Solving The Global Problem Of E-Waste

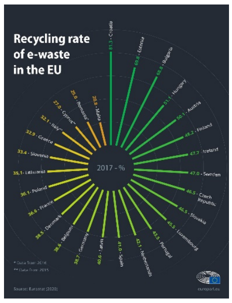
By Maria O'Mahoney, Silvia Santos, Frank Riedewald, Maria de Sousa Gallagher

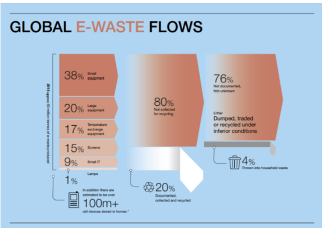
What is E-waste?

Electrical and electronic devices are a major part of modern life. The waste stream from these items, called E-waste or Waste Electrical and Electronic Equipment (WEEE), is one of the world's fastest growing waste streams. As consumption of electronic goods continues to grow, challenges will be faced in the effective management of E-waste. Within the EU, the current E-waste recycling rate is, on average, less than 40 % (Eurostat 2020), while on a global scale, only 20% of E-waste if formally recycled and the remaining 80% is often incinerated or dumped in landfill. Figures from the European Recycling Platform showed recycling rates of E-waste were the highest on record in 2020. Although the world's E-waste is a huge problem, it's also a golden opportunity (World Economic Forum, 2019).

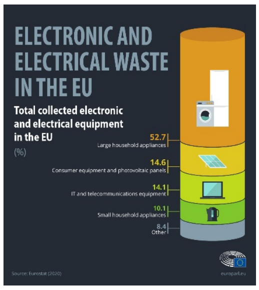
How big of a problem is E-waste?

Approximately 50 million tonnes (MT) of E-waste is generated per year, with expectations that e-waste will double to 110 MT by 2050, through increased usage of electronic items as more electronic components are used in the manufacture of other items (e.g. cars).





In the EU, the total E-waste collected is primarily composed of large household appliances (52.7%), consumer equipment and photovoltaic items (14.6%), IT and telecommunications equipment (14.1%), small domestic appliances (10.1%) and other items (8.4%) (Eurostat 2020).



Is E-waste the new Plastic-waste?

Ocean plastic pollution was one of the major environmental challenges we finally woke up to in 2018. However, in 2019, a record of the amount of E-waste was generated worldwide consisting of 53.6 million metric tons of discarded phones, computers, appliances, and other gadgets. During 2020, public attention was centred on the Covid-19 pandemic which has resulted in a more digital life style. This will drive public attention and opinion to E-waste in 2021 and onwards.

E-waste could certainly become more of a problem than plastic, in particular in light of the growing global trend towards technology and worldwide digitalisation. E-waste is a particular challenge because of the high levels of contaminating/toxic materials present. While more electronic devices are part of the problem, they also can be a big part of the solution. A more digital and connected world will help us accelerate progress towards the United Nations Sustainable Development Goals (SDGs), offering unprecedented opportunities for emerging economies and in time, manufacturers will be able to modify designs so that plastic components can be more easily recovered and recycled. At the moment, about 23% of E-waste generated consists of plastics.

Why can't E-waste just go to landfill?

At present, large volumes (> 80%) of E-waste go to landfill. However, E-waste is composed of a range of materials, some of which may be toxic when leached into the soil and water, and others such as metal components which may be commercially valuable when recovered. Finding an alternative route for E-waste can be complimentary to environmental and economic priorities.

Responsibly managing E-waste will reduce the amount of waste going to landfill, reduce harm to our environment and human health, provide safe management of hazardous materials, and allow greater recovery of valuable resources. In some cases, the metal components may originate from finite global sources and consist of critical or special metals such as indium or tantalum but also of commercially interesting metals such as copper and gold.

What is the problem with how is E-waste currently recycled?

E-waste involves complex materials such as plastics, ferrous materials and mixed metals, that are difficult to separate. Much of what is labelled as "E-waste" is actually not waste at all, but whole electronic equipment or parts that are readily marketable for reuse or can be recycled for material recovery.

For the most part, E-waste recycling is quite labour intensive as E-waste must be collected, taken apart, separated into plastics, batteries, screens etc. Metal recovery from E-waste involves a separate treatment process and not all metals present in E-waste are currently recycled, for example, the tantalum and indium recycling rates are zero recovery at the moment. For E-waste that is recycled, the current metal recovery rates are low and processes are not economically viable.

In the recent past, much of the global E-waste used to be exported to developing countries, but various international treaties have closed this route and the receiving countries are resisting the import of plastic and E-waste, as this causes problems in the environment, largely due to toxicity effects of E-waste on both the environment and human health.

What solutions are being developed?

New recycling technologies aim to improve sorting efficiency and try to recover individual elements to close-the-loop on these elements and provide critical raw materials without mining them. Some recycling technologies have been developed at laboratory stage but challenges have arisen in upscaling to industrial-scale. Such challenges include a lack of productivity or high costs of the technology that discourage companies from investing rather than landfilling or incinerating.

New recycling technologies must address problems that have prevented the realisation of E-waste recycling opportunities. These include sorting efficiency, sorting individual elements into small pieces (through sensors, mechanical segregation, chemical processes or combinations of these), delivering high productivity, and solve the problem of recycling difficult materials such as non-recyclable plastics. Furthermore, new technologies need to be more efficient at separating the E-waste components and recovering the metals, plastics and chemicals that can be re-used. Technologies need to be more cost-effective and environmentally effective.

The **RecEOL technology**, developed by Composite Recycling Ltd. in Cork, Ireland, can recycle shredded *Printed Circuit boards* (PCB), *tantalum capacitors* from PCB, *indium from glass* LCD screens, *lithium ion batteries*, *Automobile Shredded Residues* (ASR), *glass and carbon composite* fibre materials, and a wider range of other composite materials such as aluminium-laminated plastics (e.g., Tetra Pak), mixed plastics, single plastic streams and plastic packaging films. This technology involves a **single unit** that can be **scaled-up depending on the waste stream**, and is **complementary to, rather than competing with**, existing metal recycling because metals such as tantalum, cobalt, lithium and indium must be separated into their own highly concentrated streams to recover the pure metals.

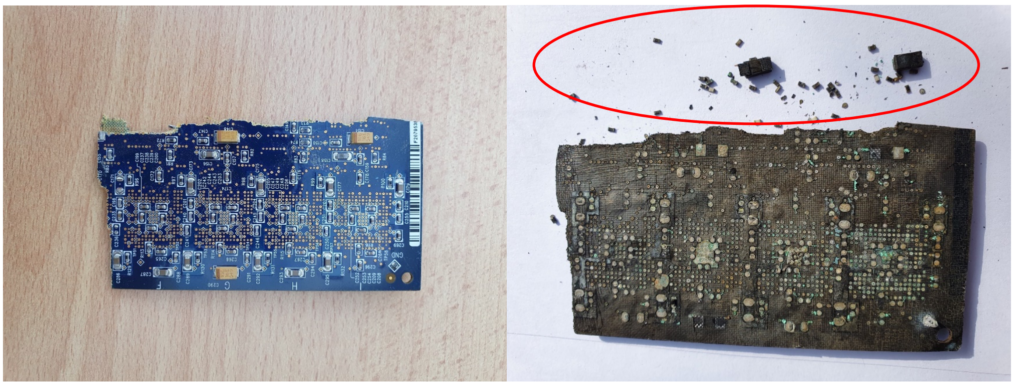


Fig. 1: Recycling PCB with tantalum capacitors using the RecEOL technology (*l to r: pre & post recycling). Circle: recovered tantalum capacitors.*

Fig. 2: Recycling lithium ion batteries using the RecEOL technology (*l to r: pre & post recycling) making the contents of the waste lithium ion battery available for recycling.*

Fig. 3: ASR & aluminium laminated pouches (middle) and Tetra Pak (right) post RecEOL recycling.

What is the future of E-waste?

Design of all products, not only electronic devices, should be established from a closed-loop perspective, ideally coming from circular economy waste streams with established and cost effective recycling pathways in place. This can be achieved by involving recycling sectors to know which materials can be recovered easily, what are the challenges, and how design can improve the rate of recycling of each product. Recycling is the responsibility of everyone, i.e., designers, manufacturers, suppliers and consumers. Going forward, regulations should be in place to ensure that recyclability is as important a factor as price or usability in the development of electronic products.

Process designers, manufacturers and consumers should prioritise the circular economy approach if we want to continue living in a sustainable society, which benefits from advances in technology. If each party comes together on the global stage, electrical and electronic industries can become more sustainable, generating less waste, and establishing pathways in which devices can be re-used as well as recycled in novel ways. This approach can also create new forms of employment, economic activity, education and trade. Already 67 countries have enacted legislation to deal with the E-waste they generate. Apple, Google, Samsung and many other brands have set ambitious targets for recycling and for the use of recycled and renewable materials. In the future, E-waste should be composed of recycled/biodegradable inputs with established post-consumer recycling pathways in place, and with recycling companies capable of recycling multiple e-waste streams.

Contact Details: RecEOL Co-ordinator: Prof. Maria de Sousa Gallagher, Process & Chemical Engineering, School of Engineering, University College Cork. Email: m.desousagallagher@ucc.ie.

The RecEOL project is co-funded in Ireland by Geological Survey Ireland & the Environmental Protection Agency under EU ERA-MIN 2 funding programme supported by the European Commission (Grant No. 2018-ERAMIN2-003).