6 June 2025 | online webinar

#EU GREEN WEEK

Partner Event

Circular Economy Business Models and their Impact on Critical Raw Material Availability

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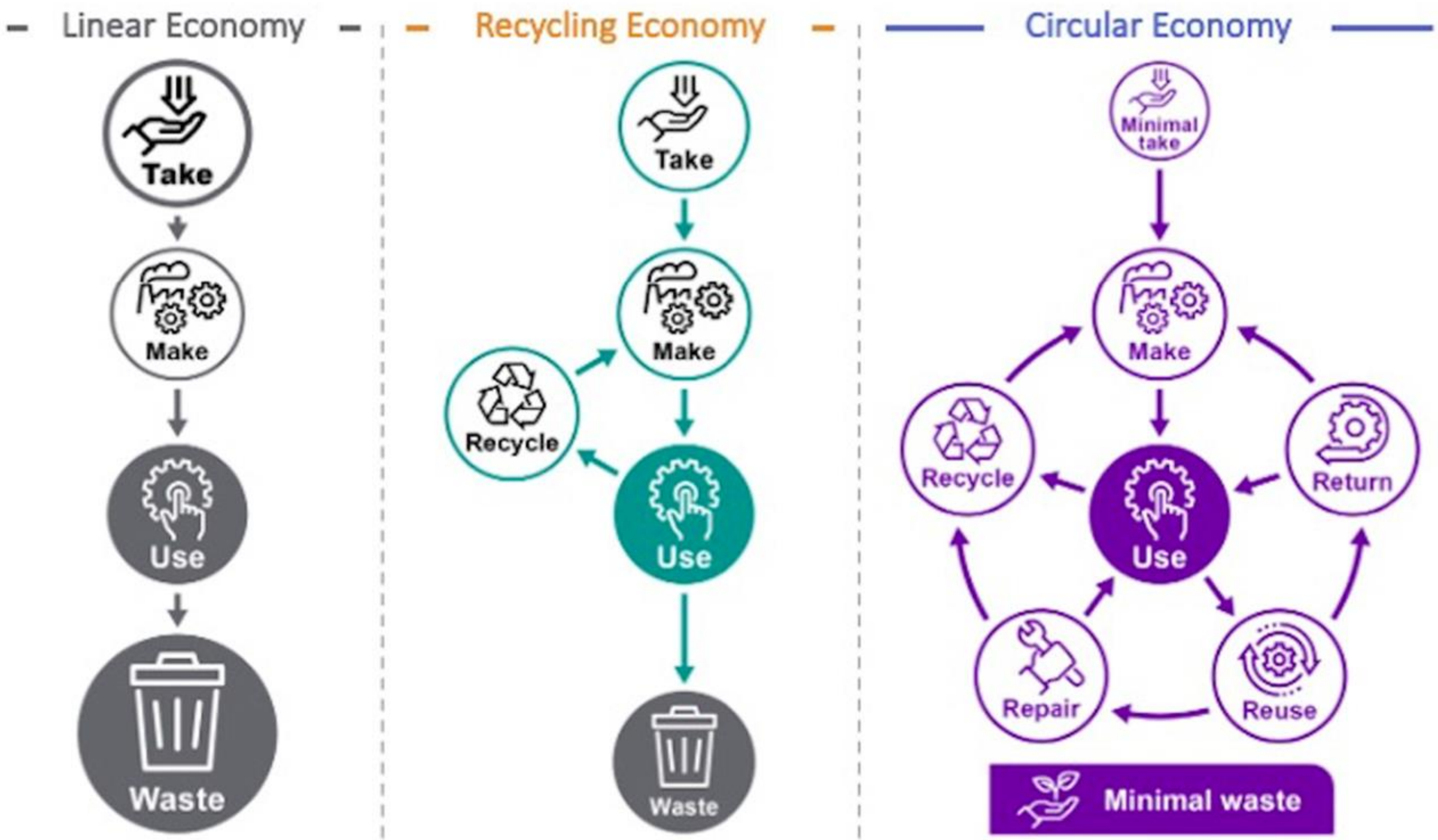
From Linear to Recycling to Circular Economy



5 Key Circular Economy Business Models

- **Sharing economy concept**
- **Circular inputs**
- **Product use extension**
- **Resource recovery**
- **Product as a service**

Source: The Circular Economy Handbook, https://doi.org/10.1057/978-1-349-95968-6

Sharing economy

- We use idle assets across a community (share assets).
- Access to an asset no longer requires buying or renting from traditional suppliers but is instead provided by individual people and companies.
- Leads to higher utilization percentage of expensive assets.
- Examples: car-sharing, sharing DIY tools, …, but also mobile recycling or production plants
  Fenix mobile plant

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Circular Inputs

- Renewable, recycled or highly recyclable inputs are used in production processes, maximizing elimination of waste and pollution.
- **Waste becomes an opportunity, not a liability!**
- Examples: TV-sets and Washing machines from Arcelik (C-SERVEES project)

- Increase recycled plastic content in TV and washing machine components
- Use novel formula to increase recycled PET content in the washing machines' tub to make it more durable
- Increase the durability of LED panel and mainboard in TV sets
- Use QR codes to provide information about materials and company's circularity to all value chain actors

https://www.youtube.com/watch?v=h4HiVGlG2kQ
https://www.youtube.com/watch?v=Hgdr8QqXEac
https://www.youtube.com/watch?v=yTYc2xdFelE

Product use extension

- Producers design their products for repairability, upgradability, reusability, ease of disassembly, reconditioning and recyclability of all components.
- In the linear economy, you sell your product to the next in line and the primary interest is in selling as many new products as possible. Whereas, circular companies design their business models so they have a continuing income stream throughout the product's usage cycles.
- Example: Printers from Lexmark (C-SERVEES project)

Product use extension @ Lexmark (C-SERVEES)

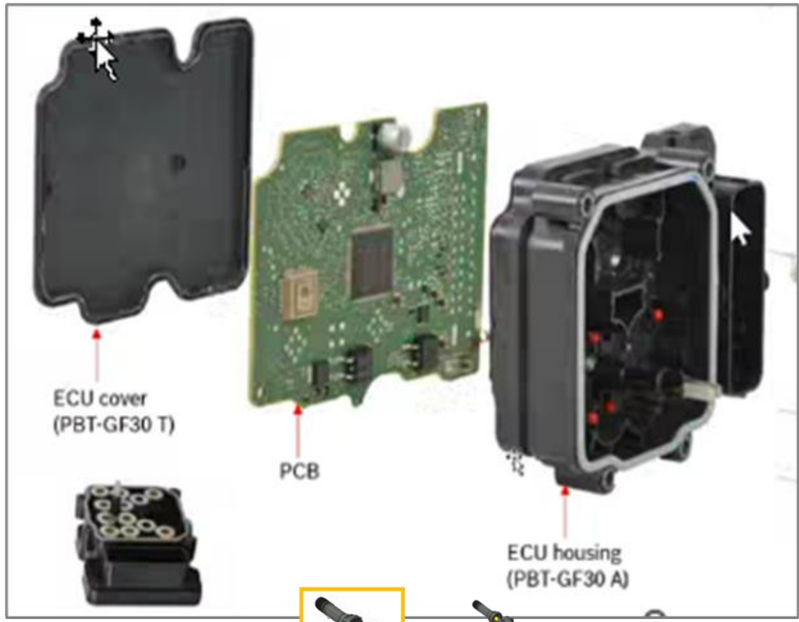
Printer products, incl. laser printers and toner cartridges

- Identify levers to reduce dismantling and refurbishing costs by setting various operating models
- Provide information about printers to LEXMARK refurbishment/remanufacturing partners
- Use ICT to support information sharing across the supply chain related to recycled content
- Devise an eco-design strategy for printers during dismantling activities
- Engage with key customers to understand their needs and requirements as it relates to refurbished products
- Promote refurbished printers
- Use QR code to inform customers about options to return their unused products to the manufacturer
- Maintain highest levels of data security by ensuring that customers' documents are erased from refurbished (E2N) printers

https://www.youtube.com/watch?v=IEo-r1P79ac

Examples from CIRC-UITS

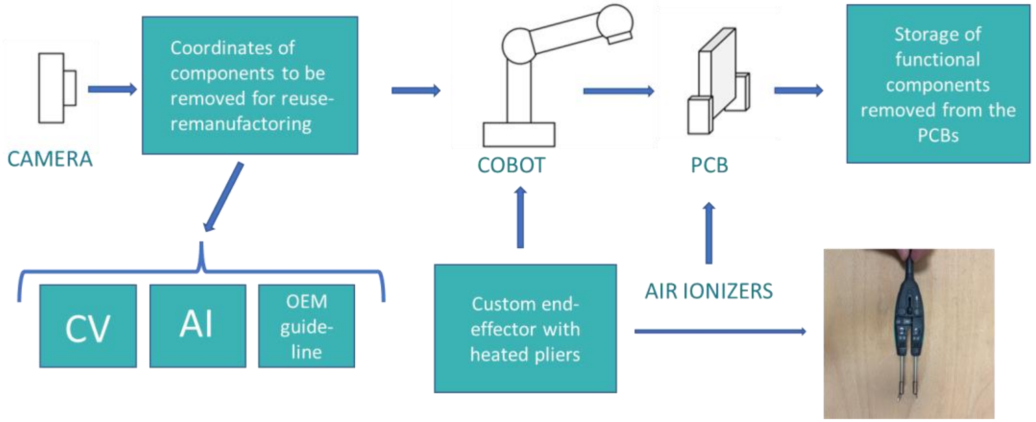
- ## Electric Control Unit (BOSCH)
- Reduce the effort to repair/reman a returned part from the field
- Re-design products to ease the recycle/reuse of electronic parts
- Full/partial adoption of recycled material in new products
- Extend product lifetime and fulfil governmental requirements to provide used parts
- Reduce the CO_2 footprint & energy consumption of products
- Ease access and disassemblability of electronic parts
- Ease sorting and separation of components/embedded materials
- Comparison between original layout vs green ECU (improved circularity/sustainability)

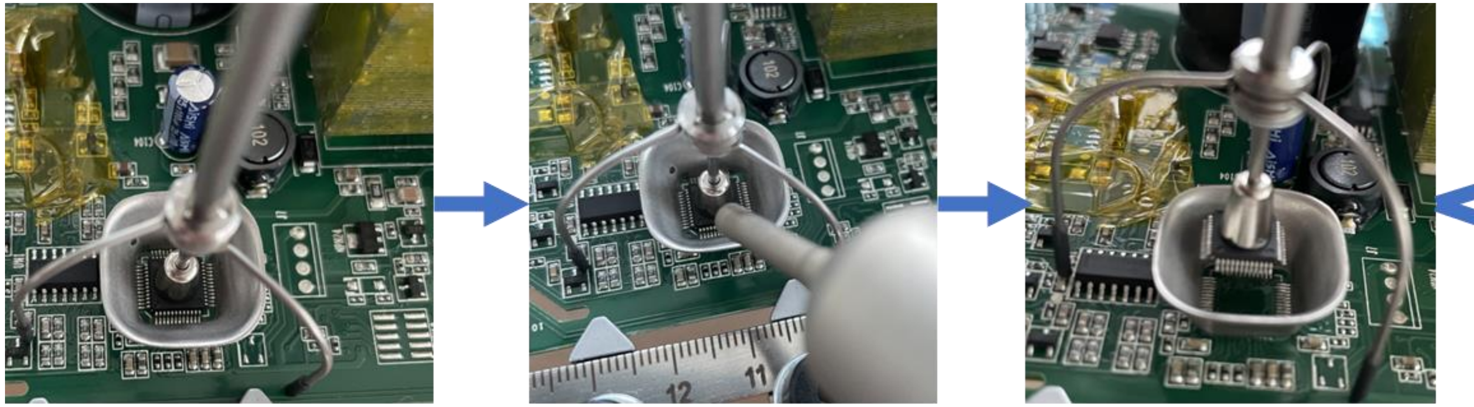


- ## Tire Pressure Measurement (Continental)
- Extend product lifetime and fulfil governmental requirements to provide used parts to the market
- Assess alternative eco-design procedures
- Reduce the CO_2 footprint & energy consumption of products
- Ease access and disassemblability of electronic parts
- Ease sorting and separation of components/embedded materials

Examples from CIRC-UITS

- **In-Mould Electronics (TNO/Tracxon)**
  - Integrate PCB functionalities into sustainable IME
  - Design for fault detection, device disassembly and repair
  - Demonstrate IME repairability
  - Develop automated repair procedures during production
  - Reduce the environmental impact of IME products
- **Semi-automated PCB disassembly (POLIMI)**



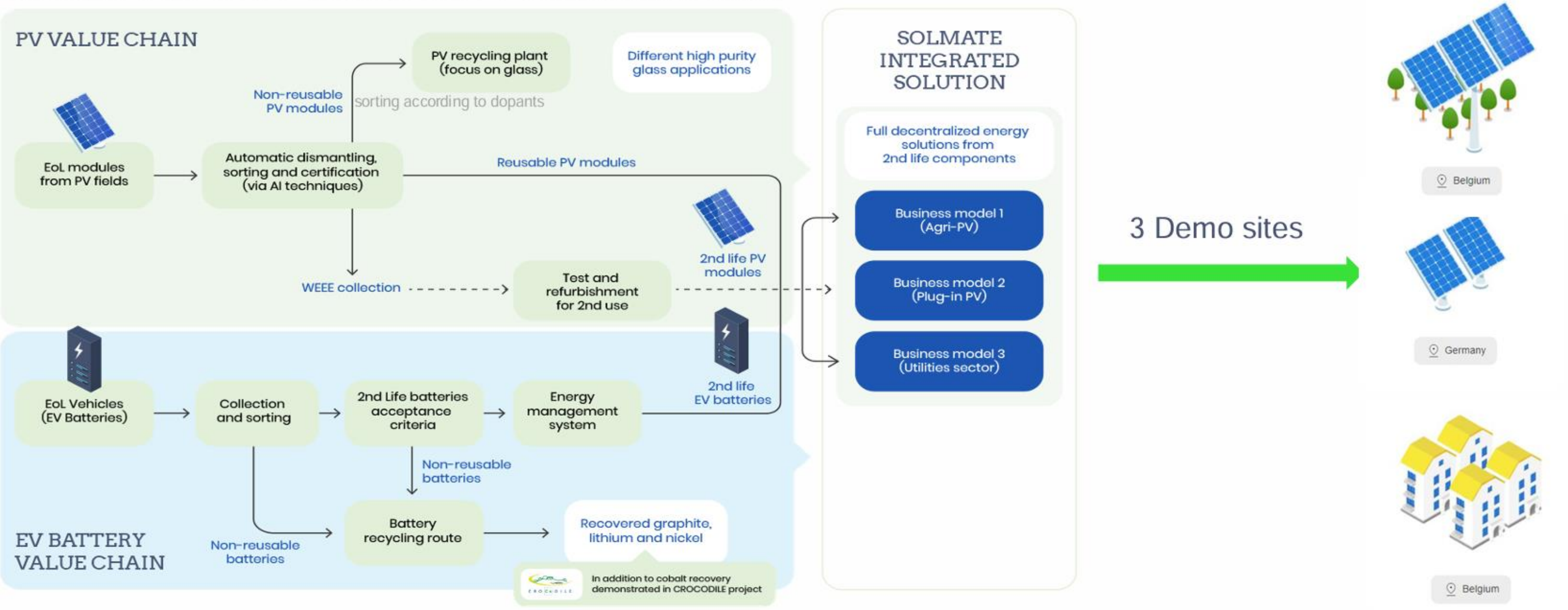


SOLMATE

Reuse of **SOL**ar PV Panels and EV Batteries for low cost decentralised energy solutions and effective Recycling of critical raw **MATE**rials from their EoL products

CONCEPT

Develop and demonstrate viable and guaranteed low-cost **decentralised energy systems for different emerging markets** based on the **reuse of batteries from End-of-Life (EoL) EV and used PV solar panels** (i.e., repowering from PV farms), including technologies that **improve the purity and increasing the recovery of (critical) raw materials** from EoL EV batteries and PV that cannot be reuse.



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Resource recovery

- Resource recovery focuses on the end stages of the usage cycle, namely the recovery of embedded materials, energy and resources from products at the end of use that is no longer functional in their current application.
- The circular company has a direct economic interest in the extraction of all their products´ recoverable value. Their design focuses on making value recovery easy and effective. Their business model ensures that users are incentivized to return the products for example contractually, through deposits or in the product-as-a-service model.

(Mobile) plants for the recovery of

- **Precious metals** from PCBs - Printed Circuit Boards (PEACOC , FENIX and HydroWEEE Demo)
- **Critical raw materials**:
  - **Cobalt** from Li-Ion batteries (CROCODILE)
  - **Platinum Group Metals** from automotive catalysts (Pt, Pd, Rh), PV modules (Ag) and low/medium grade PCBs (Au, Pd, Ag) (PEACOC)
  - **Neodymium** from permanent magnets (SICAPERMA)
  - **Rare earth metals** from CRTs and fluorescent lamps as well as **Indium** from LCDs (HydroWEEE Demo)

HydroWEEE Demo (stationary)

Industrial plant for the recovery of critical and precious metals

HydroWEEE Demo (mobile)

CROCODILE (mobile)

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PEACOC (GDEx unit)

Product as a service (pay-per-use)

- The customer purchases a service for a limited time while the provider maintains ownership of the product and remains incentivized for the product's ongoing maintenance, durability, upgrade, energy consumption and treatment at the end of its use.
- Examples:
  "**pay per wash**" - self-service laundry (if detergent is included)
  "**pay per km**" - car sharing (if gasoline/electricity is included)
  "**pay per page**" – printing & scanning (if electricity and all consumables would be included)
- Also possible for industrial production and recycling plants, e.g "**pay per kg of recovered secondary raw material**"

Conclusion

Impact on	Sharing economy	Circular inputs	Product use extension	Resource recovery	Pay-per-use (PSS)
Product durability/life time	0	0	+	+	++
Intensity of product use	+	0	0	0	+
Amount of secondary raw materials in new products	0	++	+	++	++
Material recycling	0	++	+	++	++
Re-use, refurbishment, remanufacturing	0	0	++	+	+
Critical raw materials	0+	+	0+	+	++
Energy efficiency	0+	0	0+	0+	++
Toxicity	0+	0	0+	0+	+

Contact and Acknowledgement

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