ReziProK

Resource-efficient Circular Economy – Innovative Product Cycles

Circular by Design (CbD)

Sustainable product design of consumer goods using the case study refrigerator/freezer

Resource-efficient Circular Economy – Innovative Product Cycles (ReziProK)

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A recyclable product design for refrigerators/freezers that is both energy and resource efficient is the main goal of Circular By Design. For this purpose, different scenarios are developed with the focus on repair and reuse as well as recycling paths that are as closed as possible. The combination of the resource efficiency analysis with a multi-regional extended input-output model should in future allow estimating product recyclability already at the design stage, thereby supporting a Design-for-Recycling optimization.

"Lagasys" – Ein Lagersystem für gekühlte und ungekühlte Lebensmittel

Recyclability

In order to ensure a stable supply of raw materials to the German economy in the future, rethinking the use of primary and secondary raw materials and life cycle-wide material flow management is urgently needed. In 2010, for example, only 14 percent of the raw materials used in Germany were obtained from scrap, with recycling costs of over 50 billion euros. For materials such as aluminium, steel or copper, which are found in many consumer goods, in 2016 the proportion of secondary raw materials was just 40 percent in total production in Germany.

One of the main reasons for this is the fact that in the creation of new products (product design), the ability to recycle and recover materials at the end of their life cycle (EoL) has hardly been considered. This is where Circular by Design starts, using a refrigerator as an example of a household appliance to show what material efficiency potential exists with regard to the recovery of the raw materials contained in it, both in terms of product design and the selection of materials.

Laboratory for Design

The first-time combination of the resource efficiency analysis (process simulation of recycling processes at micro level) of the Helmholtz Institute Freiberg for Resource Technology and the multi-regional extended input-output model (WI-SEEGIOM, macro level) of the Wuppertal Institute for Climate, Environment and Energy should allow in future the prediction of a product design suitable for the recycling economy. This will be demonstrated using the example of one of the most frequently used and already well characterized consumer goods, the refrigerator/freezer, with participation of the manufacturer Liebherr-Hausgeräte. Under lead of the Folkwang University of the Arts (FUdK), the aim is

Refrigeration appliances have high potential for the circular economy.

to run through various scenarios within a living lab design process during the project period. Models are to be designed and simulated whose design allows almost complete recycling and reuse of individual components, thereby opening up new market and business models such as repair, cash-back, leasing, etc.

With the cooperation of the project partners Becker Elektrorecycling (BEC) and Entsorgungsdienste Kreis Mittelsachsen (EKM) and based on the current reference product, which is particularly focussing on energy efficiency, it will be shown by quantifying the actual losses where the raw materials are lost, how these losses can be reduced by a suitable product design and how raw materials can be kept in circulation in the long term. In addition, the legal and practical feasibility of design concepts is discussed with industry experts.

First results

The Living Lab is working and the publication on the cultural history of cooling has been produced.

The first version of a simple evaluation model of the virtual recycling process is already available. This includes both the physical first treatment for refrigeration units (shredding and pre-sorting) and the further treatment steps of the metallic material flows (metallurgical treatment) and is modelled by process simulation. For further qualification, the model requires detailed product and material information as input in order to provide statements on the recyclability, quantified by indicators for material recovery, environmental impact and resource consumption. For this purpose, test designs are currently being drawn up for the manual disassembly of individual devices as well as for a large-scale test at a recycler.

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Social benefit

A transferable design concept for the recycling of the materials used in consumer goods is expected to be developed using the example of a refrigerator/freezer prototype. If one takes a look at the proportion of steel, copper and aluminium, these together represent almost 60 percent of the weight of the refrigerator/freezer to be recycled, plus plastics with a weight share of around 35 percent. This corresponds to a material value of secondary raw materials of around 25 million euros per year, just for the produced tonnage of a refrigerator/freezer producer. A savingpotential is assumed that can be achieved by reducing the amount of materials used, substituting non-sustainable materials such as PU foam or coolants, improving the collection of metallic waste and increasing the proportion of secondary raw materials in consumer goods.

Funding measure
Resource-efficient Circular Economy – Innovative Product Cycles (ReziProK)

As part of the FONA Field of action 6:
The circular economy – efficient use of raw materials, avoiding waste

Project title
Circular by Design (CbD) – Sustainable product design of consumer goods using the case study refrigerator/freezer

Project duration
01.07.2019 – 30.06.2022

Funding reference number
033R244

Funding volume of the project
799.606 Euro

Internet
reziprok.produktkreislauf.de/en

Publisher and editorial office
Networking and transfer project “RessWInn”

Design
PM-GrafikDesign

Picture credits
P. 1: Liebherr
FUdK

Status
March 2021

The project “Circular by Design (CbD)” is funded within the funding measure “Resource-efficient Circular Economy – Innovative Product Cycles (ReziProK)”.

“ReziProK” is part of the research concept “Resource-efficient Circular Economy” of the Federal Ministry of Education and Research (BMBF) and supports projects that develop business models, design concepts or digital technologies for closed product cycles.

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