



# CCE @ 71<sup>st</sup> AMAP Colloquium

A Hub for Circularity  
Dr.-Ing. Mohammad Chehadé

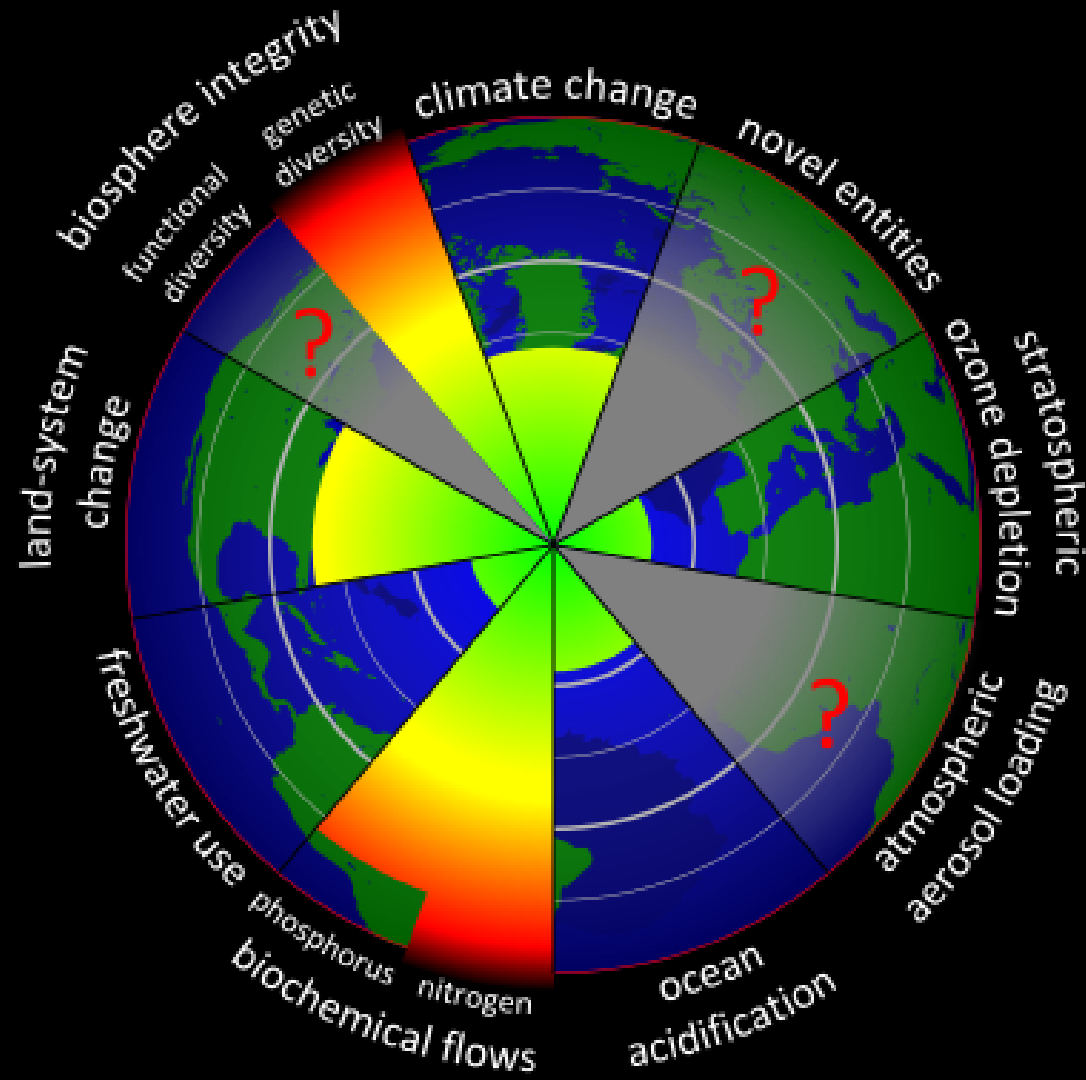
October 2022

CCE@RWTH



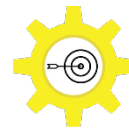






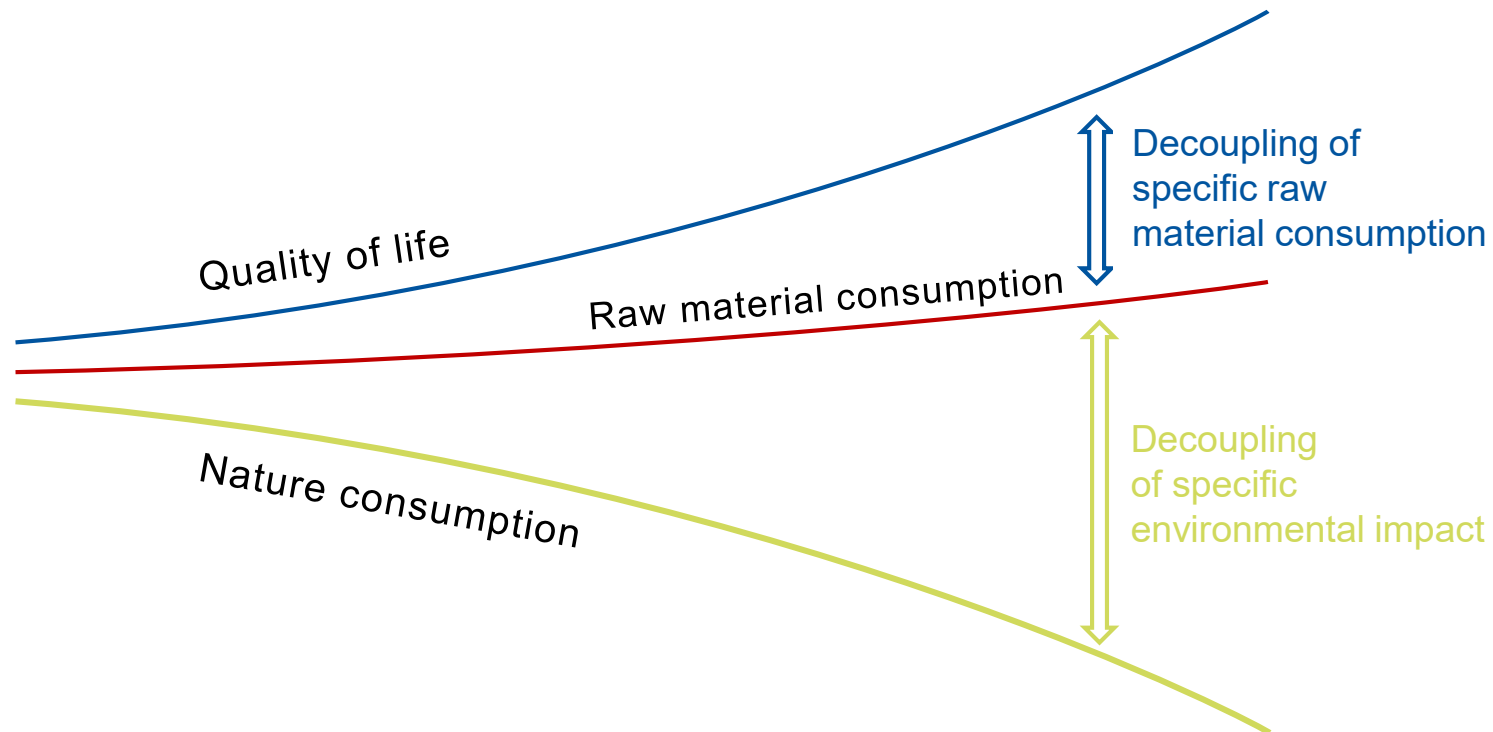
“The planetary boundaries framework defines a **safe operating space** for humanity based on the intrinsic biophysical processes that regulate the stability of the Earth System. [...] Two core boundaries—climate change and biosphere integrity—have been identified, each of which has the potential on its **own to drive the Earth System into a new state** should they be substantially and persistently transgressed.”

Steffen et al. 2015



# Sustainable Development

Twofold decoupling of resource consumption and quality of life/prosperity



## Efficiency

- ▶ less resources – same function

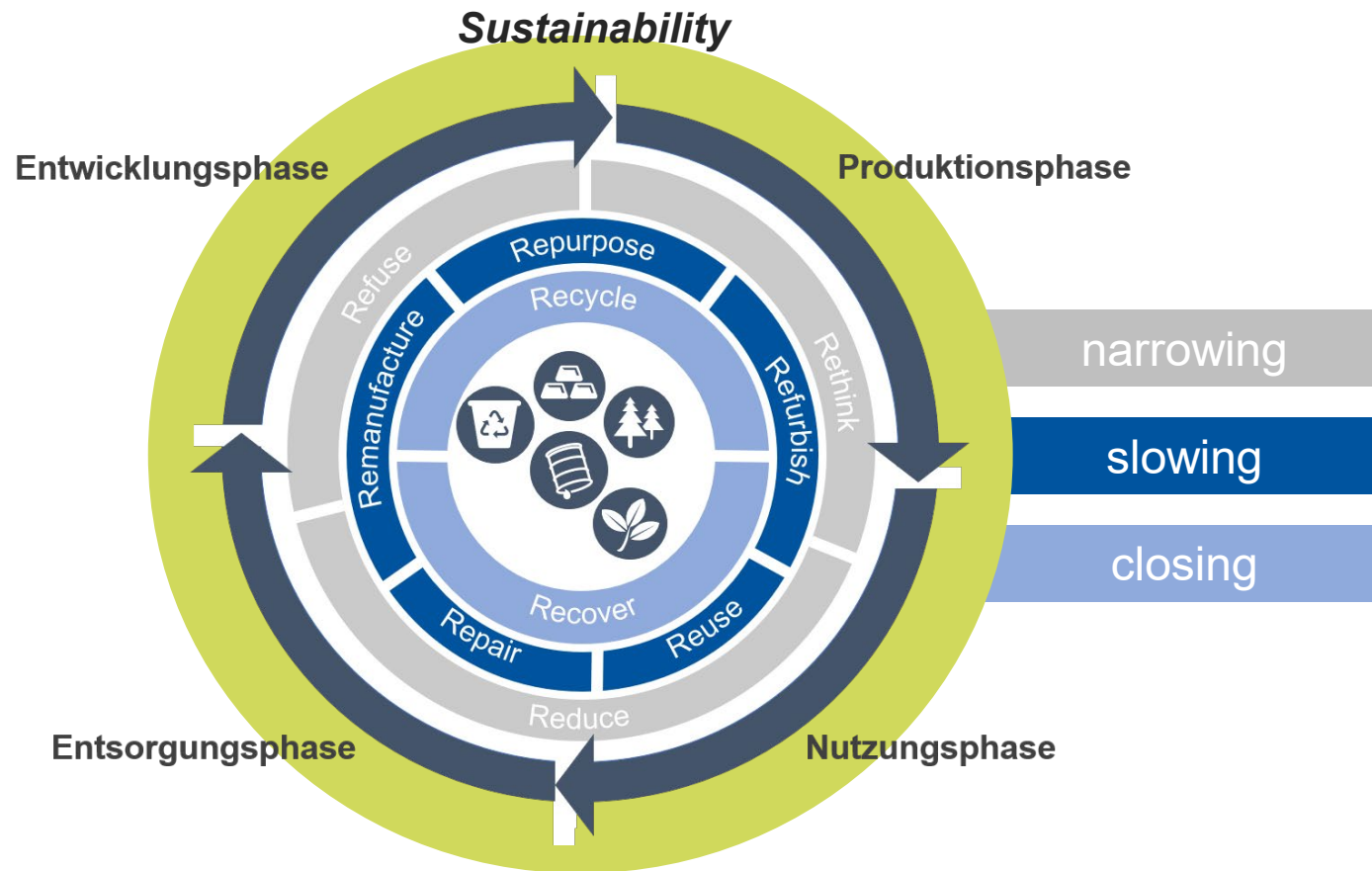
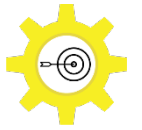
## Consistency

- ▶ Closing loops

## Sufficiency

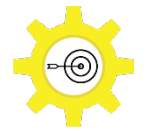
- ▶ Slower, less, better, finer

changed after Wuppertal Institute; Fischer-Kowalski et al./UNEP, IRP 2011: „impact decoupling“



*Circular Economy:*

*„(...)The value of products, materials and resources is **maintained** in the economy for **as long as possible**, and the generation of **waste is minimised** (...), to develop a **sustainable, slow carbon, resource efficient and competitive economy.**“  
(EC, 2015)*



# Circular Economy – Potential for Future Savings

*“Circular economy is an economic system that is regenerative by design. ... The linear economy is the prevailing model because simply the world is just not in tune or necessarily aware of the circular model and it’s economic and societal benefits.”*

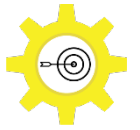
Attila Turos, World Economic Forum



Source: Circular Economy Initiative Deutschland (Hrsg.): *Circular Economy Roadmap für Deutschland*. 2021



# Circular Economy – Circular Potential for CO<sub>2</sub> Emissions Reduction



Up to 56% CO<sub>2</sub> emissions reduction thanks to Circular Economy practices:

## Material Recirculation

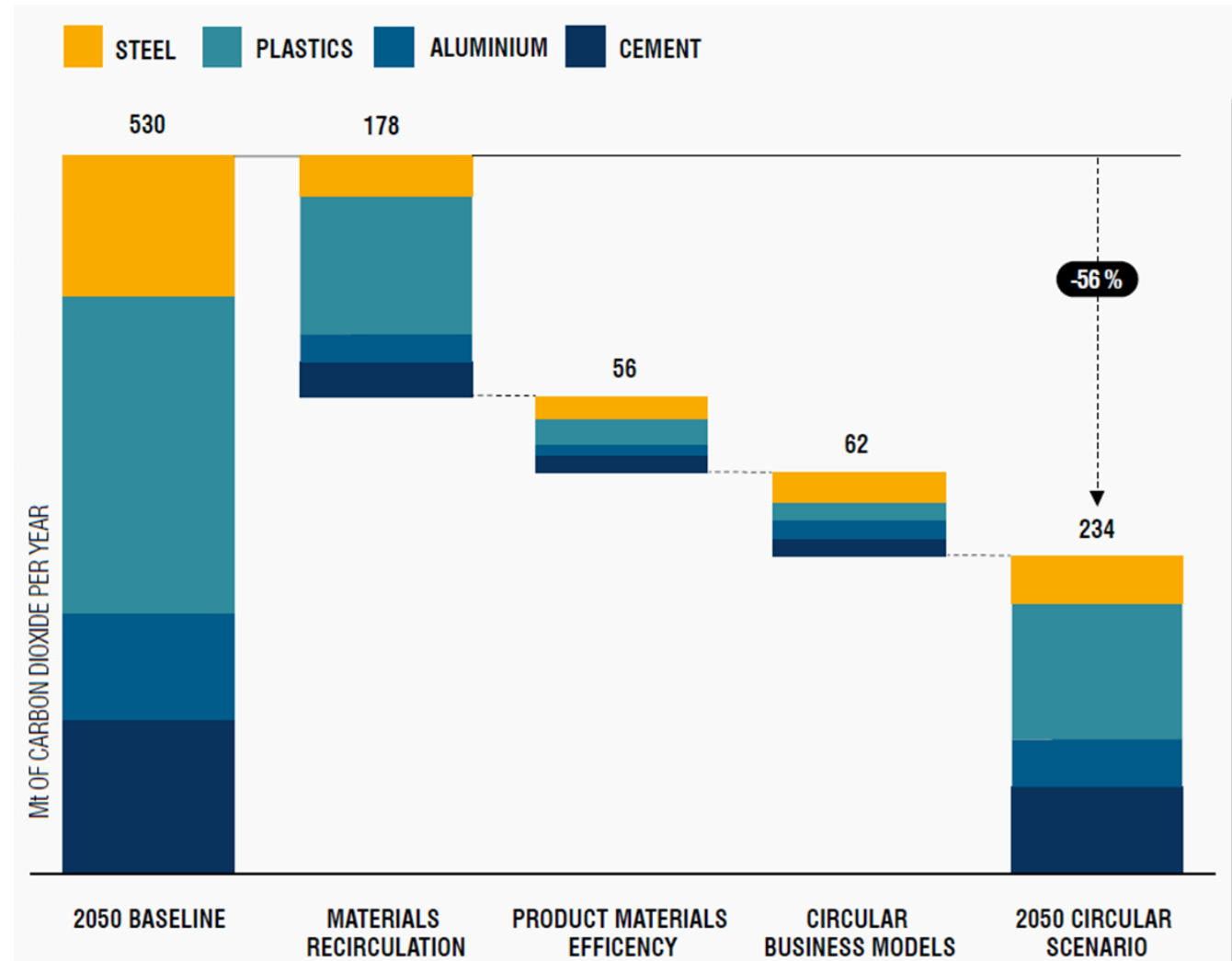
→ High value collection and recycling

## Product material efficiency

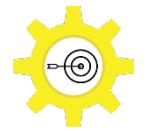
→ Less material required per product

## Circular Business Models

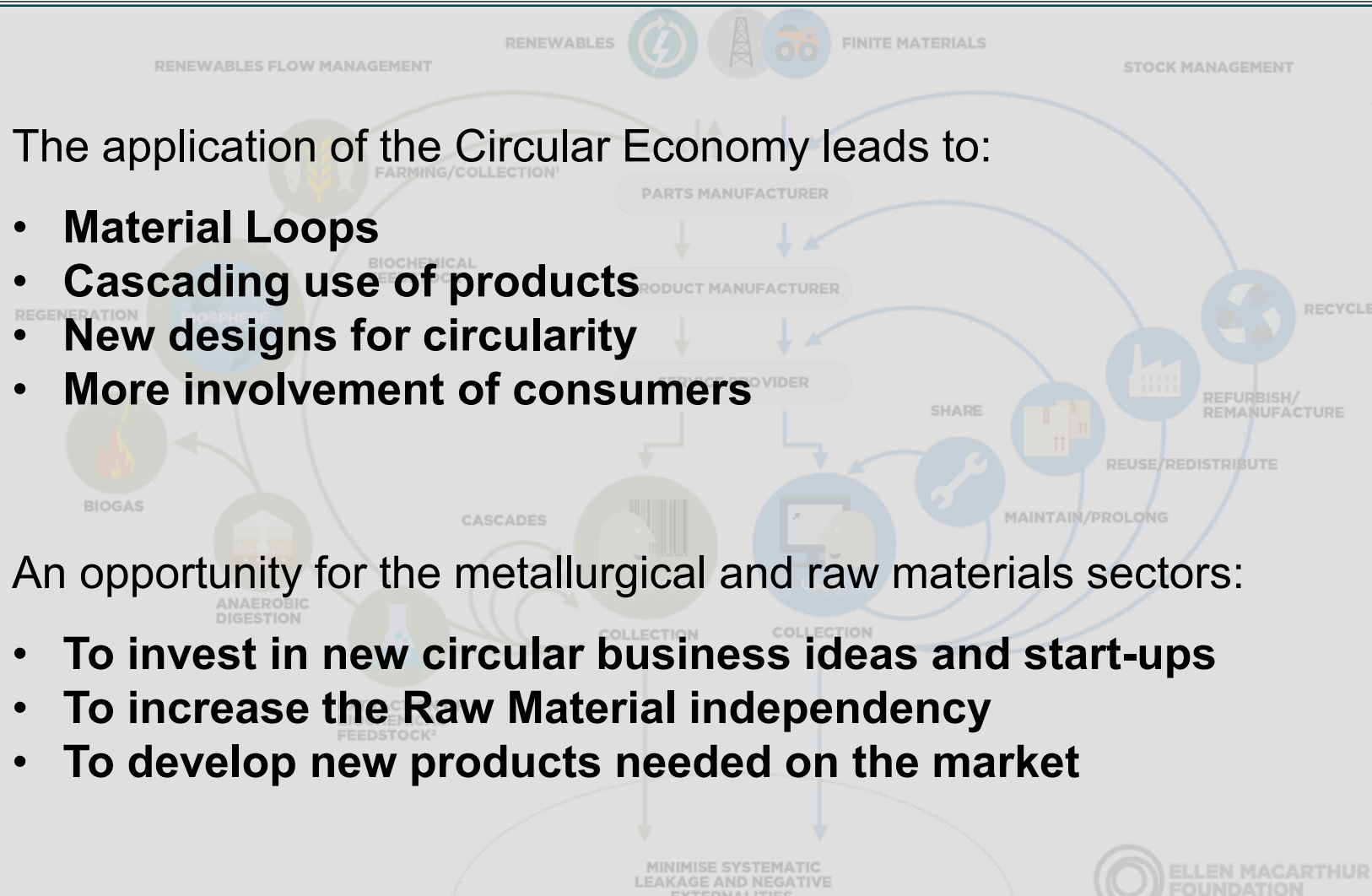
→ Achieving similar service with less products



Source: *The Circular Economy – a powerful force for climate mitigation*. Material Economics, 2018



# Circular Economy – The Butterfly



The application of the Circular Economy leads to:

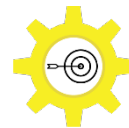
- **Material Loops**
- **Cascading use of products**
- **New designs for circularity**
- **More involvement of consumers**

An opportunity for the metallurgical and raw materials sectors:

- **To invest in new circular business ideas and start-ups**
- **To increase the Raw Material independency**
- **To develop new products needed on the market**

Source: Circular Economy Systems Diagram. Elen MacArthur Foundation. 2019

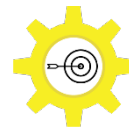




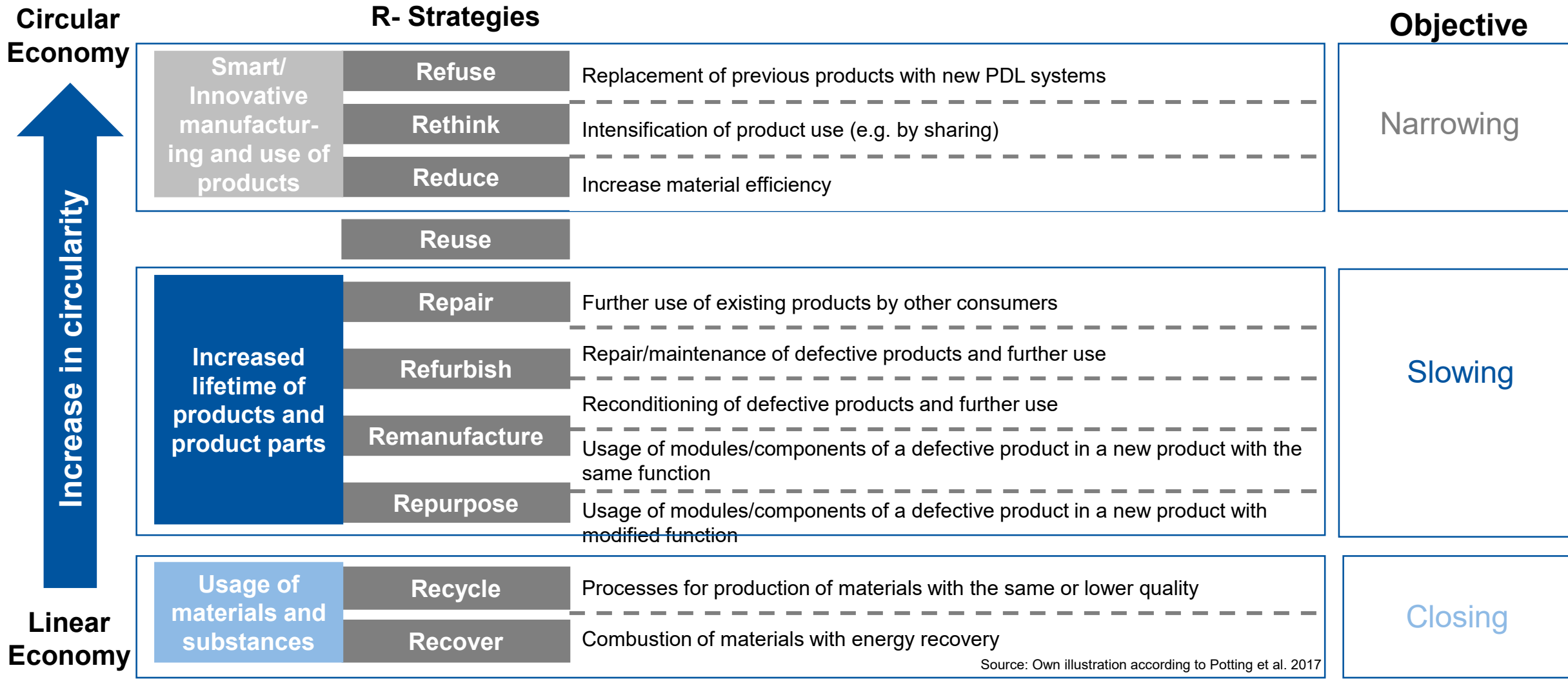
# Circular Economy – The Basis of a Sustainable Future



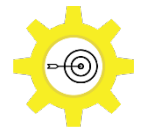
- ▶ Circular Economy is now replacing and operationalizing the previous **sustainability strategies**
- ▶ CE is highly topical and promoted by politics. The European Union and Germany's government understands **CE as a priority** for the next decade
- ▶ CE is strongly **linked to society** because of its impact on the everyday lives of the citizens
- ▶ CE requires the **collaboration** of ALL different research areas



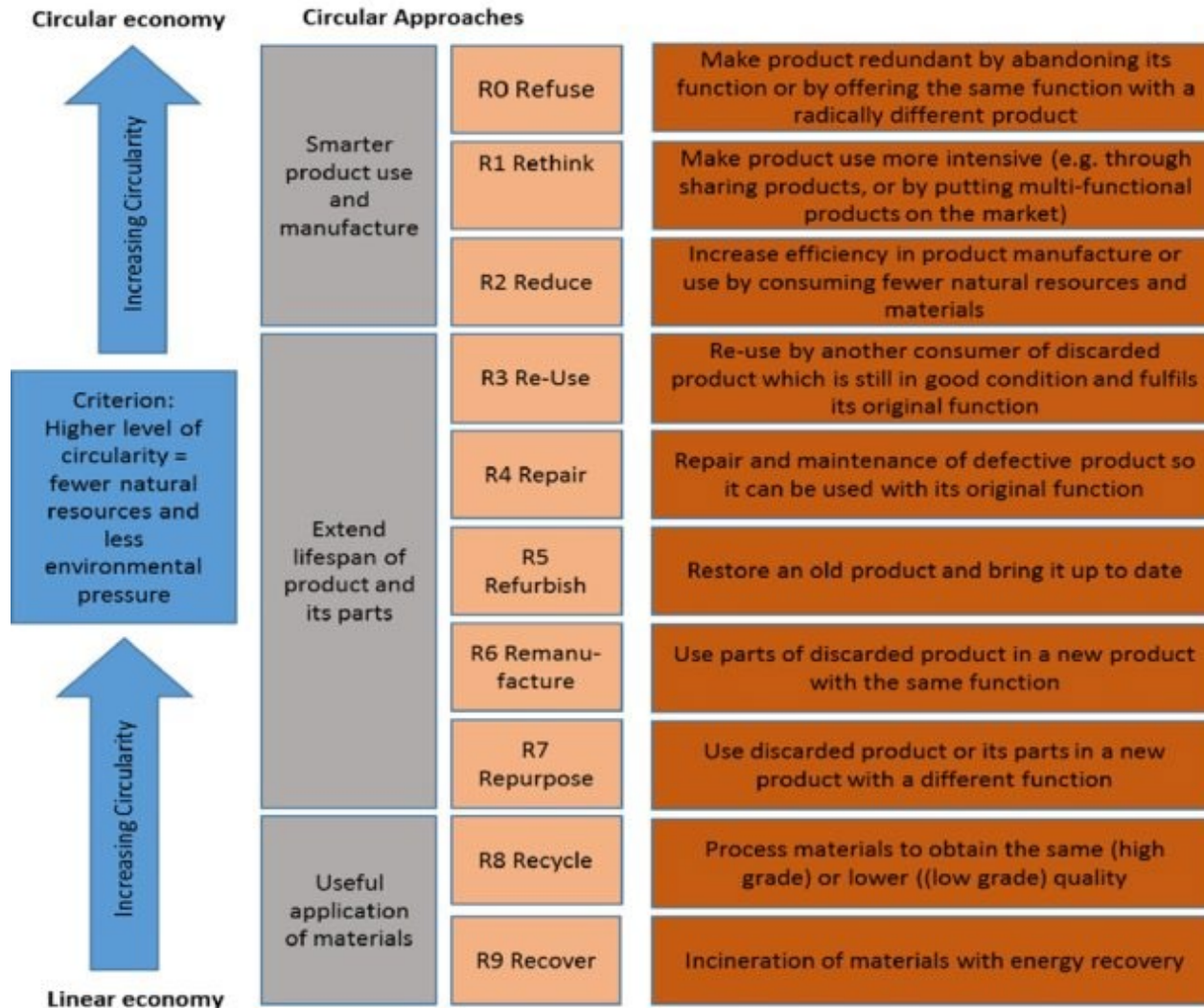
# Circular Economy – The 9R Framework



Source: Own illustration according to Potting et al. 2017



# Circular Economy – The 9R Framework



Circular Economy concepts go beyond the recycling economy – an ideal “playground” for metal containing products:

- **Keep metals, materials and products (longer) in use**
- **Produce more robust and versatile alloys**
- **Design products for cascading uses**
- **Create second use and product sharing business**

Source: *Digitisation and the Circular Economy: a Review of Current Research and Future Trends*. O. Okorie et al. In *Energies*, 2018.



# Circular Economy Use-Cases: E-Car Recycling

## DOWNGRADING AND COPPER MIXING OF STEEL

### ONLY 8% OF STEEL RECYCLED FROM VEHICLES CAN BE USED AS MATERIALS FOR NEW CARS

- *Shredding of vehicles mixes copper with steel which is a serious long term contaminant of the steel stock*
- *Alloys are not separated, leading to lost values of alloy metals, waste of critical materials, and downcycling of steel*

## DOWNGRADING OF ALUMINIUM

### MIXING OF ALUMINIUM ALLOYS RESULTS IN DOWNGRADING OF WROUGHT ALUMINIUM AUTO PARTS

- *Cars make up >40% of cast aluminium demand, a key 'sink' for aluminium recycling*
- *Aluminium used in cars is downgraded when mixed with cast aluminium, precluding other uses*

## PREVENTION OF PLASTICS RECYCLING

### HIGH-VALUE RECYCLING IS NOT FEASIBLE FOR A LARGE SHARE OF VEHICLE PLASTICS VOLUMES

- *Current practices leaves plastics in a mixed fraction that often is landfilled / incinerated*
- *Material substitution for lightweighting leads to fibre reinforced plastics that contaminate other plastics flows and that is difficult to recycle*

## LIMITED RECYCLING OF RARE CRITICAL METALS

### END-OF-LIFE VEHICLES LEAD TO LARGE LOSSES OF CRITICAL METALS

- *Rare critical metals can make up 1% of total vehicle materials*
- *Only eight out of 25 scarce metals are recycled, with the remainder lost to carrier metals, construction and backfilling materials and landfills*

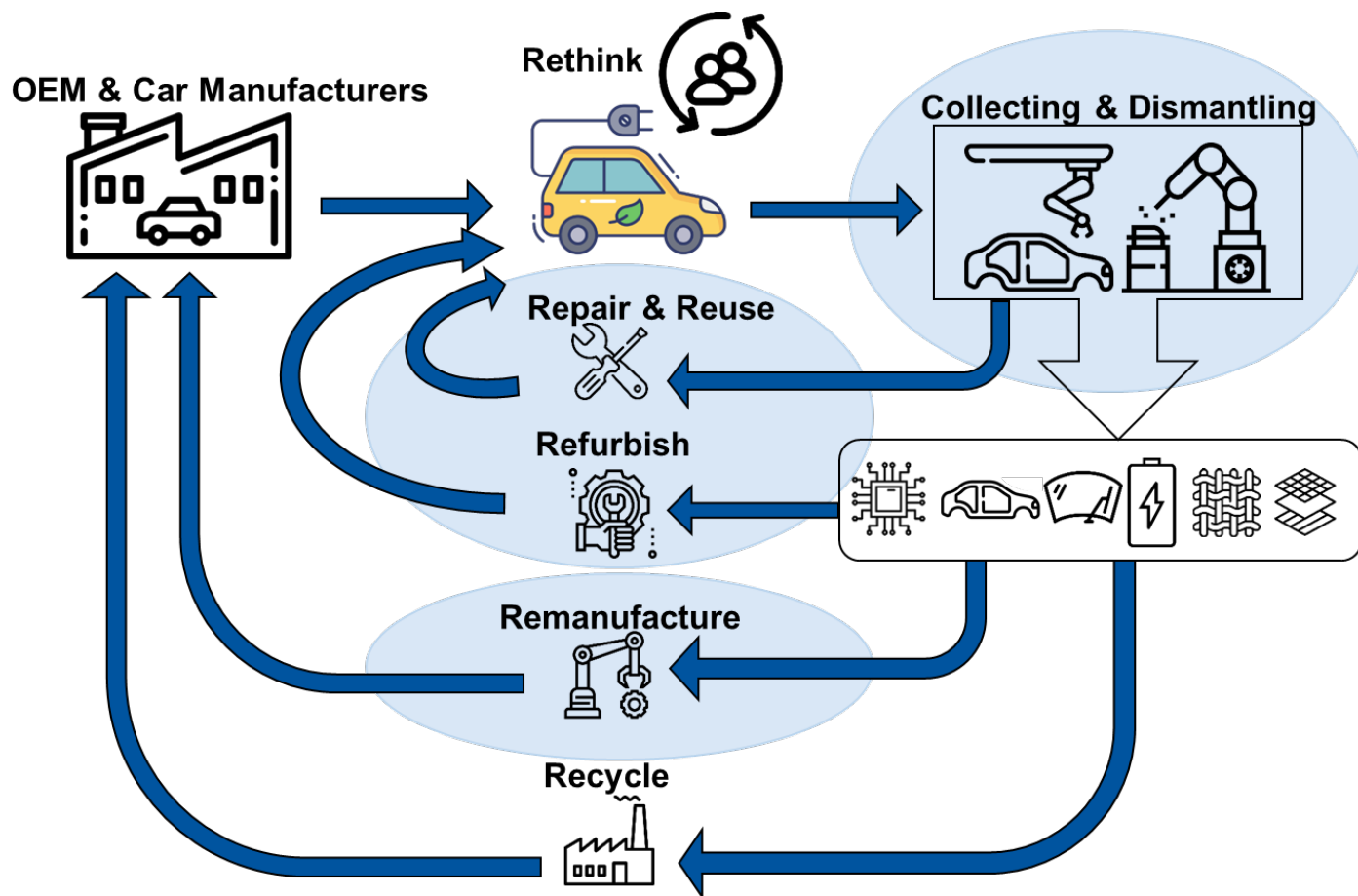


Source: *The Circular Economy – a powerful force for climate mitigation*. Material Economics, 2018





# Circular Economy Use-Cases: E-Car Recycling

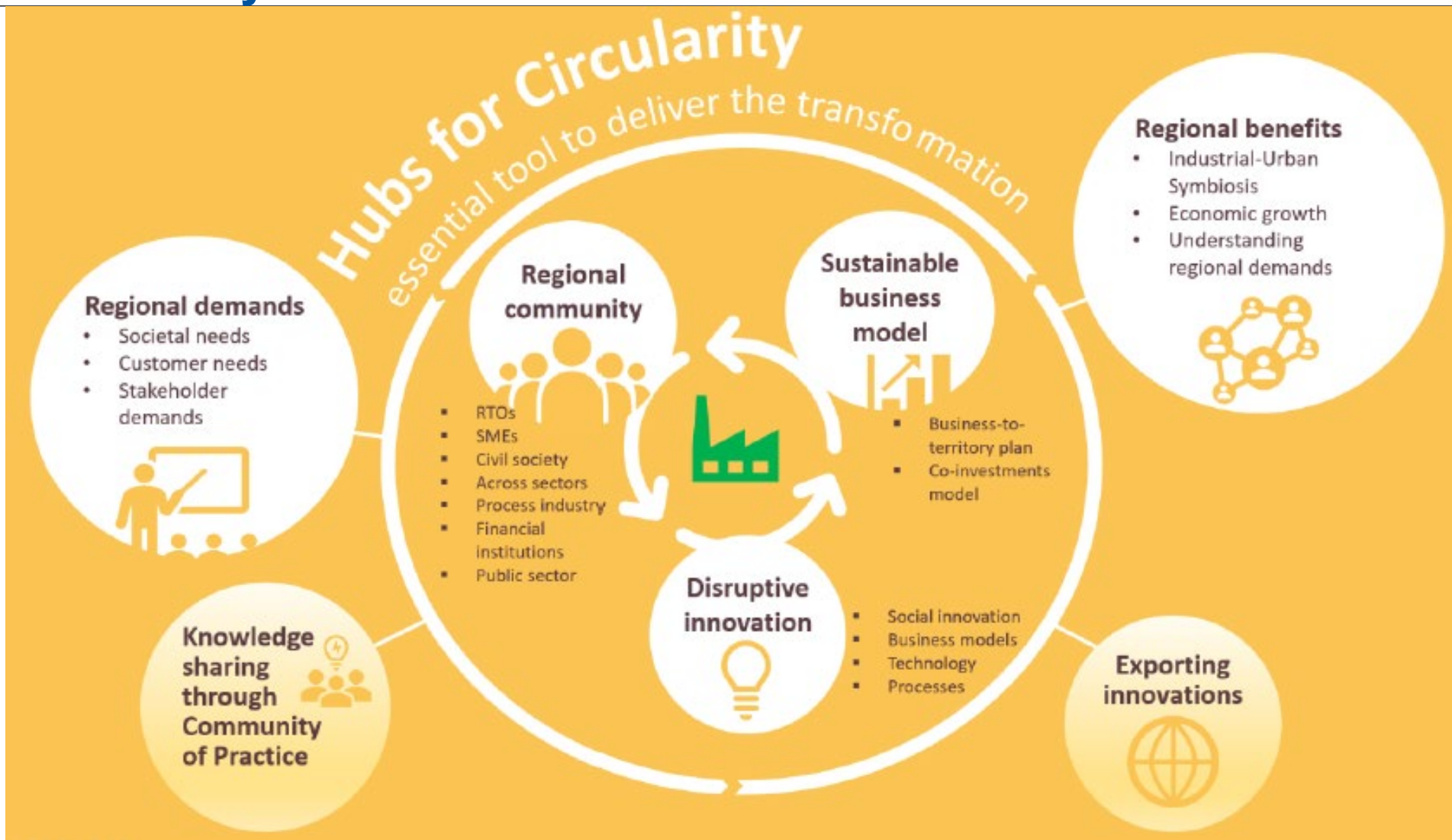


A Circular E-Car concept, from users to recyclers:

- **New Ownership and Sharing concept**
- **Developing the refurbished car market**
- **Increasing efficiency of collection, dismantling and sorting**
- **Remanufacturing of parts and modules**
- **Recycling as last solution against material loss**

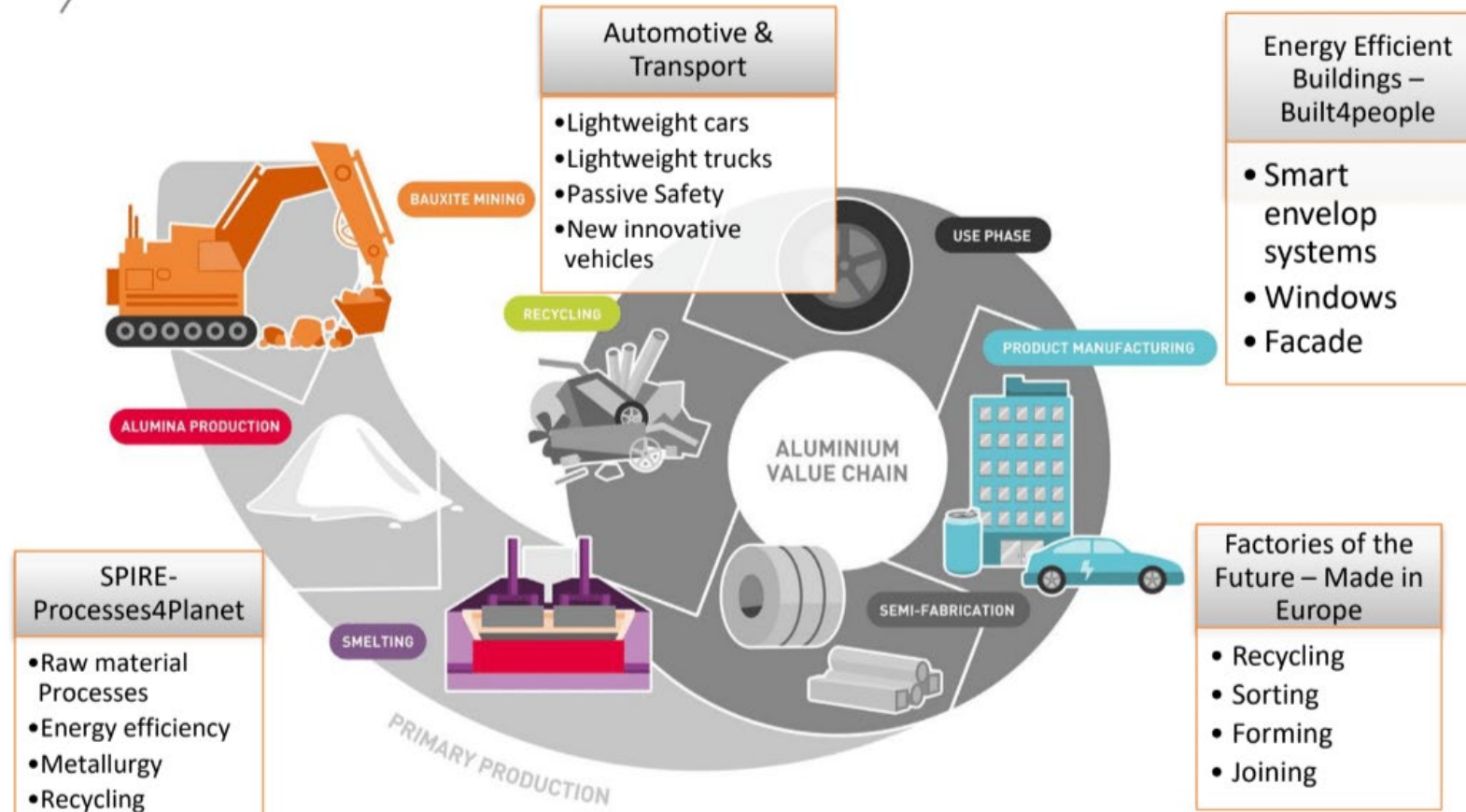


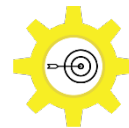
# Hubs for Circularity





## Engagement in key innovation platforms & markets



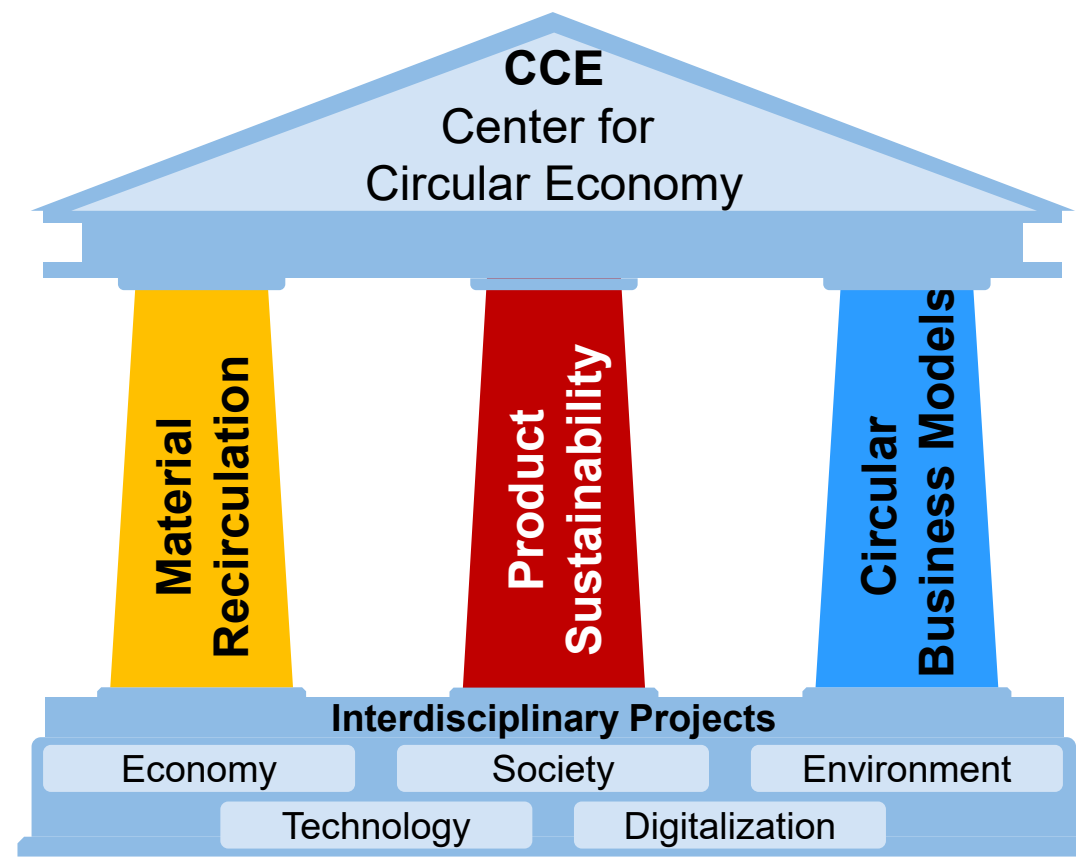


# The Vision

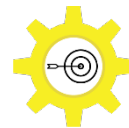
A multidisciplinary and interconnected approach to **Circular Economy** combining expertise from **ALL** faculties at **RWTH Aachen University**



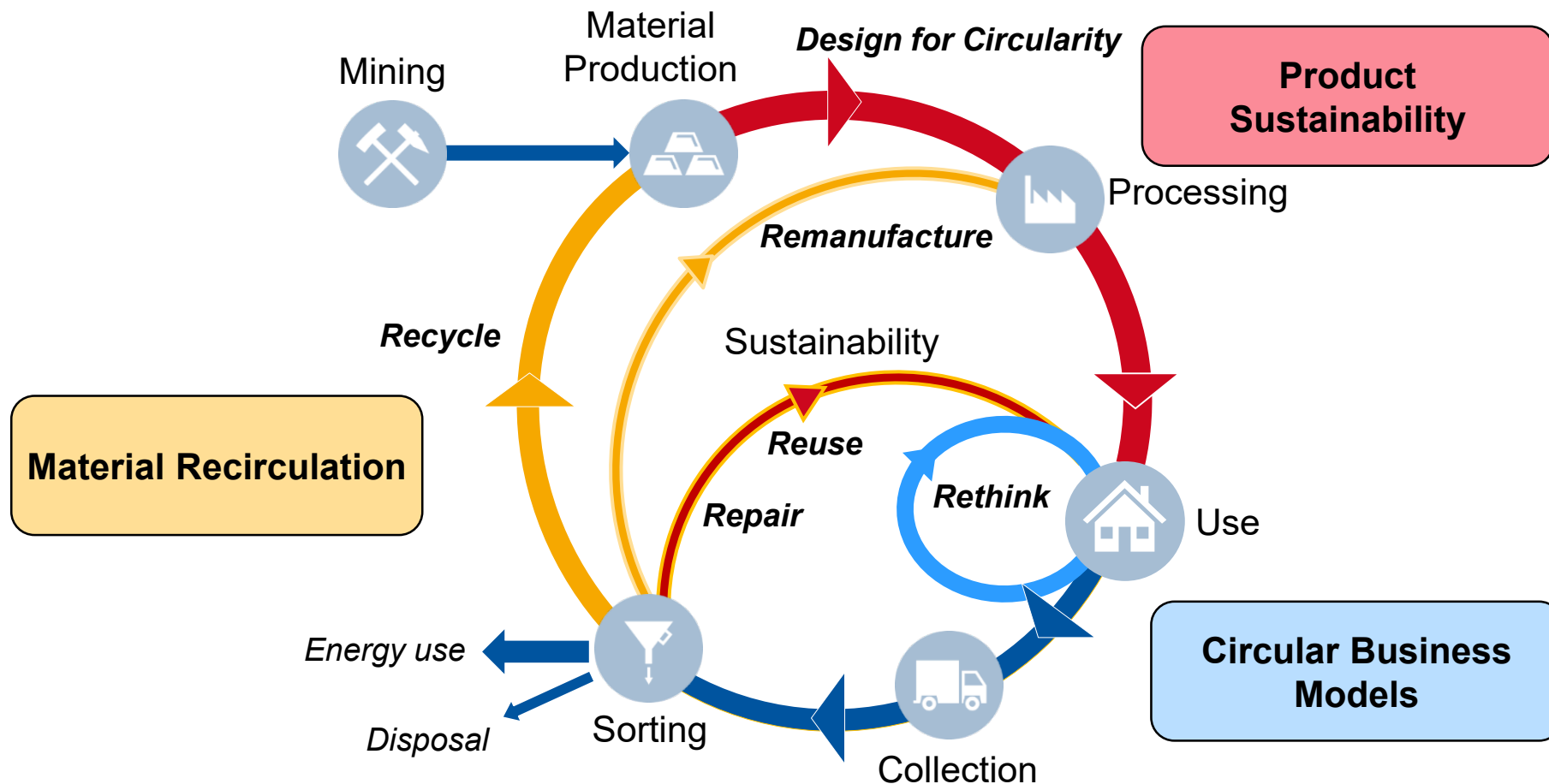
The RWTH Aachen Center for Circular Economy (CCE) is an enabler for a transformation of research, teaching and finally society, acting as a lighthouse for internal and external partners.







# The Aspects Circular Economy





# Network & Community – Faculties of RWTH Aachen (27 partners)





## **An Education Institute**

Master Program – Workshops – Seminars – Trainings



## **An Inter- and Transdisciplinary Research and Innovation Center**

Circular Economy-Related Projects



## **A Network and Mesh**

University – City – Regional – National – European – International



## **An Awareness Demonstrator**

Students – Citizens – Politicians – Stakeholders



## **An Unit for Transfer**

Accelerator – Incubator – Ideas – Startups – Spinoffs

## A Short Summary

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A Circular Economy Scenario in Europe could lead to:

- **Climate mitigation and raw materials independency**
- **New business opportunities for existing companies**
- **A need for new products, alloys and services**



**The RWTH Aachen tackles these challenges through a transdisciplinary approach at the Center for Circular Economy!**





**Thank you for your attention!**

**Dr.-Ing. Mohammad Chehadé**  
**Manager des Centers for Circular Economy**  
Chehade@cce.rwth-aachen.de



# Expert Hubs at the Collective Incubator

*(Launch in November)*

## Expert Hub #1: Digitized Hardware

### BASES

- Information & Communication Technologies
- 21st Century Production
- Future of Mobility & Urban Life
- Advanced & Sustainable Textiles

## Expert Hub #2: Resources

### BASES

- Energy
- Chemicals
- Raw Materials
- Design & Construction

## Expert Hub #3: Life Science

### BASES

- Medical Devices & Diagnostics
- (Bio-)Pharma & Drug Delivery
- Digital Health Technologies
- Tools, Services & Solutions

## Expert Hub #4: digitalStartups

by RWTH &  
digitalHUB Aachen

## Expert Hub #5: Circular Economy

### BASES

- Material Recirculation
- Product Sustainability
- Circular Business Models

| Expert Hubs  | Digitized Hardware  | Resources  | Life Science   | digitalStartups (digiHUB)           | Circular Economy  |
|--------------|---|--|--|-------------------------------------|---|
| Expert Bases | <b>Information and Communication Technologies</b><br>Prof. Max Lemme, Prof. Rainer Leupers, Prof. Gemmeke | <b>Energy</b><br>Prof. Dirk Uwe Sauer                      | <b>Medical Devices &amp; Diagnostics</b><br>Prof. Ulrich Steinseifer | <b>Powered by digitalHUB Aachen</b> | <b>Sustainable Product Design (Production)</b><br>Prof. Eckstein      |
|              | <b>21st Century Production</b><br>Prof. Johannes Schleifenbaum  | <b>Raw Materials</b><br>Prof. Elisabeth Clausen            | <b>(Bio-)Pharma &amp; Drug Delivery</b><br>Prof. Rene Tolba          |                                     | <b>Sustainable Business Model Development (Use)</b><br>Prof. Letmathe |
|              | <b>Future of Mobility &amp; Urban Life</b><br>Prof. Lutz Eckstein   | <b>Chemicals</b><br>Prof. Matthias Wessling                | <b>Digital Health Technologies</b><br>Prof. Michael Czaplik          |                                     | <b>Material Recovery and Recycling (Re-Use)</b><br>Prof. Greiff       |
|              | <b>Advanced &amp; Sustainable Textiles</b><br>Prof. Thomas Gries  | <b>Design &amp; Construction</b><br>Prof. Kai-Uwe Schröder | <b>Tools, Services &amp; Solutions</b><br>Prof. Rene Tolba           |                                     |   |





## CCE first „political“ publication



Recycling allein macht noch keinen Kreislauf. Die Transformation linearer Strukturen hin zu Circular Economy benötigt mehr als den umweltbewussten Umgang mit Abfällen. Es braucht ein Umdenken der gesamten Wertschöpfung und unserer Gesellschaft.

Das Ziel einer Kreislaufwirtschaft oder „Circular Economy“ (CE) ist die langfristige Wertschöpfung von Gütern und die nachhaltige Nutzung von Ressourcen. Der Wert eines Materials fließt auf mehreren Ebenen, berücksichtigt Form von Abfall wird zunehmend ein Luxus. Die Europäische Union strebt selber eine Kreislaufwirtschaft an, die Materialkreisläufe auf mehreren Ebenen berücksichtigt.



Eine Talk-Runde mit Prof. Bernd Friedrich (IME und Circular Economy Center Aachen, RWTH Aachen University), Dr. Ansgar Fendel (REMONDIS Assets & Services GmbH & Co. KG), Dr. Adalbert Lossin (Aurubis), Dr. Andreas Lützerath (TRIMET Aluminium SE) und Dr. Reiner Sojka (Accurec Recycling GmbH) zu Wertstoffkreisläufen in der e-Mobilität und deren wirtschaftliches Potential in Europa.

Prof. Friedrich Kreislaufwirtschaft – auch im Kontext der Elektromobilität ist – sehr aktuell und in aller Munde. Zu Gast haben wir Dr. Fendel, Geschäftsführer der Remondis GmbH – für die ganzen Fragen der Logistik,

## Das Rohstoffpotenzial von Smartphones nutzen

Smartphones sind Träger zahlreicher Rohstoffe, allen voran (kritischer) Metalle. Wie man diese zurückgewinnen kann und wo Defizite in etablierten Recyclingprozessen bestehen, untersuchen Institute der RWTH Aachen University in der Sensibilisierungskampagne „100 Smartphones“.

Durchschnittlich alle 18 bis 24 Monate tauschen wir unser Smartphone gegen ein neueres Modell (Bohnen et al. 2018). Das alte Gerät landet demnächst in der Schublade, statt fachgerecht entsorgt zu werden. So werden dem Recycling bis zu 60 verschiedene Rohstoffe vorenthalten – darunter über 20 Metalle. Zu diesen Metallen gehören neben den bekannten Basismetallen Kupfer, Aluminium und Eisen auch Edelmetalle und kritische Metalle wie Indium, Gallium und Germanium. (Birich et al. 2016)

Die Fakultät für Georesourcen und Materialtechnik (Fakultät für Georesourcen und Materialtechnik) der RWTH Aachen University (RWTH Aachen University) und dem Institut für Metallurgische Prozesstechnik und Metallrecycling (IME) beforscht im Rahmen der Kampagne die Prozesskette zur hydrometallurgischen Rückgewinnung von Basis-, Edel- und kritischen Metallen aus Smartphone-Leiterplatten. Insgesamt werden drei wesentliche Prozessabschnitte untersucht und aufeinander abgestimmt: Die Demontage, die thermische Vorbehandlung sowie die hydrometallurgische bzw. nass-chemische Metallrückgewinnung. Die entwickelte Prozessroute soll als alternativer Ansatz zum etablierten pyrometallurgischen Recyclingprozess dienen, da in diesem nur alle Metalle als Krümel- und Erzfractions



# Circular Cities Declaration



[Summary Video here](#)

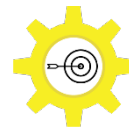
The event was planned by the city of Aachen and the CCE. It took place on the 27<sup>th</sup> of October 2021 in which the mayor signed the circular cities declaration. The event, city and center were mentioned in the [Aachener Nachrichten](#) as well.





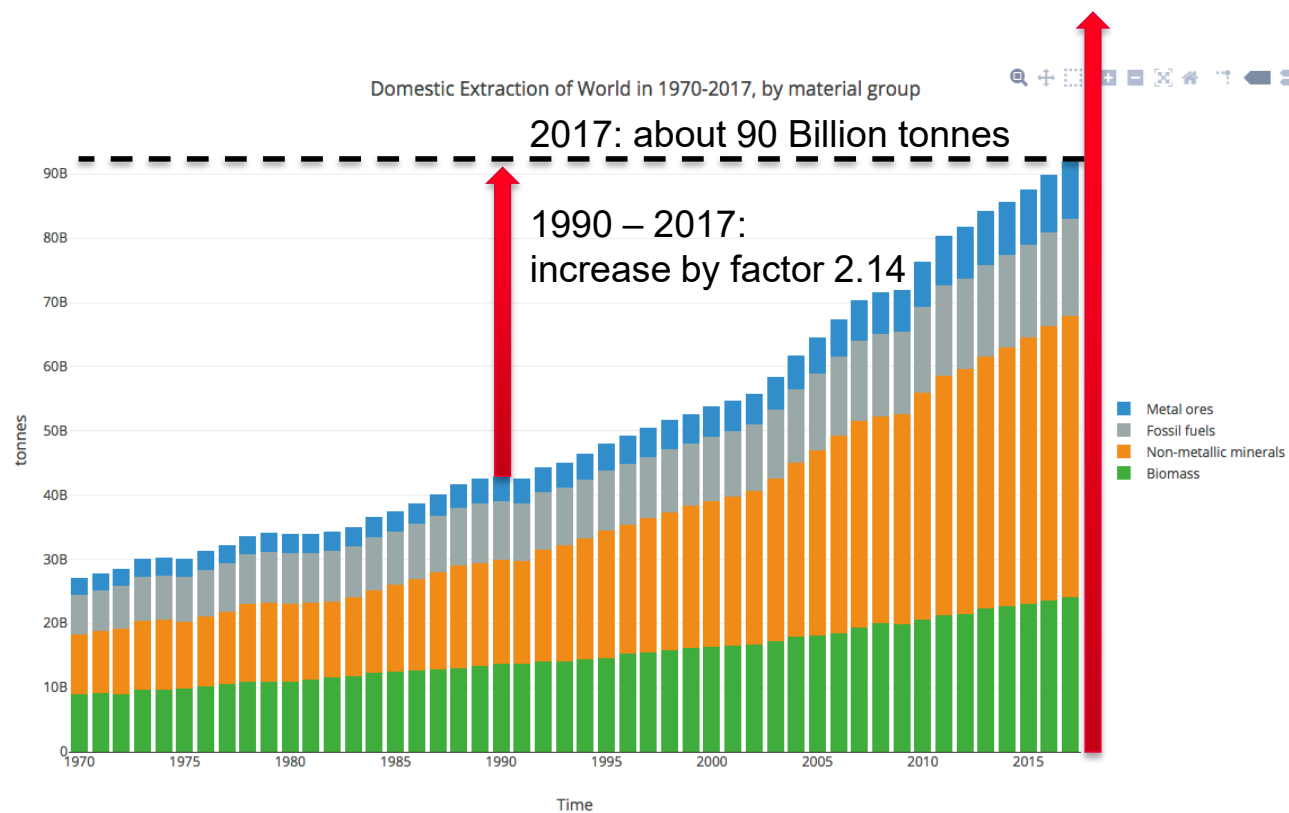


# ÖECHER LAB



# Global Domestic Extraction

|   |                           |
|---|---------------------------|
| Metals (Fe, Al, Cu etc.)                              | 4.8 Gt CO <sub>2</sub> eq |
| non-metallic minerals<br>(Cement, lime, plaster etc.) | 4.4 Gt CO <sub>2</sub> eq |
| Plastics  | 1.5 Gt CO <sub>2</sub> eq |
| Wood production                                       | 0.9 Gt CO <sub>2</sub> eq |



International Resource Panel 2019

<http://www.materialflows.net/visualisation-centre/>