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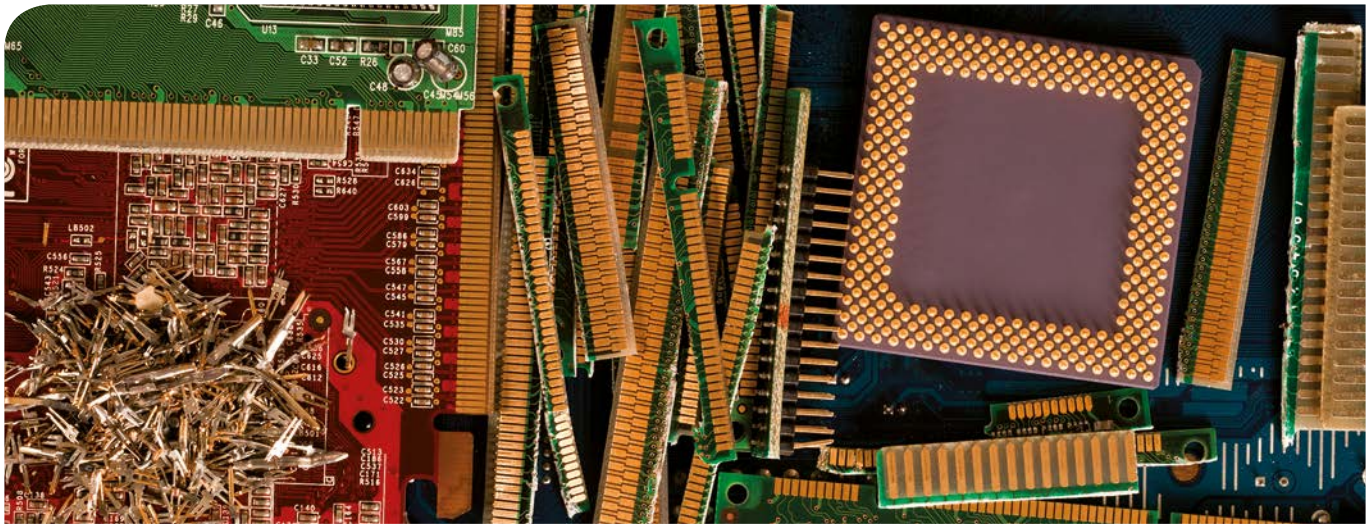
Accelerating the Transition to Sustainable Production Systems



A Bottom-up Approach to Reducing Waste Electrical and Electronic Equipment

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Key messages

- Application of the European Union waste hierarchy and circular economy principles to electrical and electronic equipment (EEE) has significant potential to reduce greenhouse gas emissions.
- As knowledge producers who use information and communication technology extensively, universities can drive low-carbon policies by developing sustainability best practices.
- The University of Bologna's *Terracini in Transizione* (sustainability living lab), in collaboration with *Nucleo Tecnico Rifiuti* (the university's Waste Technical Unit), has developed a reuse and recovery centre for disused EEE.

Introduction

A personal computer comprises around 23 per cent plastic, 20 per cent iron, 14 per cent aluminium, 7 per cent copper and 6 per cent lead, with traces of gold and silver.[1] Waste electrical and electronic equipment (WEEE) should therefore be considered as an important resource that can be mined.[2]

By 2020, the use and disposal of information and communication technology (ICT) equipment is expected to account for 2.3 per cent of global greenhouse gas emissions.[3] A study from 2011 showed that 3010–4340 megajoules of primary energy is used and 227–270 kg CO_2 is created during manufacture of a Dell Inspiron 2500, which represents 62–70 per cent of the total primary energy of manufacturing and operation.[4] Thus, intercepting discarded EEE for reuse and recycling, before it becomes WEEE, facilitates raw material recovery and can be an important strategy to mitigate energy use associated with manufacturing.

Furthermore, high recovery efficiency can be achieved, particularly when different pre-processing separation techniques are used (e.g. manual dismantling versus shredding and automated sorting).[5] While shredding and automated devices can obtain a sorting efficiency of approximately 75 per cent for silver, 70 per cent for gold and 41 per cent for palladium, using manual computer dismantling can achieve 92, 97 and 99 per cent, respectively.[2]

This *Insight* presents a case study of an Italian Climate-KIC partner, the University of Bologna, which developed a disused EEE reuse and recovery centre (known as the CLC-Lab). The CLC-Lab is intentionally integrated with teaching and research and extends the initiatives of *Terracini in Transizione* (Terracini in

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Transition), the university's sustainability living lab. This example illustrates the potential for European universities to play a key role in urban mining and the circular economy.

Universities as catalysts

Universities play a unique role in society regarding education, research and development. In addition to producing cutting-edge global knowledge through research, they have a responsibility to provide leadership and develop virtuous circles of 'learning by doing' that catalyse proactive practices. Recognising the importance of this dual role, in 2014 the University of Bologna created a sustainability living lab at the School of Engineering and Architecture campus (in Terracini Street). The lab aims to empower staff (teachers, researchers and technicians) and students through training and active participation in sustainability issues, promoting the implementation of best practices across the university. Several initiatives have already been implemented, illustrating the pioneering nature of the idea (see box).

The newest initiative (being launched in 2017) demonstrates a new approach. The CLC-Lab is dedicated to preparing disused EEE for reuse through repair and collaborating with local small- and medium-sized enterprises (SMEs) and waste recycling companies to ensure a higher rate of component and raw material recovery.

WEEE at the University of Bologna

Every year, Italian universities produce a high quantity of WEEE due to the growth and upgrade of informatics. In 2012, Remedia, an Italian consortium providing integrated handling of end-of-life EEE, batteries and accumulators, established a free programme for collection and recycling of university WEEE. The 2015 estimations of WEEE flows in the biggest Italian universities and managed by Remedia are given in Table 1.

Terracini in Transizione initiatives (2014–2016)

- Experimental green roofs and green technologies for urban resilience designed to test rainwater runoff, heat island effects, thermal and acoustic insulation, capture of pollutants etc.
- Energy saving and management measures at a building level, promoting use of renewable energy.
- Sustainable mobility for students, teaching and technical staff, promoting greater use of bicycles and public transport.
- Urban waste collection and management to improve recycling rates, and a community composting plant.
- Water saving systems, including rainwater collection and reuse.

Table 1. WEEE flows from Italian universities to Remedia (2015)

Campus	WEEE to Remedia (kg)
Politecnico di Milano	33,055
Uni statale di Milano	29,100
Uni Roma	14,700
Uni Bologna	**14,500**
Uni Siena	13,850
Uni Trieste	13,640
Politecnico di Torino	10,700
Uni Parma	10,500
Uni Modena - Reggio Emilia	7,150
Uni Catania	6,900
Uni Napoli	6,650
Uni Pavia	3,900
Others	32,400

Source: Remedia Seminar at the University of Bologna, May 2015

Any goods considered as waste are assigned a European waste code (EWC) from the *European Waste Catalogue and Hazardous Waste List*,[6] which describes the waste being transported, handled or treated to ensure it is managed responsibly at the end of its life. The most common WEEE from universities is hardware and computers (160214 EWC), cathode ray tubes and monitors (160213 EWC), electric and electronic components and cables (160216 EWC) and refrigerators (160211 EWC). Table 2 shows the total WEEE from Italian universities for each EWC. Figure 1 provides an overview of the WEEE produced by the University of Bologna between 2012 and 2015.

Recognising that more than half of the total amount of disused EEE (160214 and 160216 EWC) is likely to be either reusable or recyclable, Bologna University decided to investigate the possibility of a centralised disused EEE management centre. The feasibility of this idea had already been illustrated in that recovery and regeneration of computers had been practised by the student association of the University's Cesena since 1998.[7]

The CLC-Lab (EEE recovery centre)

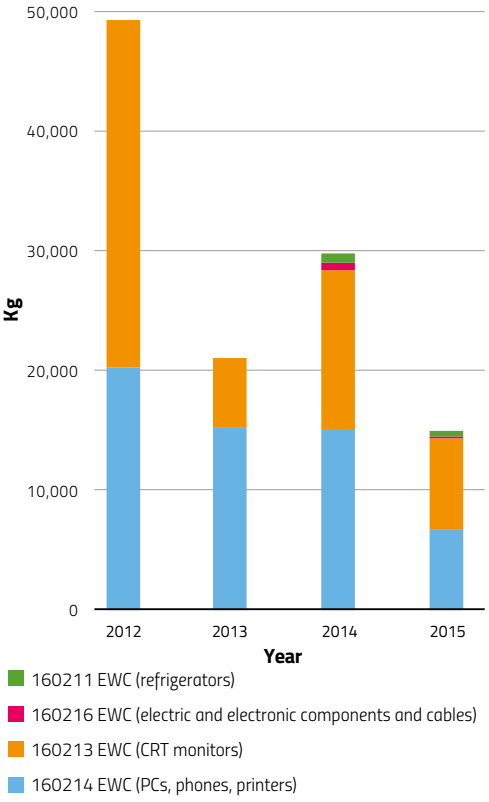
The idea for the CLC-Lab, which would facilitate the storage and preparation of the University's disused EEE to intercept it for reuse before it becomes waste, was

Table 2. WEEE flows from Italian universities to Remedia for each EWC (2012–2015)

WEEE from universities to Remedia	2012/2013 (kg)	2013/2014 (kg)	2014/2015 (kg)
160214 EWC (PCs, printers)	142,375	164,898	135,351
160213 EWC (CRT monitors)	69,580	104,162	62,206
160216 EWC (electric and electronic components and cables)	1,336	2,823	3,724
Others	5,082	3,602	16,646
Total	**218,373**	**275,485**	**217,927**

Source: Remedia Seminar at the University of Bologna, May on 2015

Figure 1. WEEE production at the University of Bologna (2012–2015)



Source: University of Bologna

explored initially through a university module. It is being implemented through collaboration between *Terracini in Transizione* and the *Nucleo Tecnico Rifiuti* (the university's Waste Technical Unit).

The lab will be located in an unused space within the School of Engineering and Architecture, where there is ground-floor access for loading and unloading, and a workspace area in the loft, connected by an elevator (Figure 2). More specifically, each device will be tested to see if it can be repaired adequately. If refurbishment and repair is possible, goods will be given a second life, either within the university or by being donated to the local community (e.g. to non-profit associations or schools).

If an item cannot be repaired, it will be dismantled manually, allowing the hard disk to be recovered and sent to local SMEs to extract any rare-earth and strategic metals.

The remaining waste from which no further materials can be recovered will be given to a local multi-utility for urban solid waste management. This will incur no additional costs to the university, since the cost of collecting 'other waste' is already included in the urban waste tax. Introduction of the concept of dual use, which refers to the use of commercial EEE in public workplaces and private settings, allows the university to work with public sector organisations and avoids the need for private contracts, such as that held previously with Remedia. This reduces the complexity, time and financial costs traditionally associated with preparing waste disposal permits, while ensuring that disused EEE is handled responsibly.

The CLC-Lab will be operated by students as part of their undergraduate and master's programmes. Software courses for engineering students will also be provided and these will 'add value' to the university's educational offering. Research activities will also be co-developed and run in partnership with local SMEs from the Emilia-Romagna ICT sector.

Enabling factors: regulatory environment and commitment to sustainability

The CLC-Lab is being established in response to external factors including the EU regulatory environment, and internal factors relating to the commitment of university staff to making Bologna a leader in sustainability issues.

External factors: Increasing recognition of the need to address resource productivity has created a positive and logical environment for developing the CLC-Lab. For example, the European WEEE Directive 2012/19/EU (implemented in Italy in April 2014) set a target of 45 kg of waste WEEE recovered compared with 100 kg of new EEE placed on the market in the period 2016–2019,[8] thus incentivising the university and local government to back initiatives like the CLC-Lab. Momentum to implement the

Figure 2. Visualisation of the new CLC-Lab

Source: University of Bologna

CLC-Lab was further reinforced by the *European Cohesion Policy*[9] and the *EU Action Plan for Circular Economy*.[10]

Internal factors: The decision to develop a centralised management process to deal with the growing WEEE produced by the university was driven by a desire among staff and students to reduce the university's environmental impact. The University of Bologna's ongoing commitment to sustainability issues has been recognised by other Italian universities, which have joined Bologna, a founding partner, in the *Rete Università Sostenibili* (Italian Network of Sustainable Universities). This network coordinates and shares examples of best practice in sustainability among Italian universities. Bologna has excellent representation inside the network scientific committee and coordinates the theme of waste management. These activities contribute to the university's reputation and reinforce the importance of engaging in pioneering initiatives like the CLC-Lab.

Conclusion

Every university laboratory, office and classroom has at least one computer. Universities should therefore be considered as valuable urban mines. Although the CLC-Lab is still in its infancy, its relevance and importance have been recognised widely, with additional partnerships developing between the University of Bologna and some of Emilia-Romagna's other municipalities to explore how to replicate the lab in their cities. However, more can be done, and this initiative also aims to influence the university's procurement policies to introduce a 'total cost of ownership' approach to the acquisition of EEE in the future.

Universities can therefore play multiple roles in enabling the transition to a circular economy through research and development activities, and through bottom-up educational initiatives like the CLC-Lab, which has increased awareness of the importance of closing loops. Reuse and recovery labs for disused EEE have great potential to reduce WEEE and its associated environmental impact, especially if replicated across universities and cities throughout Europe.

Endnotes

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Climate Innovation Insights is a platform for reflection and discussion on the lessons, challenges and opportunities of addressing climate change through innovation. It brings together key insights, informed opinion, best practice and methodological approaches to understand how research, education, business and government can, together, accelerate the transition to a zero-carbon economy. The series is developed and published by Climate-KIC, Europe's largest public–private partnership focused on climate innovation. We would like to thank the Series Editor, Dr Geraldine Brennan and the two external reviewers, Dr Carmen Ruiz Puente and Dr Inês dos Santos Costa.

About Climate-KIC

Climate-KIC is Europe's largest public–private partnership addressing climate change through innovation. With a focus on sustainable production systems, Climate-KIC is building a new foundation for industry in Europe – developing climate-friendly and economically viable circular models of manufacturing for a zero-carbon economy. Climate-KIC is supported by the European Institute of Innovation and Technology (EIT), a body of the European Union.

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About the University of Bologna

The University of Bologna is one of the oldest in the world and currently has about 85,000 students in five campuses. An important teaching and research mission relates to developing innovative technologies for environment and climate change, supporting urban resilience and the transition to a sustainable 'low carbon' future.

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