

Circular Product Design in the Electronics Sector

OST Coffee Lectures

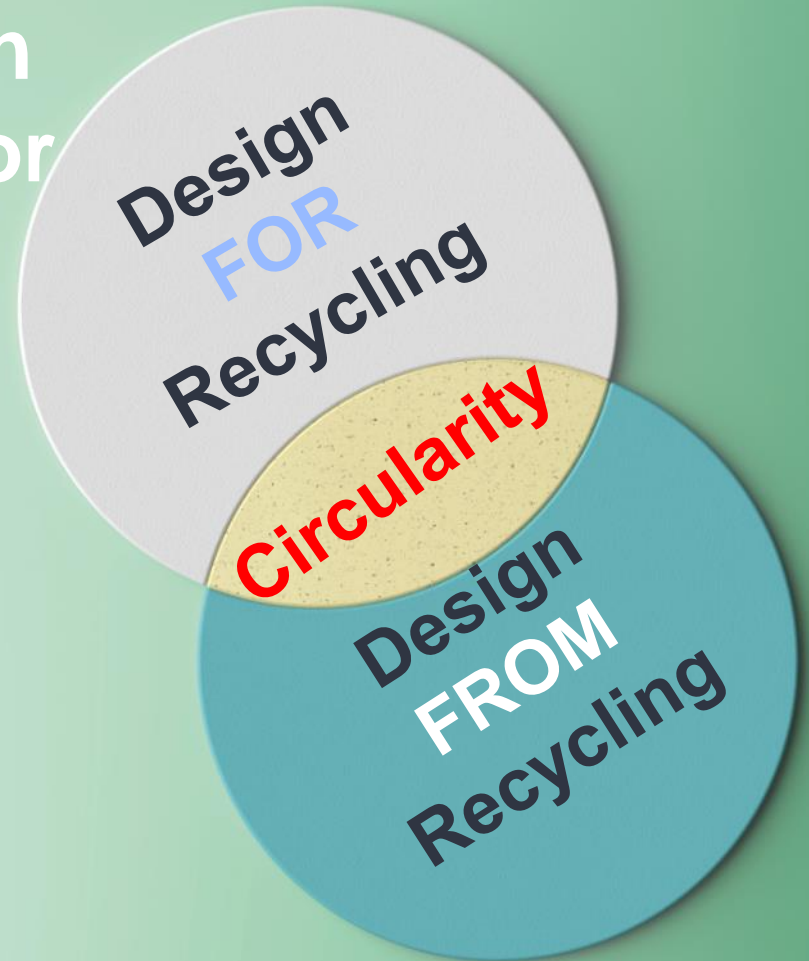
16th November 2022

Gergana Dimitrova

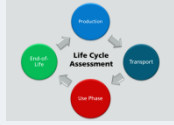
Researcher and Project Manager, Fraunhofer IZM, Germany

Thijs Feenstra

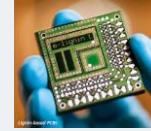
Product Developer and Project Lead, Pezy Group, the Netherlands



Fraunhofer IZM - Environmental and Reliability Engineering



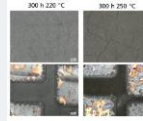
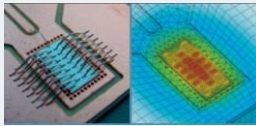
Life Cycle-, Eco-Assessment,
EcoDesign



Resource Efficiency, Circular
Economy, Obsolescence



Developing sustainable and circular products & processes
through systematic assessment methodologies



Failure mechanisms, Lifetime
Modelling, Material
Characterization



Reliability Requirements,
Accelerated Test Methods

Policy Background

1st Circular Economy Action Plan (CEAP)

Close the loop of product lifecycles

Circular Plastics Alliance

Pledges from > 300 organisations from industry, academia, public authorities

2nd CEAP

Design of sustainable products, promoting circularity, ensuring resources used are kept in the EU economy for as long as possible

Dec 2015

Jan 2018

Dec 2018

Dec 2019

Mar 2020

Mar 2022

CE Plastics Strategy

All plastics recyclable by design by 2030; 10 Mt target by 2025

EU Green Deal

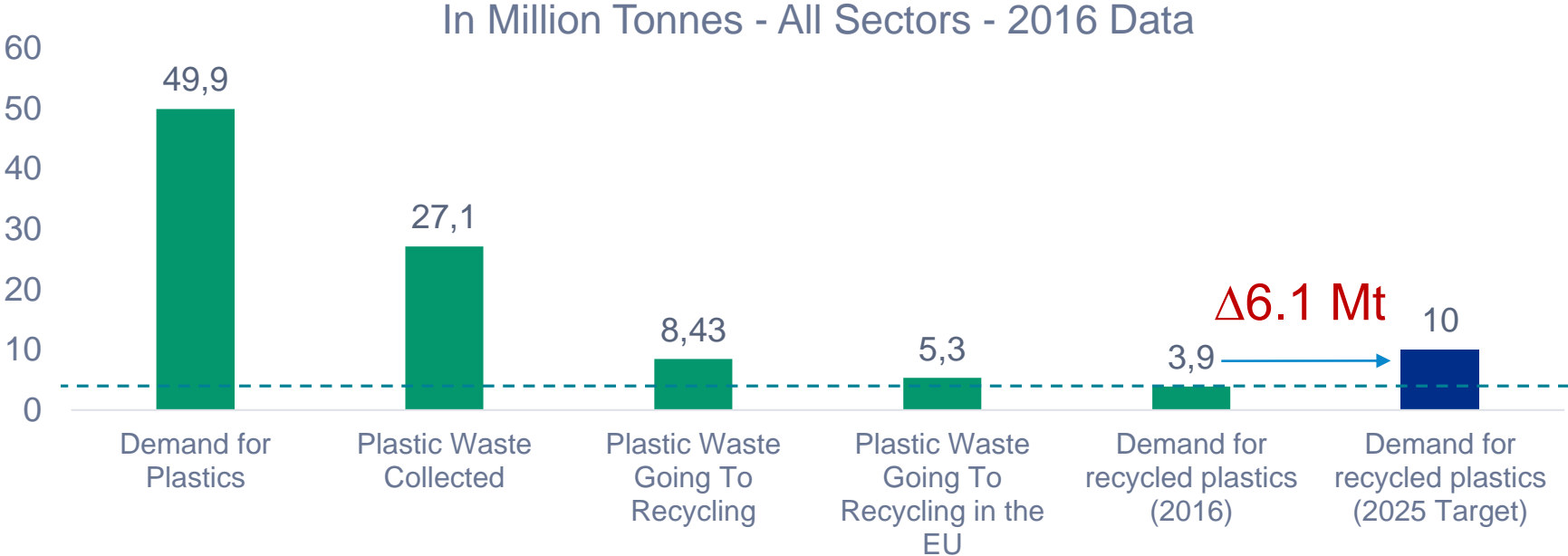
Transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy

Ecodesign for Sustainable Products Regulation

Legislative measures for more sustainable products (durable, reusable, repairable, recyclable, with recycled content and energy-efficient)

Assessment of voluntary pledges

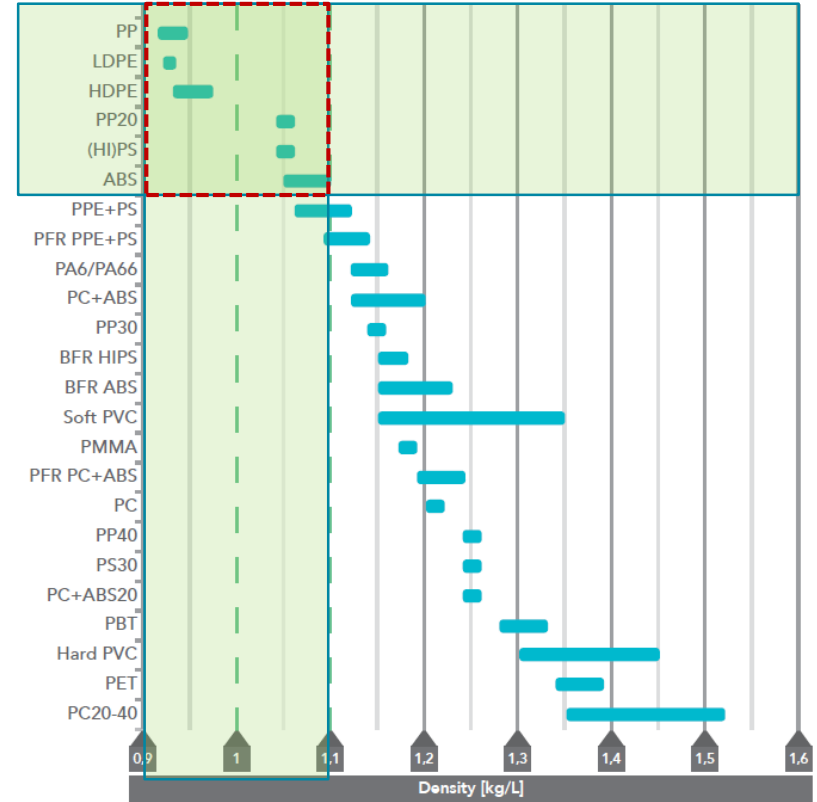
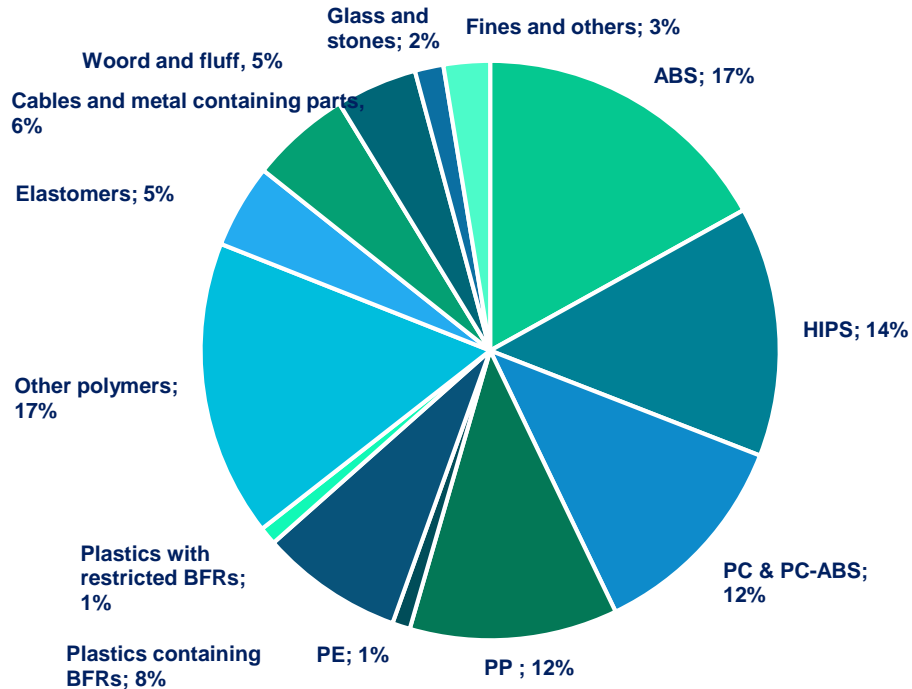
From virgin plastics demand to recycled plastics demand



Source: European Commission, Assessment report of the voluntary pledges under Annex III of the European Strategy for Plastics in a Circular Economy, 2019

Polymers currently recycled

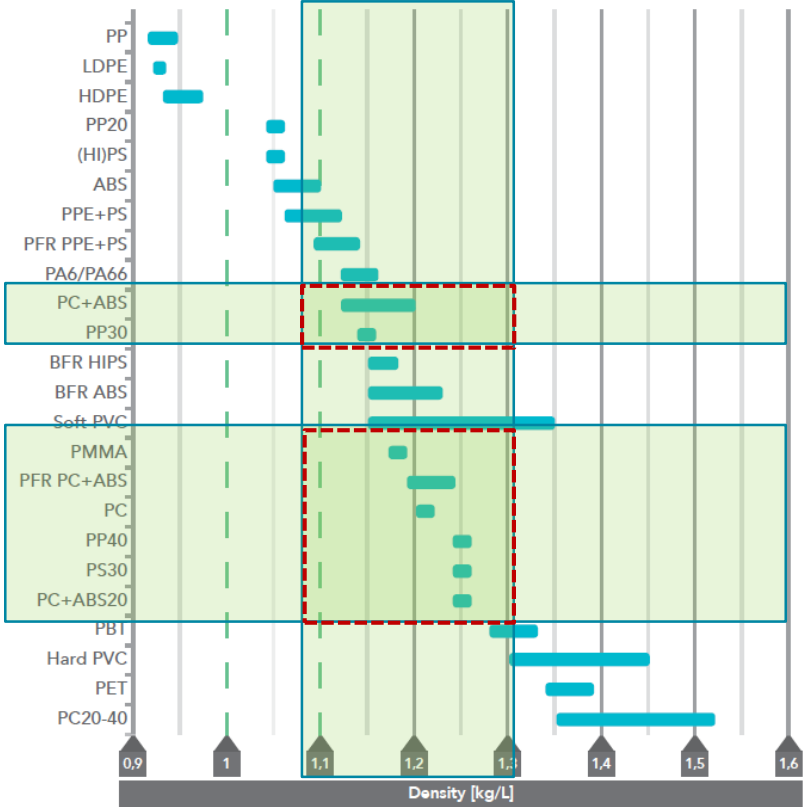
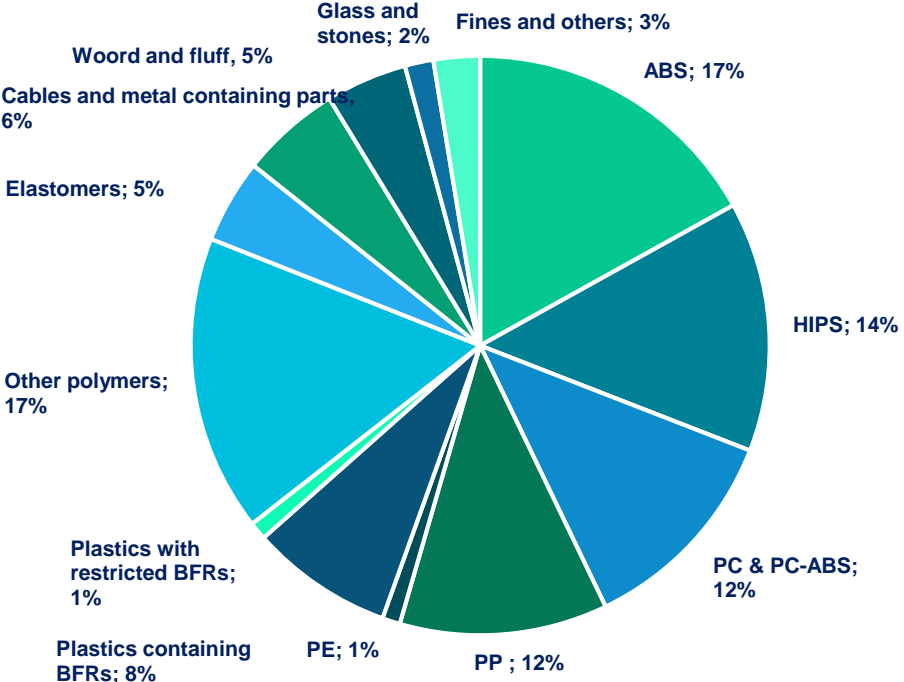
The industry currently works with the “light” ranges



Source: Chris Slijkhuis, MGG Polymers

Innovations happen in new density ranges

Future PCR plastic types to be developed from the “heavies”



Source: Chris Slijkhuis, MGG Polymers

CloseWEEE



Dec 2014 to Nov 2018
Funding: € 5.9 million,
supported by Horizon 2020
Consortium: 12 partners from 7 countries

Challenge:

Develop a cost effective, high-gloss
piano black ABS with comparable
mechanical properties as virgin.



Recycled ABS coming from different
sources with different separation
technologies:



Virgin ABS



Coolrec
Mechanical
recycling



Fraunhofer
IIV
CreaSolv®



GAIKER
Sensor
sorting

CloseWEEE has received funding from the European Union's Horizon 2020
research and innovation programme under grant agreement No 641747



PolyCE

June 2017 to May 2021
Funding: € 8.3 million, supported by Horizon 2020
Consortium: 20 Partners (11 countries)

Main objective: Increase the uptake of recycled plastics in new electric and electronic devices.



PolyCE

POST-CONSUMER HIGH-TECH RECYCLED
POLYMERS FOR A CIRCULAR ECONOMY



PolyCE has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 730308



INCREASE

June 2022 to May 2026

Funding: € 7.2 million, supported by Horizon Europe

Consortium: 17 partners

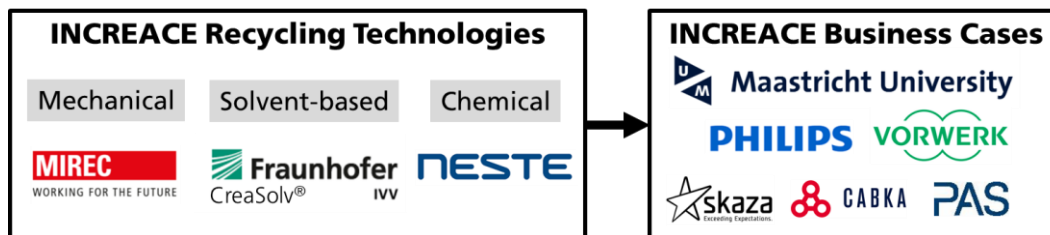
Main objective: Enable an increased uptake of recycled plastics in added value products through innovative and systemic solutions along the entire recycled plastics value chain.



INCREASE



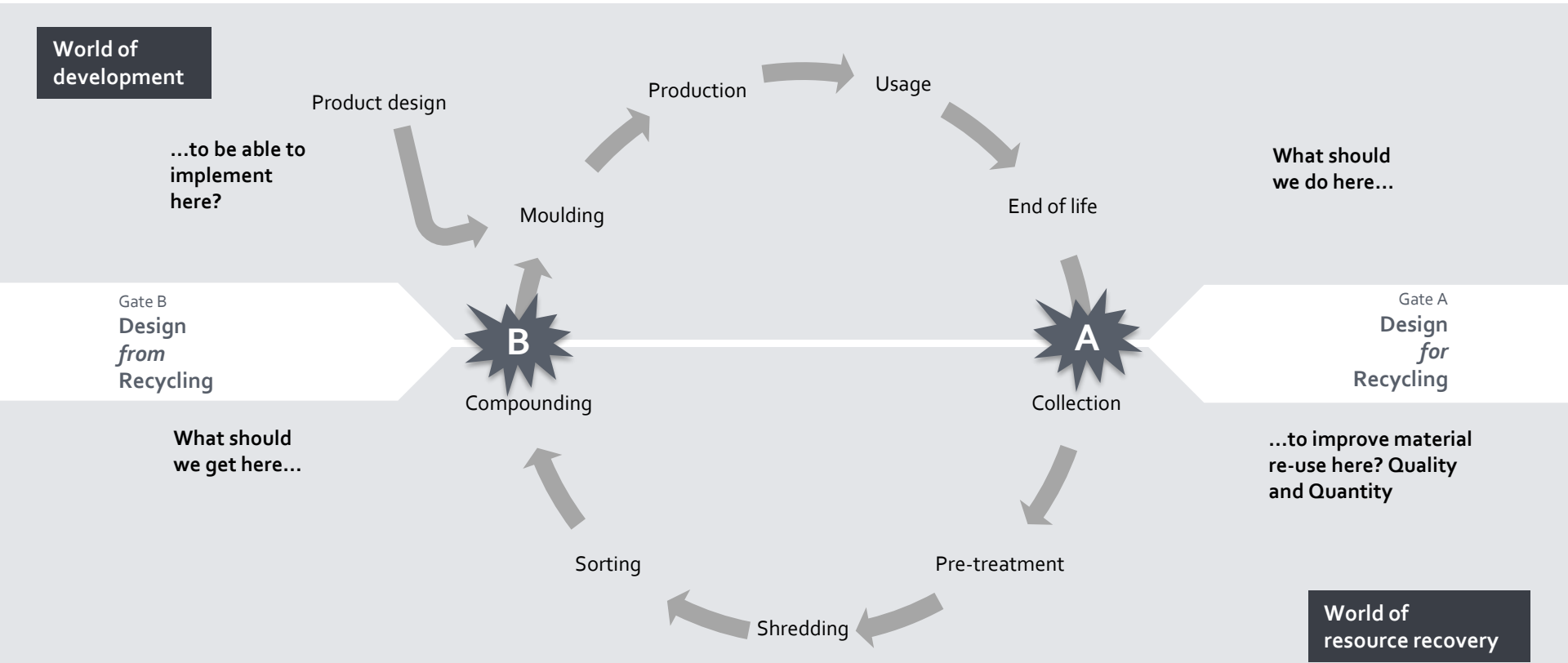
INCREASE kick-off| Berlin| 5-6 July 2022



INCREASE has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101058487



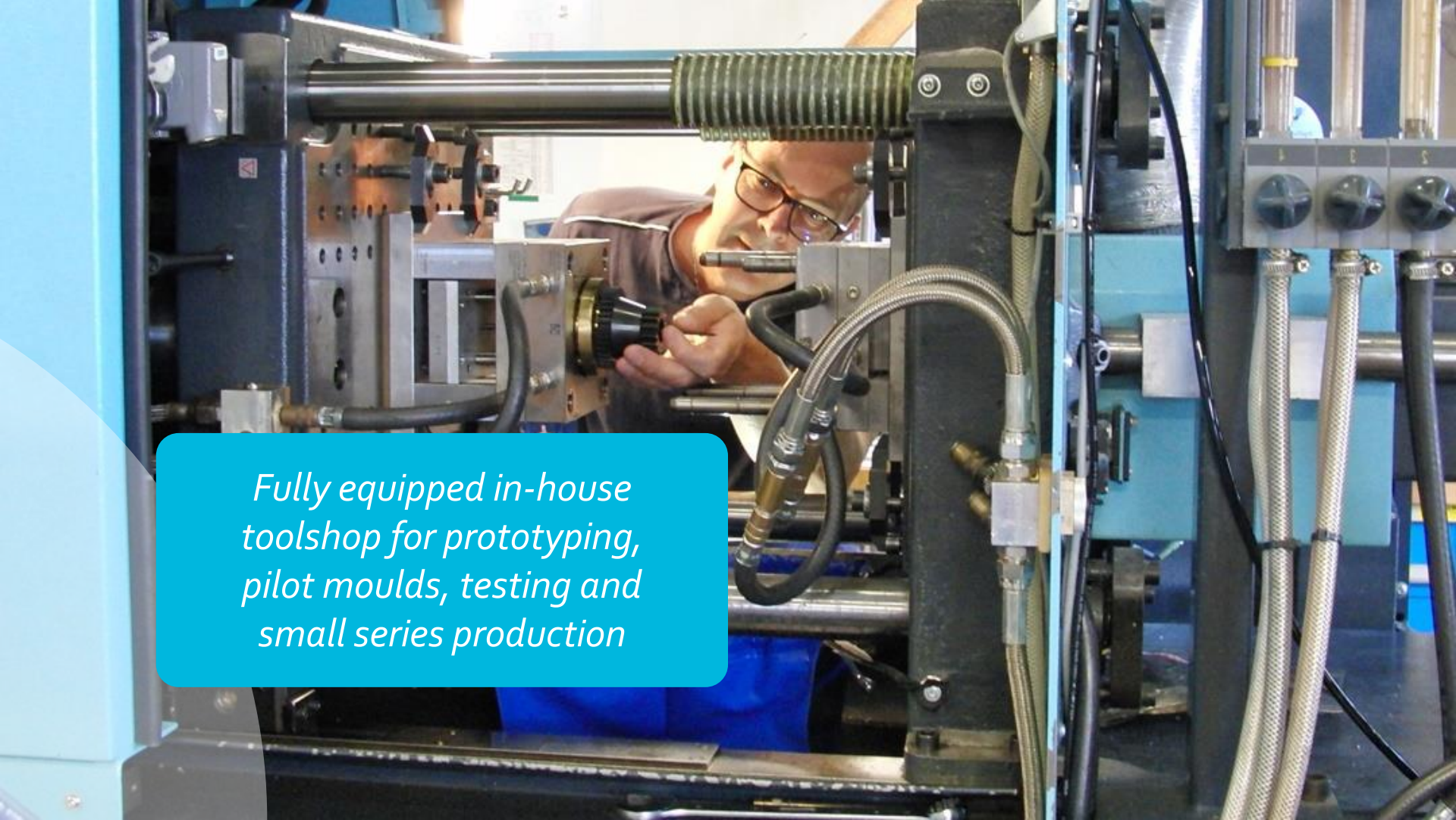
Closing the gap requires switching from linear thinking... to circular thinking



With 80+
experts we
innovate
products
everyday



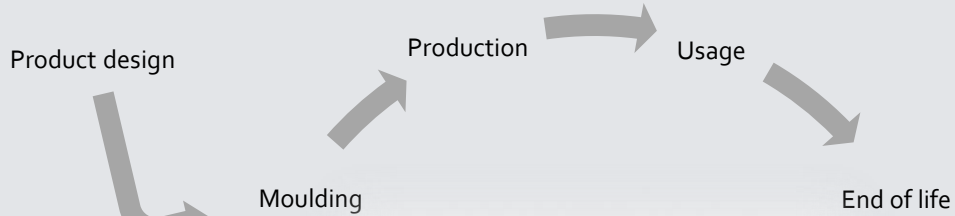
PEZY
GROUP

A technician wearing glasses and a brown shirt is focused on adjusting a component within a large, complex industrial machine. The machine features various metal parts, hoses, and a control panel with three knobs. The scene is set in a well-lit workshop environment.

*Fully equipped in-house
toolshop for prototyping,
pilot moulds, testing and
small series production*

Get to work!

World of development



Gate B
Design
from
Recycling



Gate A
Design
for
Recycling

World of
Resource recovery

Gate B: Design from Recycling

A quick fix!

- Processing ✓
- Visual ✓
- Mechanical ✓
- Chemical ✓



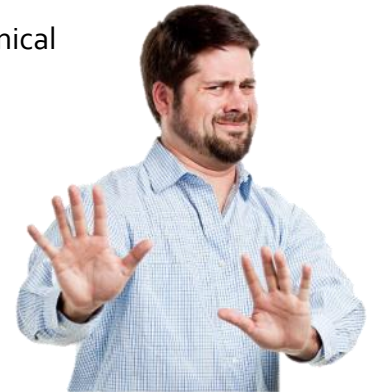
- Processing
- Visual ?
- Mechanical ?
- Chemical



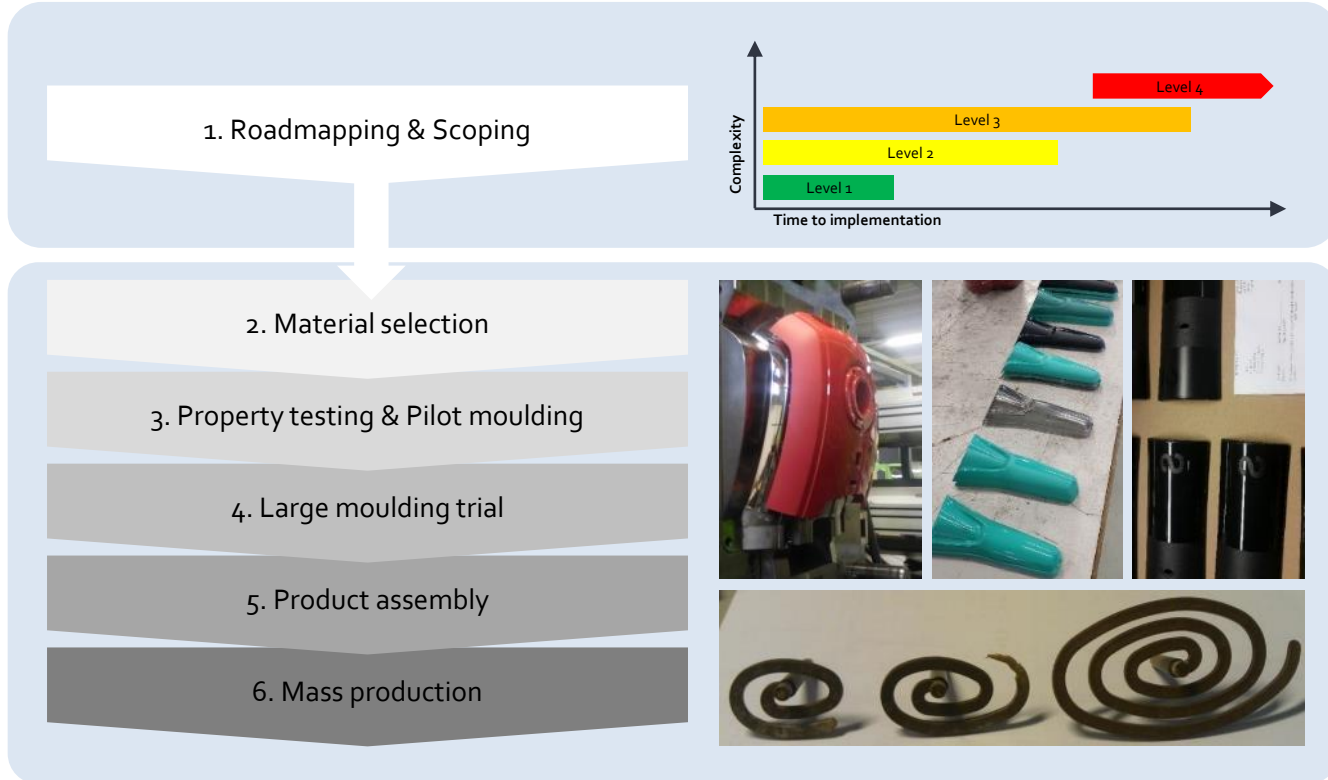
Virgin grade



Recycled grade



Gate B: Design from Recycling



rPlastics in high-end products

Existing product...to learn apply r-plastics

Lid cover

top part and lever in recycled PC in Nougat colour with speckle effect for aesthetic imperfection appearance

Lid / Housing / Base plate

in recycled ABS from post-consumer plastic in high gloss Deep Black colour

Buttons / front cover / Lid window

buttons and front cover from recycled black post-consumer ABS



New product...based on r-plastics knowledge

Side panels

In recycled ABS from post-consumer plastic in high gloss Deep black colour. With a subtle print

Other parts

In recycled PC from post-industrial plastic.



Gate A:
Design for Recycling



Different product, different category

Specific policies

Batteries and accumulators EU rules on batteries and accumulators.	Biodegradable waste EU measures on treating bio-waste, including by limiting the amount sent to landfill.	Construction and demolition waste EU rules on the management of construction and demolition waste.
End-of-life vehicles EU measures to prevent and limit waste from vehicles once they come to their end-of-life.	Landfill waste EU rules to reduce the amount of waste sent to landfill, as this is the most polluting way to deal with waste.	Mining waste EU rules on the proper management of mining waste.
Packaging waste EU rules on packaging and packaging waste, including recycling targets and recycled content.	Polychlorinated biphenyls and polychlorinated terphenyls (PCBs/PCTs) EU rules on the safe disposal of PCBs and PCTs.	Restriction of Hazardous Substances in Electrical and Electronic Equipment (RoHS) EU rules restricting the use of hazardous substances in electrical and electronic equipment (RoHS).
Sewage sludge EU rules regulating the use of sewage sludge, and promoting its use in agriculture.	Ships EU rules on making ship recycling greener and safer.	Waste containing POPs EU rules on waste containing persistent organic pollutants (POPs).
Waste oil EU rules on collecting and treating waste oils.	Waste shipments EU rules on transporting waste within and beyond EU borders.	Waste from Electrical and Electronic Equipment (WEEE) EU rules on treating waste electrical and electronic equipment (WEEE).

 Category 1 Temperature exchange equipment	 Category 2 Screens & monitors
 Category 3 Lamps	 Category 4 Large equipment
 Category 5 Small equipment	 Category 6 Small IT & telecom equipment

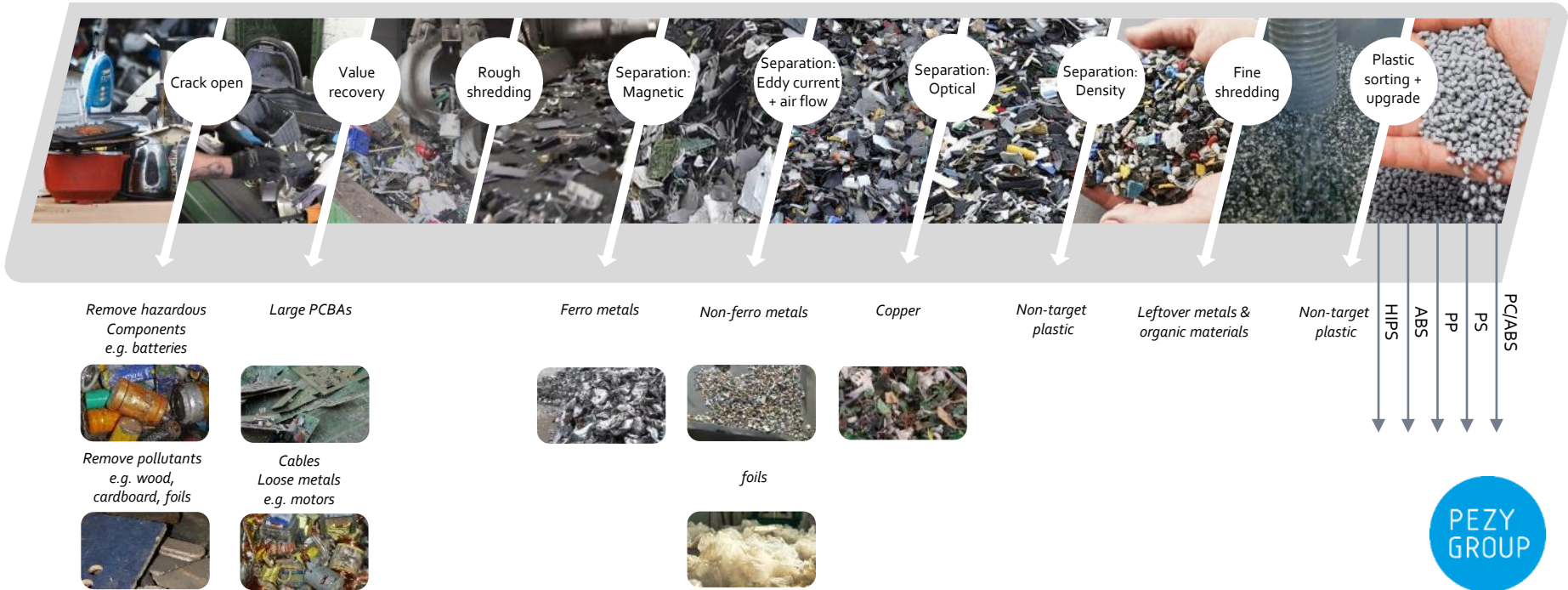
E-waste recycling process

Category 5: Small appliances



E-waste recycling process

Category 5: Small appliances



Standard keyboard after initial shredding



Silicon stuck



Labels



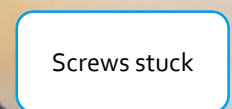
Foam pads



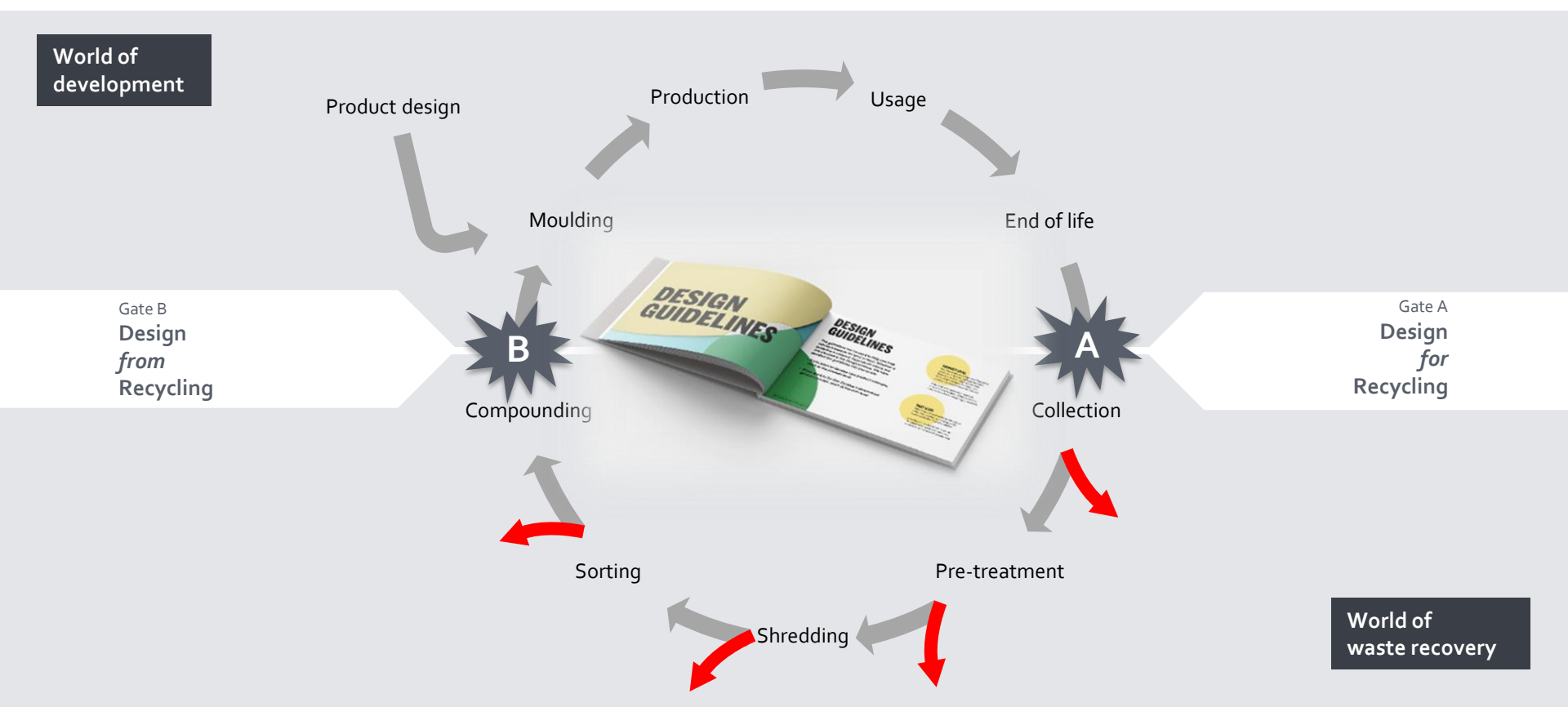
Combined parts



Screws stuck



Designing for Recycling = closing the gap



Guidelines



DESIGN FOR & FROM RECYCLING

Four years ago, a consortium of 20 expert organisations, joined forces to investigate how to improve the circular use of plastics in product development. Our goal was to significantly reduce the use of virgin plastics and increase the use of recycled plastics in electronic devices.

The initiative, called the Plastic2Product project, was coordinated and funded by the European Commission and coordinated by the Fraunhofer IPA. The project was led by Fraunhofer IPA, with the support of 20 expert organisations. Within the Plastic2Product project, we set ourselves the goal to create a framework for the design of plastic products that take into account the different levels of plastics and the challenge of a better end-of-life management of electronic material parts in recycling processes. These guidelines are based on the results of the Plastic2Product project and represent the state-of-the-art in the field.

FOR WHO

The guidelines are best used as a starting point for a wide range of product developers. The guidelines are also focused on one particular aspect: creating plastic products. The intention is to design circular plastic housings for electronic products and devices.

THE DEFINED PRODUCT CATEGORIES FOR RECYCLING

The design guidelines for electronic devices are divided into six categories by the DfR. These categories are defined by the recycling streams and processes used for the final recycling of the products. The level of effort in the design process varies across the different material streams and categories. The design guidelines are specifically tailored to the different material streams and categories. The design guidelines are specifically tailored to the different material streams and categories. The design guidelines are specifically tailored to the different material streams and categories.

Figure 02 shows the EU categories as defined by Directive 2012/19/EU of the European Parliament and of the Council of July 4, 2012 on Waste Electrical and Electronic Equipment (WEEE).

The guidelines are developed based on how to separate the product design into plastic parts housing, the product elements that are not plastic, and the product elements that are not plastic. The design guidelines are developed based on how to separate the product design into plastic parts housing, the product elements that are not plastic, and the product elements that are not plastic.

Fig. 01: Linking recycling categories to the design



DESIGN GUIDELINES

The guidelines can be used to help you map relevant aspects for your project. To determine whether a guideline is relevant depends on where you are in your design process. We have divided our guidelines into two levels. Where to start depends on what you want to develop.

If you want to develop new product concepts you start at the product level. If you want to further develop a determined product concept you start on the part level.

PRODUCT LEVEL

This level is the highest level of feasibility aspects of a project in recycling processes. Therefore, the main intention is to provide the base for your own product concept and its realization.

At this level, the design guidelines in depth knowledge on both product development and recycling processes.

PART LEVEL

This level is in the design of the use of recycled plastic and is specific to individual projects to be realized.

At this level, the design guidelines in depth knowledge on both product development and recycling processes.

Fig. 03: Design process and recycling process



In meeting the guidelines both Design and Recycling are affected.

Design for Recycling

- Avoidance of hazardous substances
- How to avoid easy access and removal of hazardous substances
- How to use recyclable materials which will be recycled in WEEE recycling
- How to use technical components and connections that allow disassembly

Design from Recycling

- How to use recycled materials

Additional guidelines for technical design and development

- Avoidance of hazardous substances
- How to avoid easy access and removal of hazardous substances
- How to use recyclable materials which will be recycled in WEEE recycling
- How to use technical components and connections that allow disassembly



FROM START TILL CONCEPT BUILDING A PRODUCT ARCHITECTURE

ENABLE EASY ACCESS AND REMOVAL OF HAZARDOUS OR POLLUTING COMPONENTS

Use design solutions to facilitate access to product, avoid components being cut by glass, avoid sharp corners.

Use design solutions to facilitate access to product, avoid components being cut by glass, avoid sharp corners.

Use design solutions to facilitate access to product, avoid components being cut by glass, avoid sharp corners.

Fig. 04: Design process and recycling process



Use design solutions to facilitate access to product, avoid components being cut by glass, avoid sharp corners.

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