

## Activating Circular Services for Electrical and Electronic Equipment – demonstration of Circular Economy Business Models in EEE

Pascal LEROY<sup>1\*</sup>, Ana Isabel DÍAZ<sup>2</sup>, María ANTA<sup>1</sup>, Bernd KOPACEK<sup>3</sup>, Klaus GROBE<sup>4</sup>,  
Mohamed OSMANI<sup>6</sup>, Maxime FURKEL<sup>7</sup>, Aybüke KABA<sup>8</sup>, Itziar CARRACEDO<sup>5</sup>, Vicente B.  
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<sup>1</sup>WEEE Forum, Auguste Reyerslaan 80, 1030 Brussels, Belgium

<sup>2</sup>GAIKER, Basque Research and Technology Alliance, Parque Científico y Tecnológico de Bizkaia, Edificio 202, 48170 Spain

<sup>3</sup>Austrian Society for Systems Engineering and Automation, Konrad-Duden-Gasse 33, 1130 Vienna, Austria

<sup>4</sup>ADVA Optical Networking SE, Fraunhoferstr. 9a, 82152 Martinsried, Germany.

<sup>5</sup>AIMPLAS, Plastics Technology Centre, València Parc Tecnològic, Calle Gustave Eiffel 4, 46980 Paterna, Valencia, Spain

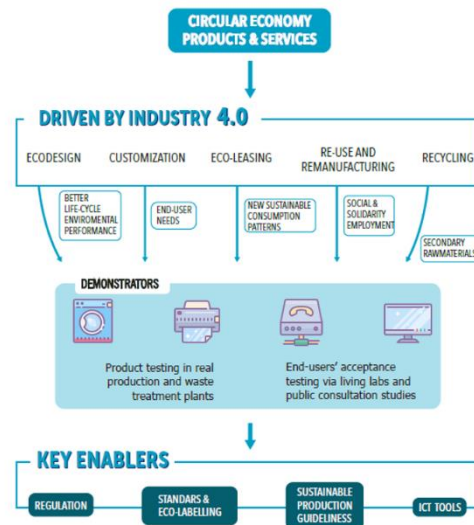
<sup>6</sup>Loughborough University, Loughborough LE11 3TU, UK

<sup>7</sup>Lexmark International nv/sa

<sup>8</sup>Arçelik

\*Corresponding author: [pascal.leroy@weee-forum.org](mailto:pascal.leroy@weee-forum.org)

C-SERVEES is a European project that aims to boost a resource-efficient circular economy in the electrical and electronic sector (EEE) through the development, testing, validation and transfer of new circular economy (CE) business models (CEBMs). These business models are based on systemic eco-innovative solutions that include eco-design, product customization, eco-leasing, improved waste management, together with complementary ICT services to take full advantage of the potential and synergies of two major revolutions of our time: the circular economy and the Industry 4.0. The techno-economic, environmental and social viability of the new CEBMs is being tested through demonstrations involving the whole life cycle of four target products: 1) washing machines, 2) printers and toner cartridges, 3) televisions, and 4) access link monitoring (ALM) equipment used in telecom. These products belong to EEE categories that together account for 77% of waste electrical and electronic equipment (WEEE) collected in the EU.



**Figure 1.** Schematic overview of the C-SERVEES project and its main innovative solutions

First, a circular business reference model for the EEE sector was developed based on CE principles collected through wide stakeholders consultation. The reference model was further tailored to each

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product targeted in the project in liaison with the industry partners Lexmark (printers and toner cartridges), ADVA (telecom ALM products) and Arçelik (washing machines and television sets/displays), who were each in charge of each model demonstrative scenarios.

During the demonstration phase of the project, the new CEBMs were fully implemented in real environments, involving the whole life cycle of the target products as well as their associated value chains. Life-cycle sustainability assessment (LCA) methodology was chosen to assess the feasibility of the CEBMs of the four target products and related eco-services, including their impact upon and acceptance by society.

ICT tools for bidirectional communication and secure information exchange throughout the value chain were developed using a zero-knowledge protocol. Circularise, RINA-C, and Soltel are the partners involved in the delivery of a minimum viable product for manufacturers, end-users and WEEE management organisations to manage and track repairing, refurbishment and recycling routes for different products/materials, while complying with EU data regulation.

Some of the most relevant insights obtained during the demonstration period are listed below:

- There are opportunities to improve the design of printers in order to facilitate dismantling. Colour labelling or QR codes on the products to identify valuable parts/components have proven to be very useful.
- Successful trials have demonstrated the potential to reuse plastics from Lexmark end-of-life printers and laser cartridges, using only same-brand products.
- Customer feedback obtained during the demo shows that customers are willing to use refurbished printers but are expecting significantly lower prices than for new products.
- Informed decisions about lifetime optimisation of electrical and electronic products require life-cycle analysis (LCA) and life-cycle cost (LCC). Circular economy considerations should focus on the most relevant lifecycle phases.
- Results from an in-depth product-service-system (PSS) analysis for ICT equipment show that not all PSS make sense. Material recovery yield at end-of-life is a determining factor when choosing a PSS. If this yield is limited through obsolescence, for example, then the PSS do not differ too much. If meaningful services can be offered, leasing seems to make sense.
- ICT solutions offer the possibility to provide useful information to the customers via QR codes, e.g. the rate of recycled material used in the product; and allow downloadable digital documents to replace printed documents.
- A feasibility study for washing machines and TV's shows that the rental model may be a suitable option depending on the number of customers, rental years and model content. There is a growing belief that it can be an alternative to be offered to customers, on favourable terms.
- Arçelik and Emaús, an organisation employing people at risk of social exclusion, are exploring a viable business case for the refurbishment of washing machines and TV's, which will extend the product lifetime and promote sustainable consumption.
- 3D printing technology can be an alternative for some product parts needed in refurbishment operations or as customization options.

**Key words:** circular economy; electrical and electronic sector; WEEE; business models; ICT

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