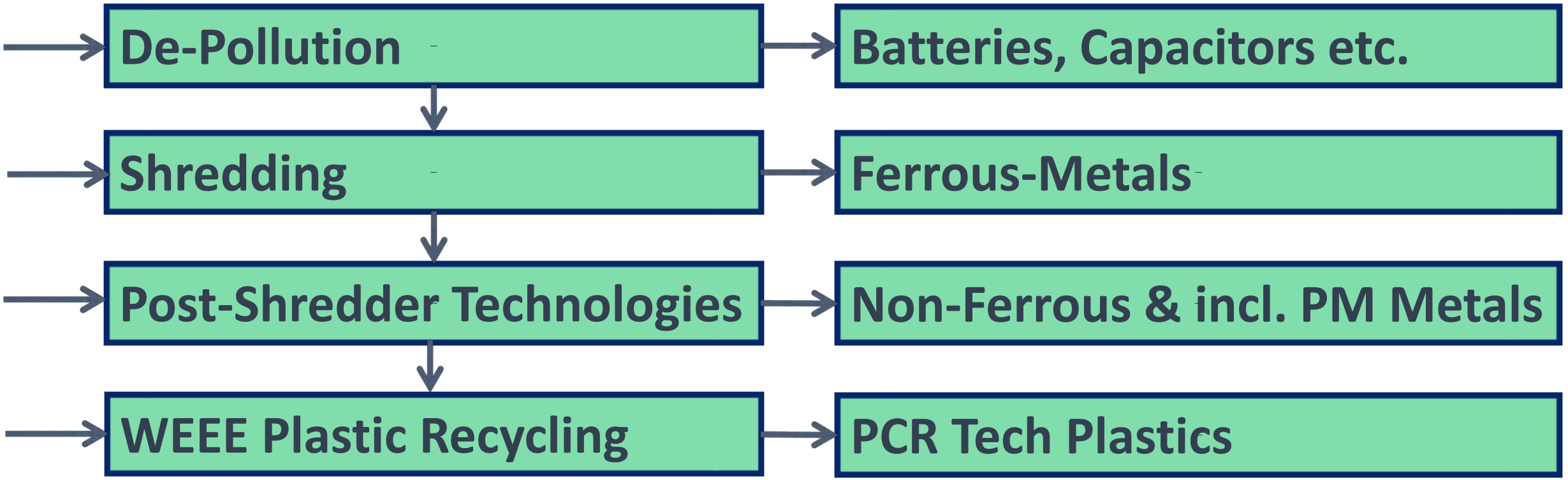
Compliant recyclers solve environmental problems and reduce risks

Separation of plastic is difficult compared to metals

Source: Mike Biddle, TED Talk

Plastic Recycling from WEEE



WEEE Plastics are the last remaining fraction to be treated

The concept of WEEE Plastics Recycling

Goods-In and Pre-processing

- Each receipt is sampled and analyzed
- Material cleaned from non-plastics

The concept of WEEE Plastics Recycling

Goods-In and Pre-processing

- Each receipt is sampled and analyzed
- Material cleaned from non-plastics

High-tech plastic separation

- Cleaning and separations
- PP, HIPS, ABS and PC-ABS

The concept of WEEE Plastics Recycling

- **Goods-In and Pre-processing**
  - Each receipt is sampled and analyzed
  - Material cleaned from non-plastics
- **High-tech plastic separation**
  - Cleaning and separations
  - PP, HIPS, ABS and PC-ABS
- **Blending, Extrusion and Compounding**

The concept of WEEE Plastics Recycling

Waste

Product

Goods-In and Pre-processing

- Each receipt is sampled and analyzed
- Material cleaned from non-plastics

High-tech plastic separation

- Cleaning and separations
- PP, HIPS, ABS and PC-ABS

Blending, Extrusion and Compounding

Lab Analyses Physical, Chemical (REACH/RoHS/POP) & Rheologic

Output Material are PCR polymers, used as drop-in replacement for virgin

Producing sustainable PCR WEEE plastics

Procurement

- Growing supply
- Incinerated

- Self-replenishing
- Sustainable

Processing

- Mechanical ‘mining’ process
- Innovative technologies

- < 10% of energy
- Save about 3-4 tons CO_2/ton

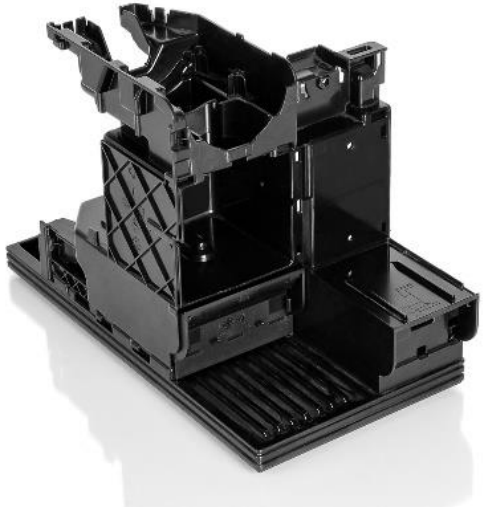
Selling

- “Green” products
- Virgin-like quality possible

- More sustainable business
- PCR plastics

And these are just some examples of products with 100% PCR Plastics

Post-Consumer Recycled WEEE Plastics (**PCR Plastics**)



PLASTICS RECYCLING AWARDS EUROPE 2021
WINNER

Deutsche Telekom
Speed Home WLAN

Automotive, Electrical or Electronic Product

www.prseventeurope.com

What are the challenges……

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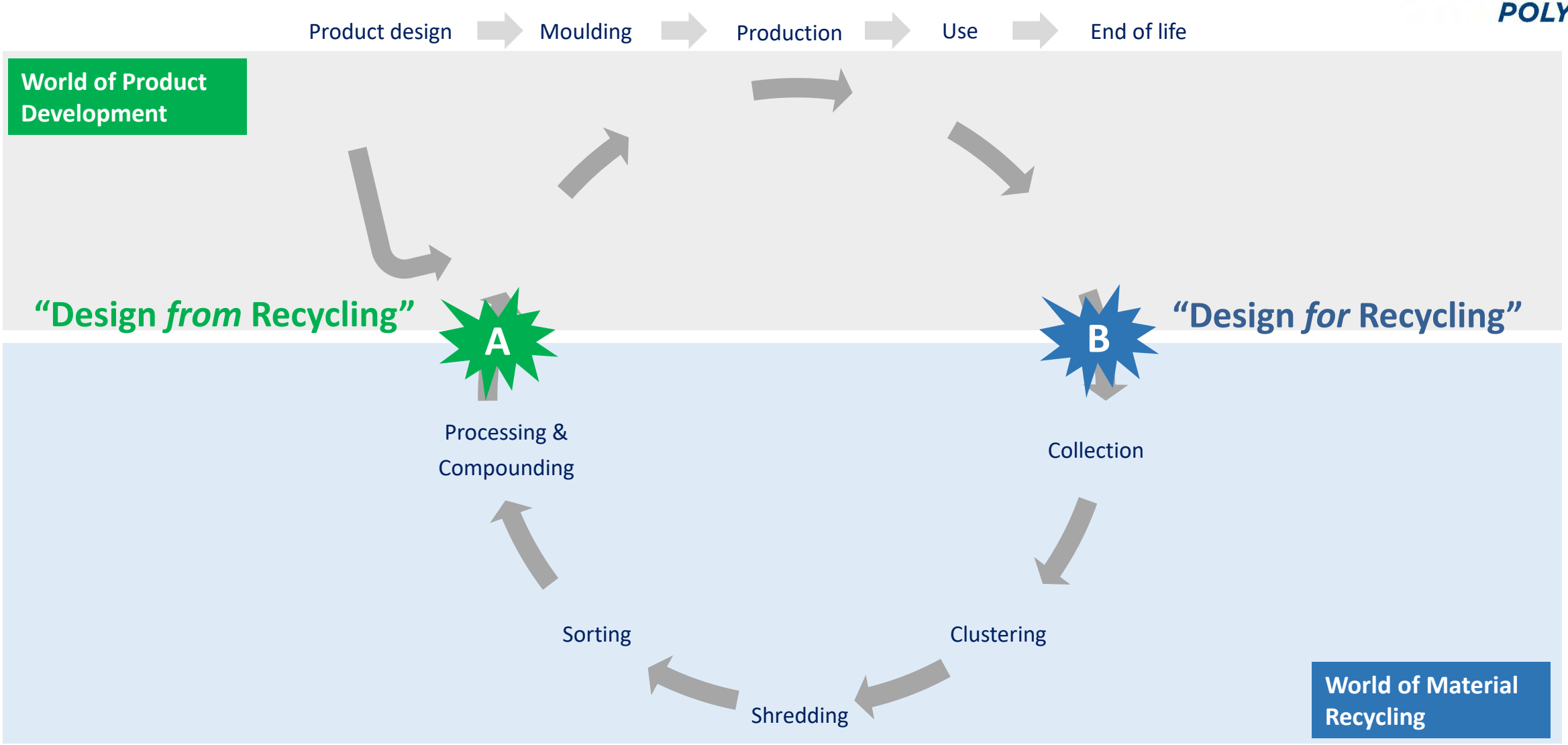
Compliant recyclers solve environmental problems and reduce risks

A recyclers' view on policy development……

Closing the missing link in the Circular Economy

Product design → Moulding → Production → Use → End of life

Closing the missing link in the Circular Economy



Book-Recommendation: [Design from and for Recycling (Poly-CE)]

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Legislation overview Brominated Flame Retardants

EEE Products

IT electronics

(microprocessors, computer servers, modems, printers, copy machines…)

Consumer electronics

(hair dryers, heaters, TV sets, laptops…)

White goods

(tumble dryers, dishwashers, washing machines…)

Source: EFRA

Legislation overview Brominated Flame Retardants

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(microprocessors, computer servers, modems, printers, copy machines…)

Consumer electronics

(hair dryers, heaters, TV sets, laptops…)

White goods

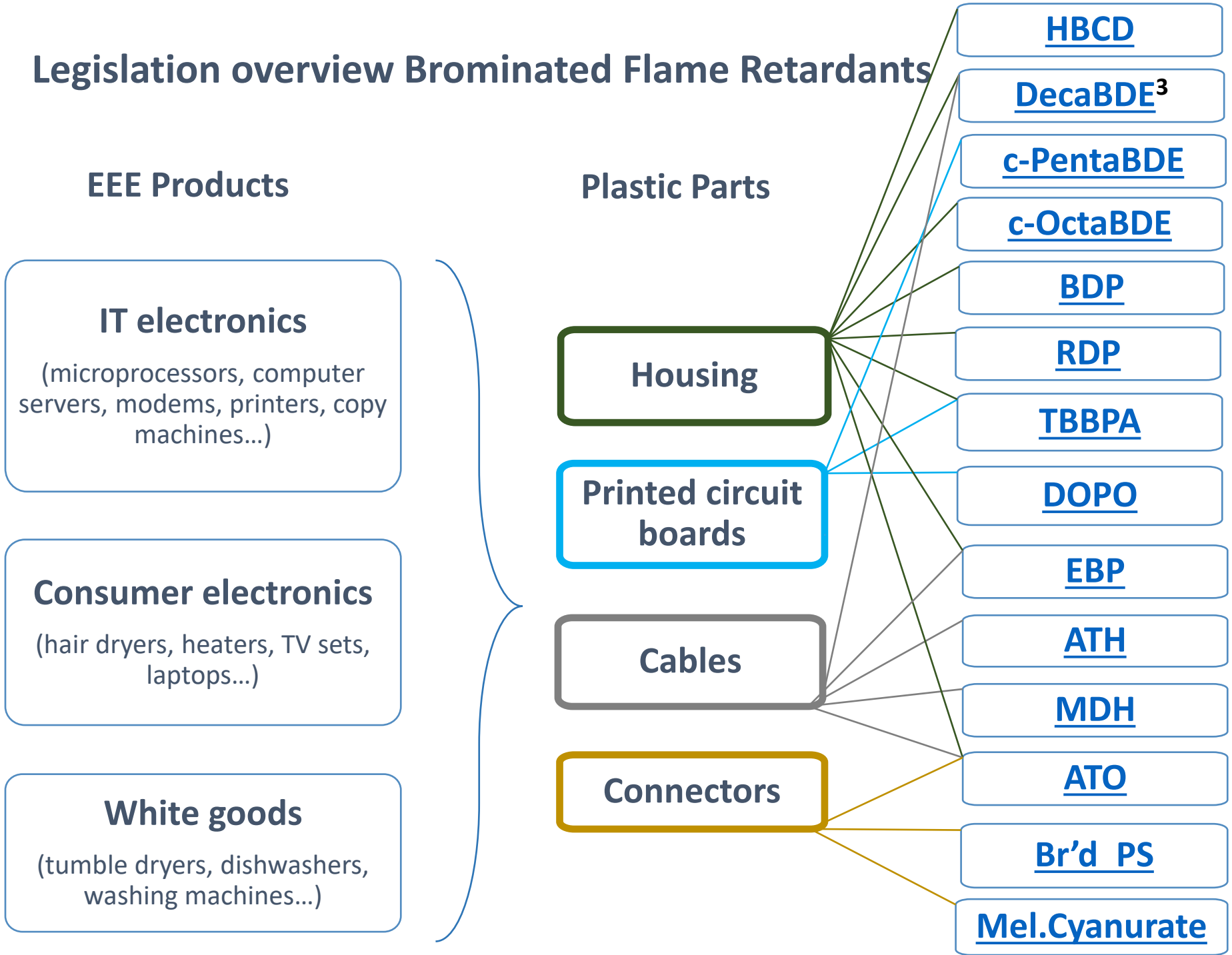
(tumble dryers, dishwashers, washing machines…)

Plastic Parts

- Housing
- Printed circuit boards
- Cables
- Connectors

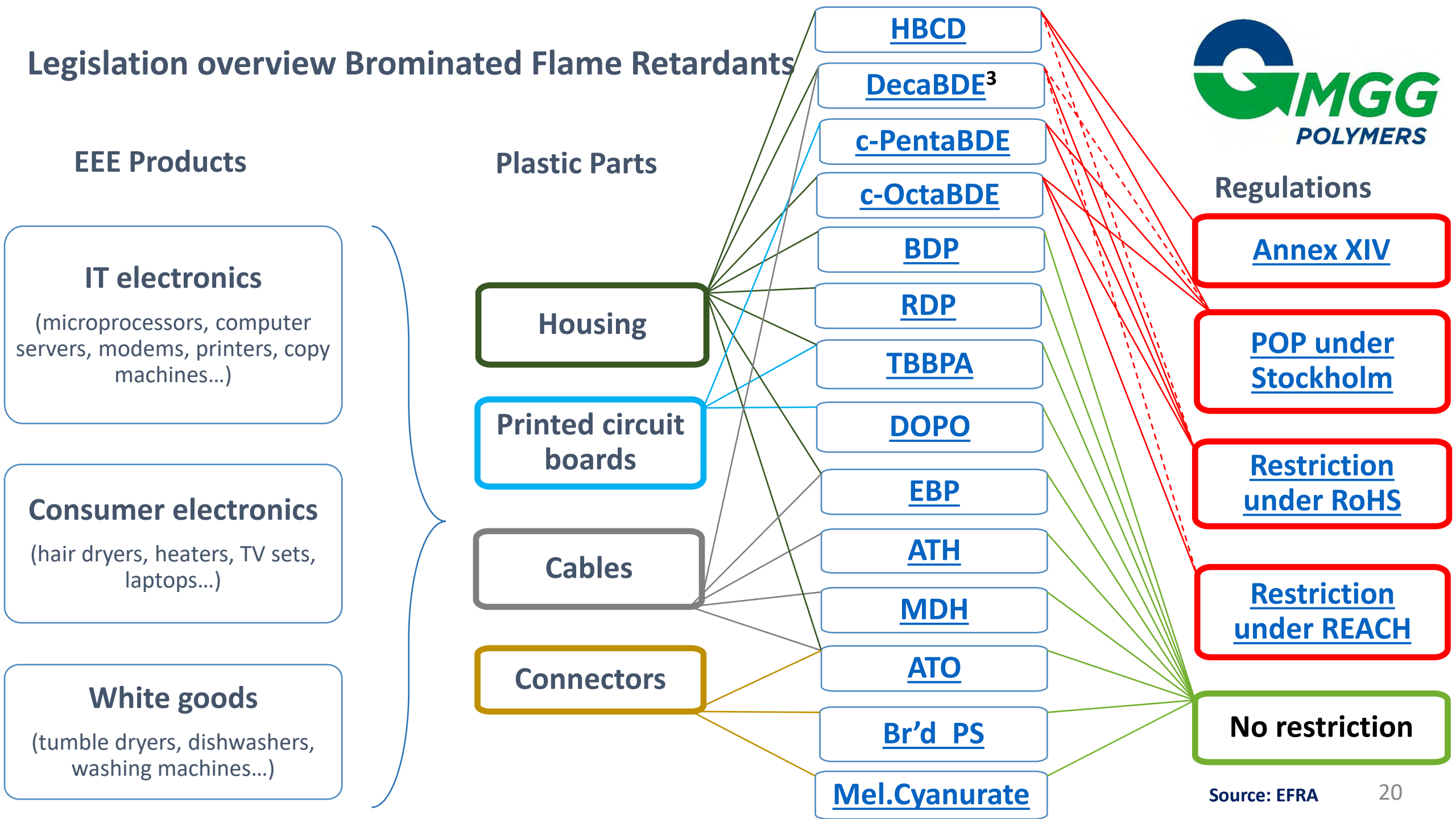
Source: EFRA

Legislation overview Brominated Flame Retardants



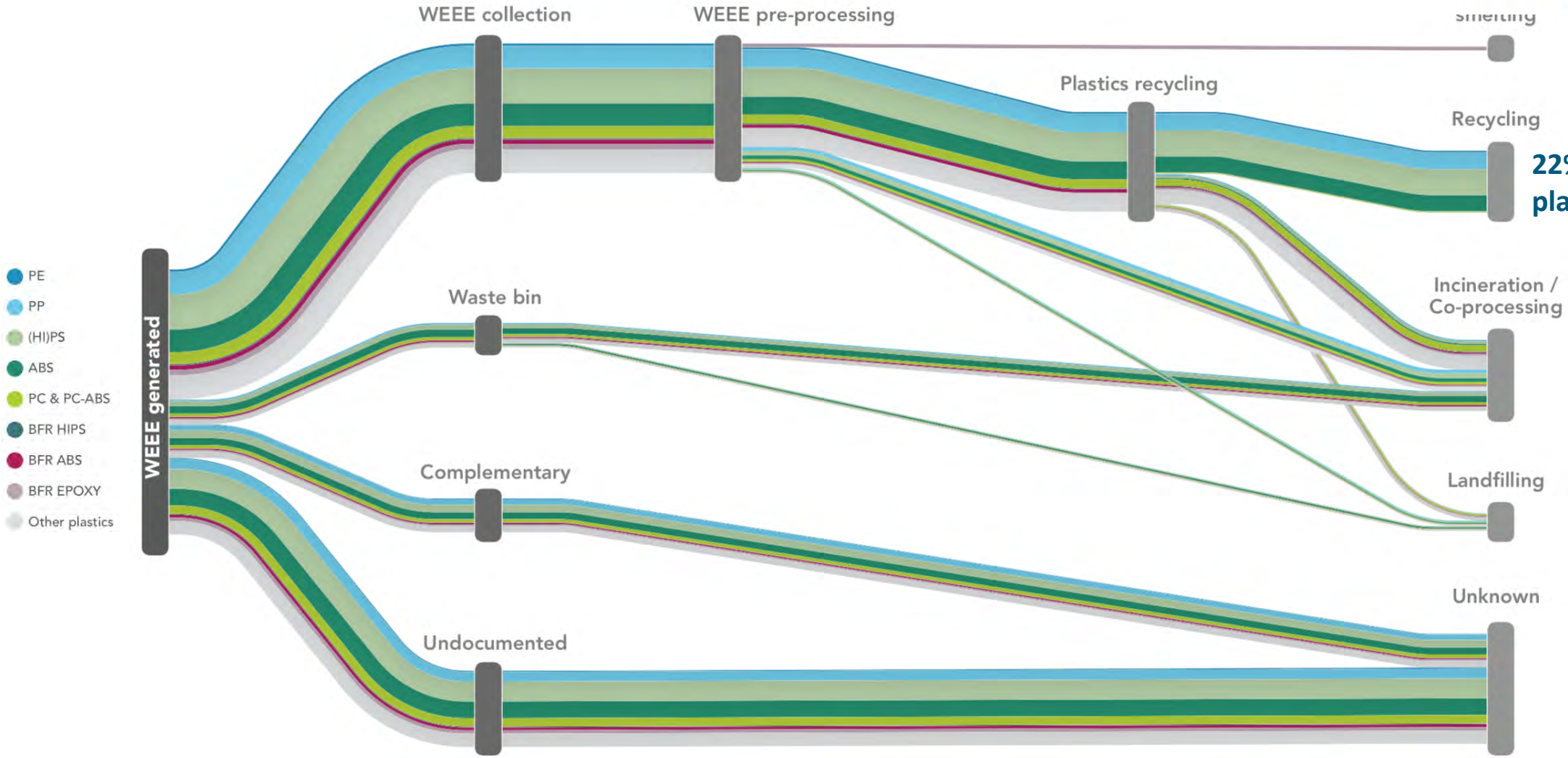
Source: EFRA

Legislation overview Brominated Flame Retardants



Source: EFRA

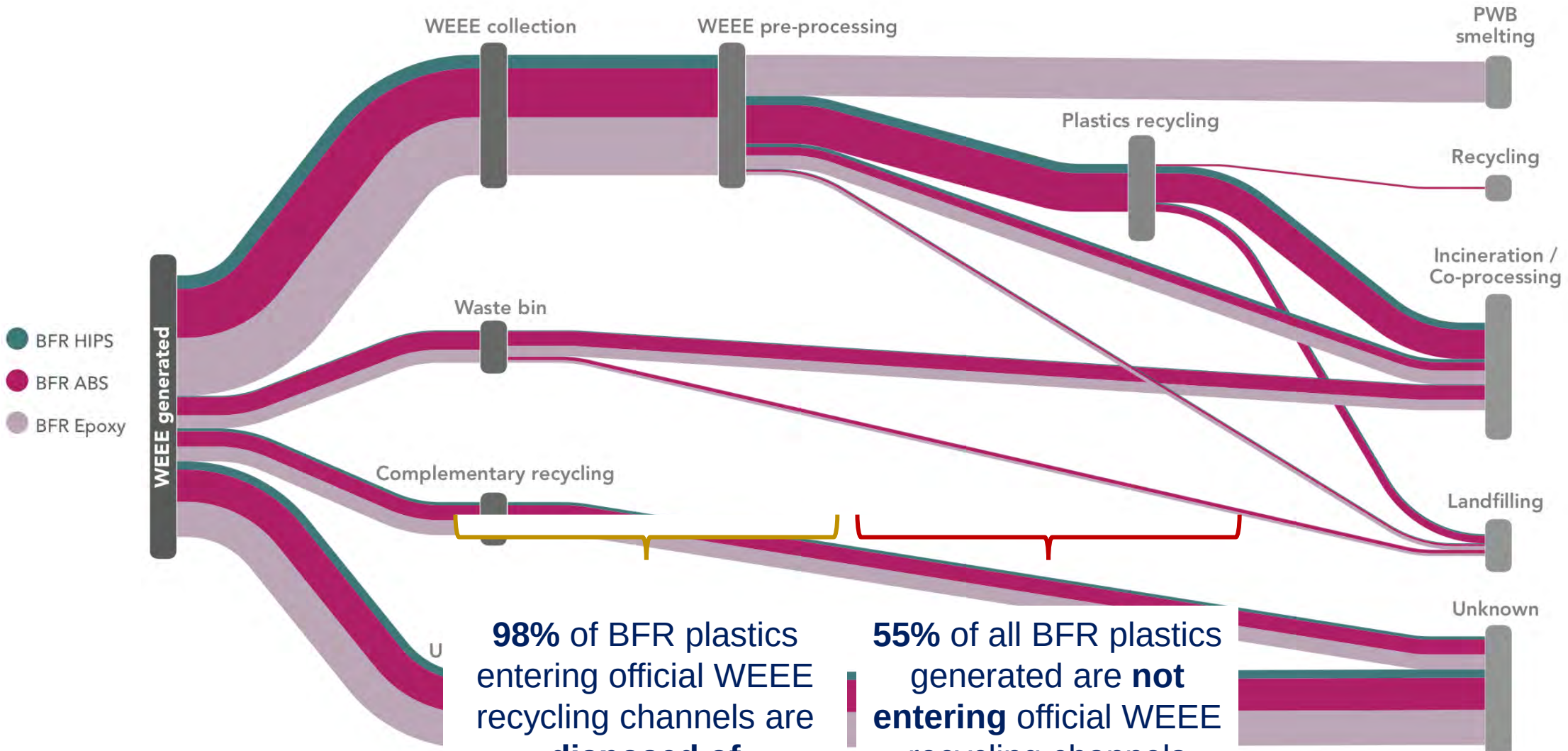
WEEE Plastics Mass Flows (EU28+2, 2020)



22% of all WEEE plastics

Source: SOFIES Study

BFR plastics mass flows (EU28+2, 2020)

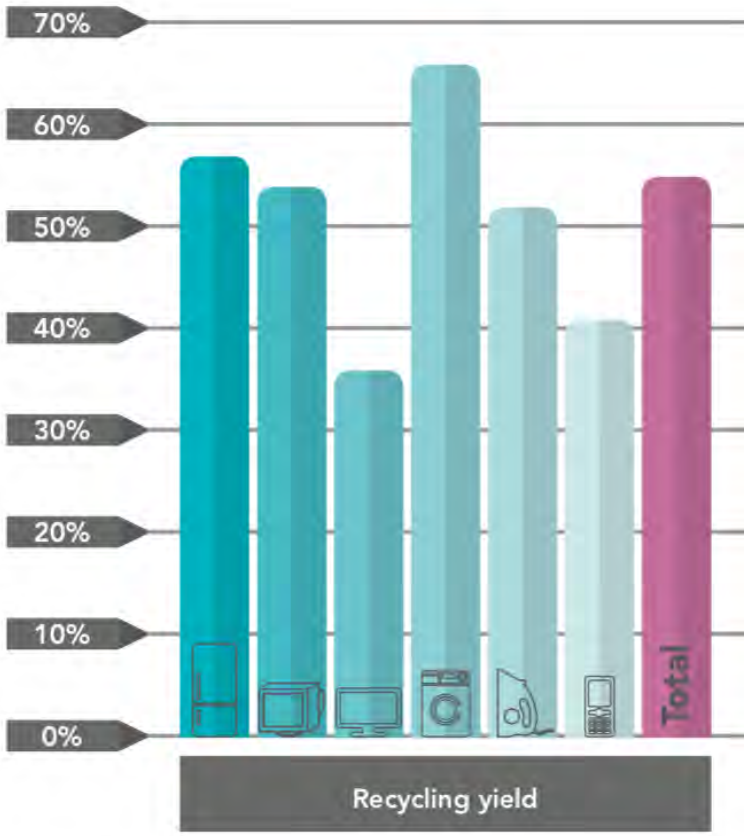


98% of BFR plastics entering official WEEE recycling channels are **disposed of**

55% of all BFR plastics generated are **not entering** official WEEE recycling channels

Source: SOFIES Study

Impacts of continuous discussions about BFRs



recycled plastics output / input to plastic recycling process

Source: SOFIES Study

Mainly influenced by

Share of target polymers

- Mainly PP, PE, ABS, PS and PC-ABS **– averages some 50 %**
- Can be **separated**

Lacking reliable validated screening techniques

- Reducing already low thresholds are an **existential problem**
- These **cannot be reliably screened** with existing XRF methods
- EEE products need **a risk and not a hazard approach**

Continuous and complex discussions

- This debate about thresholds runs **over 15 years.**
- **POP BFRs** today only represent **15% of the BFR charged plastics**
- Cycle: **Stockholm, Basel, POP Regulation, REACH, RoHS, WEEE**
- We need a **One-Substance – One Asessment** logic

What are the challenges……

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Compliant recyclers solve environmental problems and reduce risks

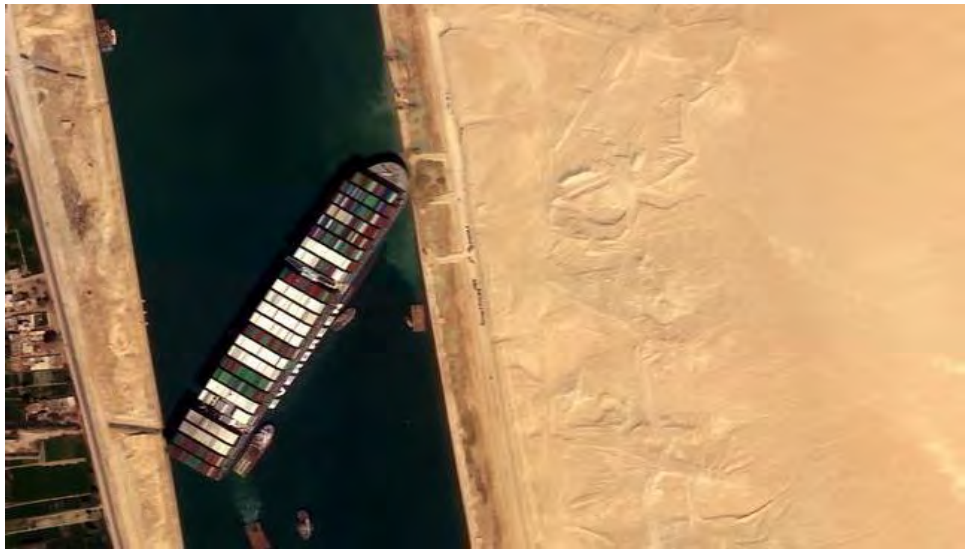
A Never Given fact was given by the Ever Given…..

…as it wedged the Suez Canal for 6 days and it was major global news for this amount of time and beyond.

Do you know that this is happening day-in-day out with waste?

The plastics recycling industry is facing more and more bans on shipments and all mixed WEEE plastics need notifications.

If Europe is serious about the Circular Economy, this needs to be changed urgently – shipments of plastic waste to compliant recyclers must be quicker and easier.



Source pictures: CNN

We call it the”big waiting”……..

- Huge files are involved
- Many authorities still need original signatures
- Files are sent to all authorities involved
- No harmonized rules and procedures
- Interpretations can differ per country/region
- It is linked to major costs
- But most importantly…..with huge delays

One notification took us over 4 years……. How can a circular economy develop this way?

The EU needs Fast-Track Notifications

- Much simpler and harmonized business processes and waste classifications are needed
- Compliant and environmentally sound recyclers should be able to be authorized to take in defined wastes
- And "green lanes“ or "fast-tracks“ should be created for these flows, at least within the EU

We should be able to work at the pace of business and not at the pace of administration

What are the challenges……

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Compliant recyclers solve environmental problems and reduce risks

Circular economy and harmonization

- Often requires measurements of SOC‘s
- There is an inflation of classifications as hazardous
- Recycling technologies developed to remove SOC’s
- Recycling facilities may not take in hazardous waste
- Simpler and harmonized rules are needed

Circular economy and harmonization

- Recycled resources re-enter Circular Economy
- Need to compy with product legislation (REACH)
- Here is where the analyses should take place
- And this should be based upon harmonized rules

- Often requires measurements of SOC‘s
- There is an inflation of classifications as hazardous
- Recycling technologies developed to remove SOC’s
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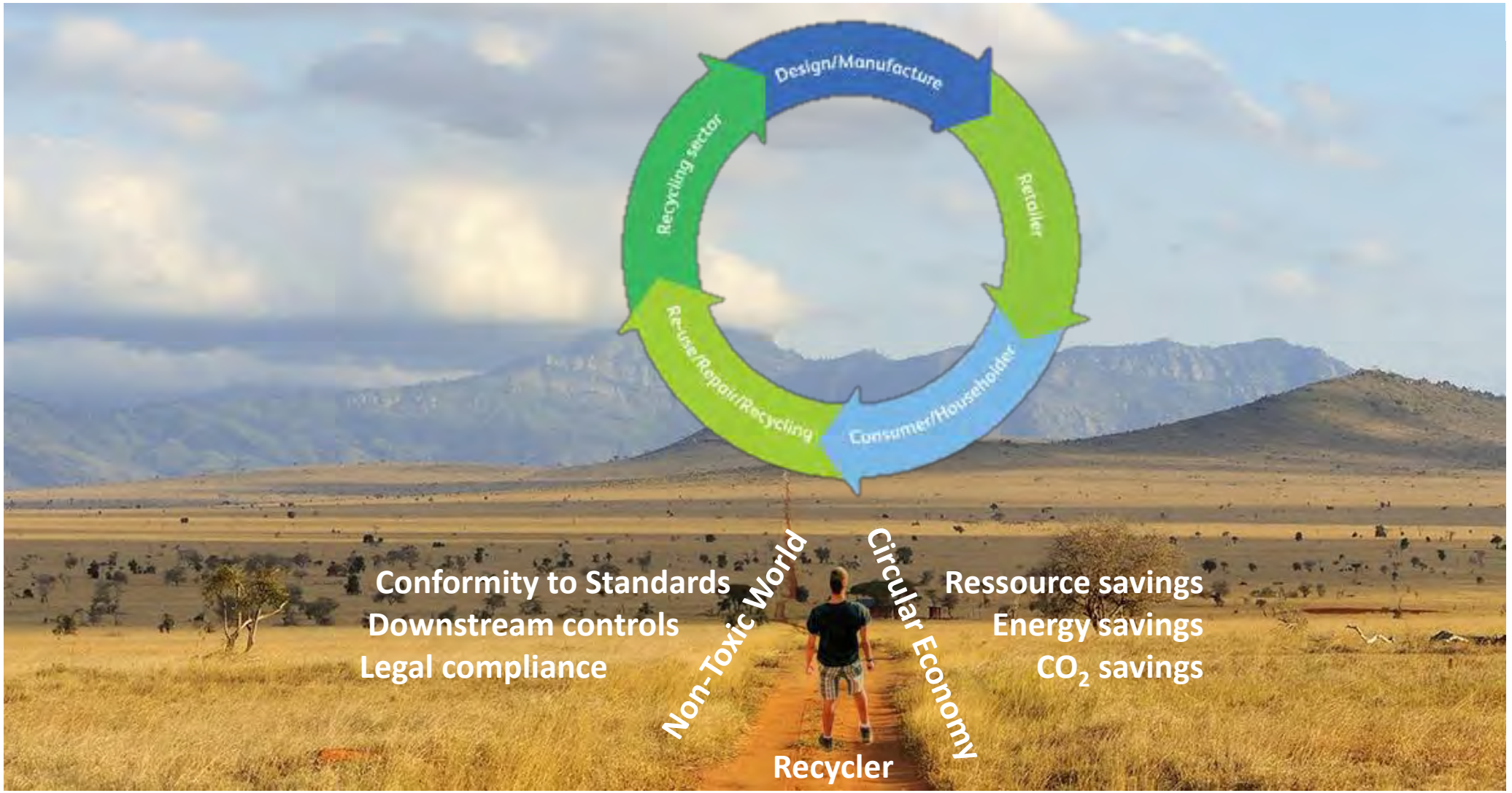
Let’s please strike the right and intelligent balance……



Art between “Non-Toxic” and “Circular Economy” objectives


THANK
YOU
GRACIAS
ARIGATO
SHUKURIA
DANKSCHEEN
JUSPAXAR
BOLZÏN
MERCI
BÏYAN
SHUKRIA
TINGKI
YAQHANYELAY
TASHAKKUR ATU
SUKSAMA
EKHMET
MEHRBANI
GRAZIE
KOMAPSUMNIDA
GOZAIMASHITA
EFCHARISTO
SPASSIBO
SNACHALHUYA
NUHUN
CHALTU
WABEEJA
MAITEKA
YUSPAGARÀTAM
HUI
GUI
HATUR
UNALCHÉESH
SPASIBO
DENKAUJA
NENACHALHYA
EKOJU
SIKOMO
MAKETAI
MINMONCHAR
DHANYABAAD
AMHA
ATTO
MERSI
MAAKE
SANCO
MERASTAWHY
GAEJTHO
LAH
PALDIES
TAVTAPUCH
MEDAWAGSE
AGUYJE
FAKAAUE
BAIKA

Flame Retardant plastics are circular: Novel technologies enabling efficient recycling

Lein Tange
Sustainability Director
ICL-IP

Chemicals, Electronics, and Circularity – Drivers for Decision Making

November 3rd., 2022

About ICL Group

- $7.0 bn sales in 2021
- Global manufacturer of bromine, fertilizer and specialty chemicals
- ~13,000 Employees
- 20 R&D centers with 500 researchers
- Multiple awards for sustainability efforts, inclusion in FTSE4Good and A- Carbon Score

About BSEF

- BSEF – the International Bromine Council, is the global representative body for bromine producers and producers of bromine technologies
- Founded in 1997, BSEF works to foster knowledge on the societal benefits of bromine and its applications
- The members of BSEF are Albemarle Corporation, ICL Industrial Products, Lanxess and Tosoh
- Offices & representatives in Europe, China, Japan, India, Brazil, Canada
- Affiliate member of the European Chemicals Council; member UNEP Hg Partnership; member European Association for Energy Storage

www.bsef.org **@BromineInfo**

Why fire safety is important

Changing demographics – an aging and more vulnerable population

- 5,000 fire deaths in the EU every year (EUROFSA, 2020)
- 50,000 fire induced injuries, according to conservative estimates.
- Special attention needs to be paid to Europe's **growing vulnerable community** (in 2020, over 20% of the EU's population was aged 65 or over, Eurostat)

Dangerous reduction in escape times

- Changes in the material composition, higher combustible content in rooms
- Wider range of products in people's homes (smart devices and homes etc.)
- Trend towards more airtight homes for energy efficiency

A fire is a traumatic experience and wastes materials

- Human tragedy, fatalities, burn injuries
- Financial and psychological damage
- Materials are damaged, contents are lost, water is wasted, and pollutants are released into the environment

End of Life options for waste plastics

End-of-life management
& emissions scenarios

- Reuse of plastics / recover of metal,
- Physical recycling to recover polymer/ additives
    - Mechanical recycling
    - Solvent based purification process
- Chemical recycling:
(de-polymersiation/pyrolysis)
- Incineration – energy recovery
- Landfill – least favored

Challenges ahead for plastics with SVHC/POP's:

- POP regulation lowering SVHC/POP concentrations preventing normal plastics recycling
- RoHS/REACH (end of waste => 'new' products) - SVHCs < 1000 ppm
- Uncertainty in technologies being part or NOT part of the recycling quota preventing investors to start up innovative technologies

But relevant to all plastics within heavy (ABS-BFRs) sorted fraction:

- Sorting black plastics
- Concentrating the plastics to a purity of > 95%
- Quality of recyclate
- Proof of product being compliant with REACH and POP regulation
- Analytical proof of POPs/ and SVHC is extremely challenging due to lack of standardized global approved analytical methods
- Scale of Economy

Example recycling process of waste plastics from E&E plus ASR
(Electrical & Electronic Equipment plus Automotive Shredder Residue)

Manual sorting → Reuse products

Size reduction by Shredder

Ferrous Separation → Metals

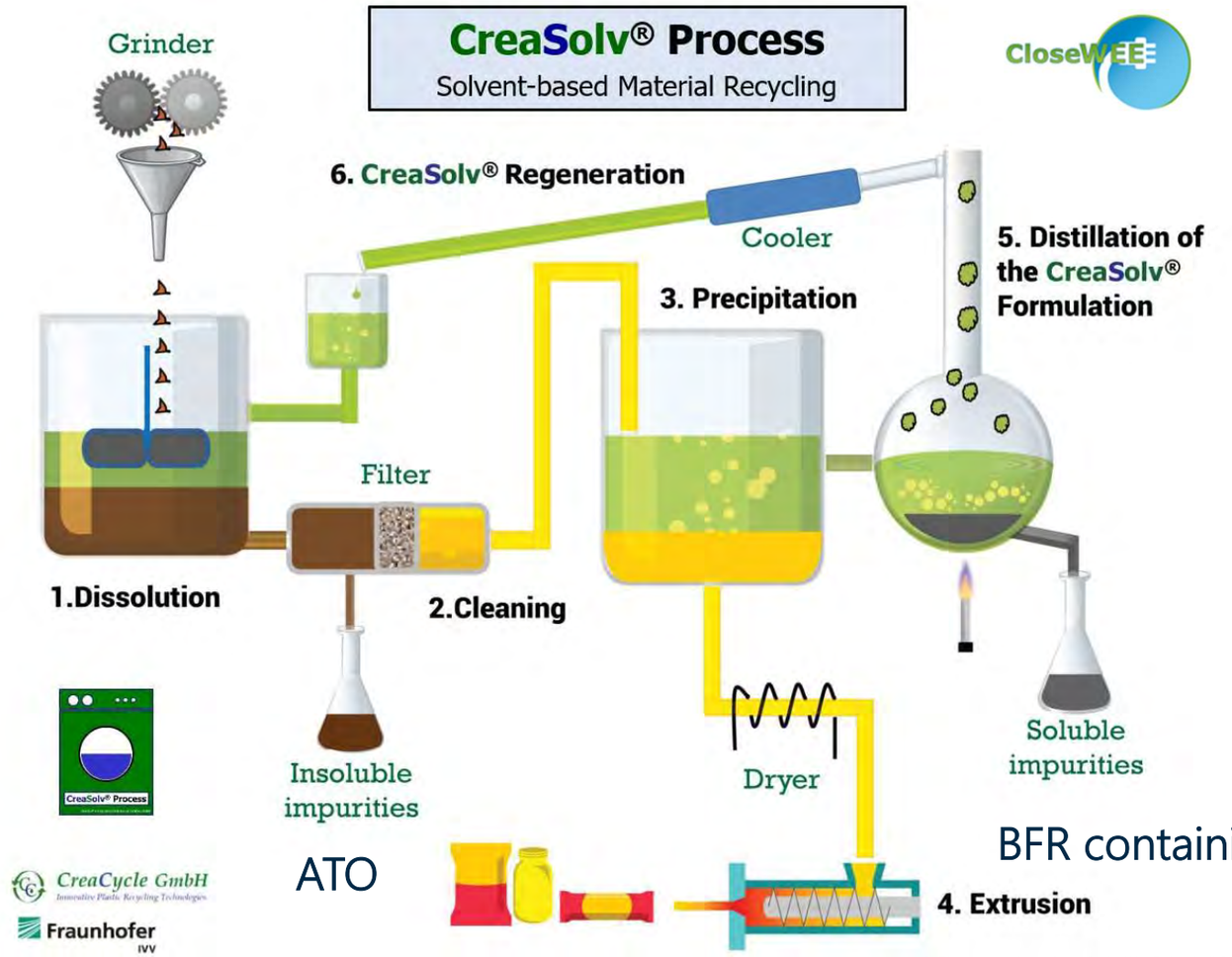
Non - Ferrous Separation → Non-Ferrous Metals

Plastics:
Density separation

After sorting → Solvent based purification process

- Lightweight plastics: PE, PP, PS, HIPS, ABS → Mechanical recycling ✓
- Heavy plastics: **HIPS FR's plus ATO, ABS FR's**, PC, PVC, PA, … → Incineration or Landfill ✗

Solvent based purification process for possible scaling up to demoplant 3KT of ABS

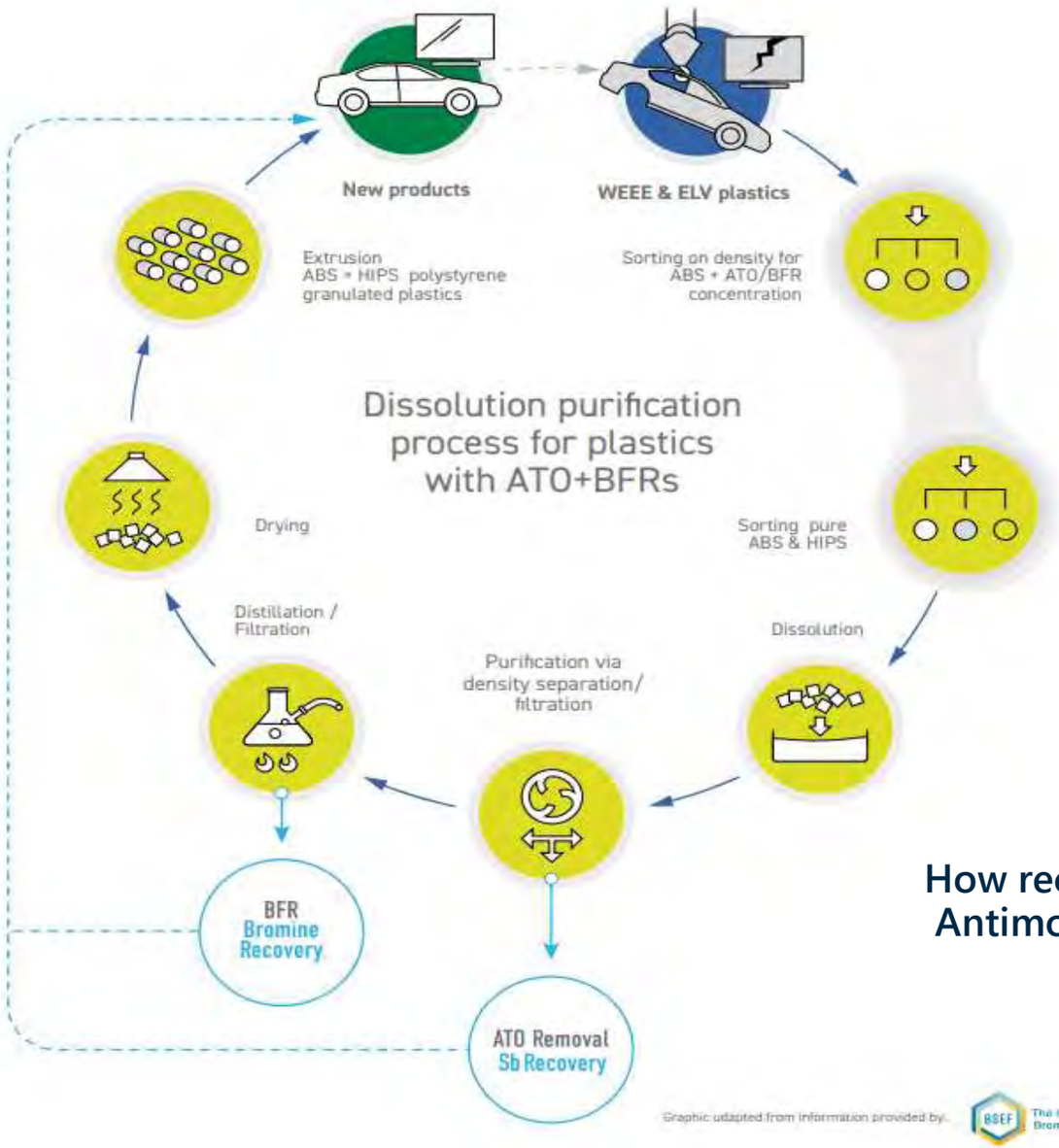


Demoplant PSLoop as example for scaling up: EPS insulation foam with HBCD

ATO

BFR containing stream

Plastics from E&E and ELV closing the loops



How recyclable is plastics with Bromine and Antimony and how do we close the loops?

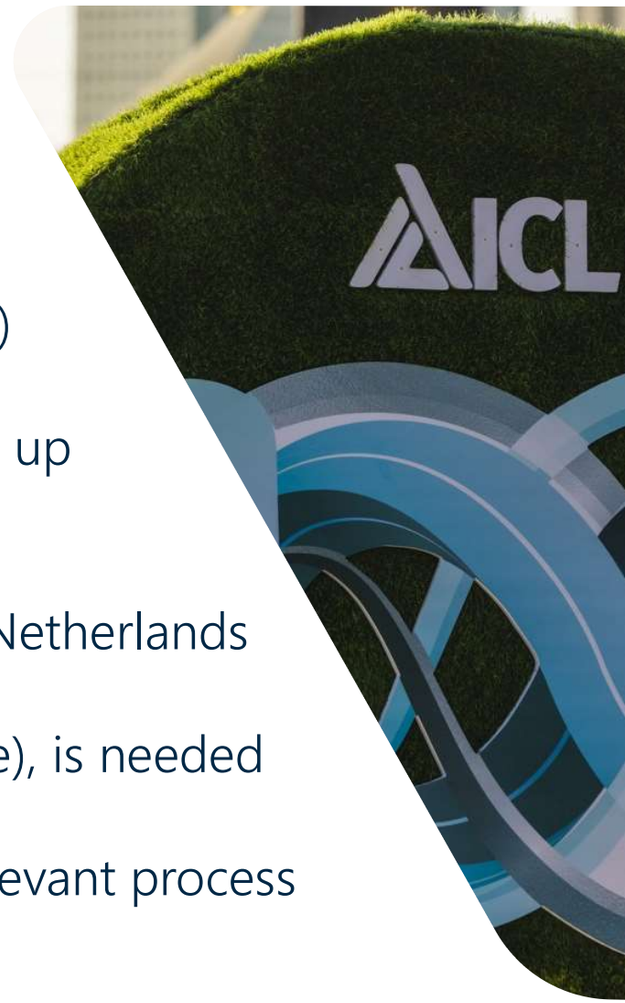
Chemical Recycling containing BFRs:

Processing difficult to handle mixed plastics waste streams with “less sorting” efforts → chemical recycling can be a valuable option

- Styrenics plastics for depolymerization into styrene monomer handling EPS with HBCD (Agilyx)
- R&D studies on different levels handling plastics containing BFRs via pyrolysis using catalysts and acid scavengers
- Charles Darwin University work on Pyrolysis – catalysts and additives research to enhance hydrocarbon, bromine and antimony recovery
- Super critical CO2 for extracting BFRs out of the plastics (CreaTor-NONTOX)
- Push to include CR in Europe as “transitional” CE option

Conclusions:

- ✓ Challenges for mechanical recycling due to scale of economy, sorting identification and quality (also SVHCs/ POPs contaminants)
- ✓ Innovative technologies can be used for plastics with BFRs/ATO
- ✓ Need for predictable and stable legislation (UTC-LPLC-REACH-standards)
- ✓ Solvent based dissolution technologies are emerging and ready for scale up especially for the “heavy” plastics fraction (ABS) containing BFRs/ATO
- ✓ Scaling up R&D/Pilot into a demoplant takes years → 2024-2028 NPPR Netherlands
- ✓ Teamwork of recyclers, BFR producers (ICL) and ATO producers (Campine), is needed
- ✓ Chemical Recycling for difficult to handle plastics is becoming a more relevant process



Thank You

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Key Takeaways

Key Takeaways

- Recycling landscape is complex & evolving
- Increasing interest from regulatory authorities
- New technologies are emerging that may increase options and possibilities for circularity
- Public policy challenges require product manufacturers to be informed and weigh-in where appropriate

Questions & Discussion

American Chemistry Council

Thank You for Attending