E-waste (Waste Electrical and Electronic Equipment) – The Other Side of Rapid Technological Changes

Dr. Sigrid Kusch-Brandt
University of Padua, Italy
Department for Civil, Environmental and Architectural Engineering
Contact: mail@sigrid-kusch.eu

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Abstract

Occurrence of WEEE (waste electrical and electronic equipment), or e-waste, is closely linked to the economic development stage of a country. Economic growth is today reliably accompanied by rising WEEE quantities. E-waste represents one of the fastest-growing waste steams worldwide. In addition to rising quantities, contents of e-waste merit high attention. Precious and hazardous components are both relevant. Major e-waste quantities today do not enter formal management and valorisation schemes. Where recycling is implemented, it often focuses on recovery of bulk components, while materials with low concentrations remain largely without recuperation. This includes rare earth elements (REE) and other minority components which at the same time represent critical raw materials of an economy, especially with view to more widespread implementation of green technologies. One challenge is the large diversity of technical equipment on the market and continuously occurring alterations of characteristics of WEEE material flows as result of rapid technological changes.

Achieving the Sustainable Development Goals (SDGs) will to a significant extent be based on technological innovation and more widespread usage of key modern technologies. In addition to further growing e-waste quantities, all rapid technological change will result into even higher diversity of e-waste. Significantly more attention is required to advance high-value valorisation of e-waste streams and to end planned obsolescence. At the same time, e-waste is characterised by high mobility. In particular, WEEE is often subject to transboundary movements, with partially low levels of transparency. This calls for an urgent response in the form of coordinated action at a global level both under the scope of a circular economy and to limit detrimental health and environmental effects caused by hazardous substances present in electrical and electronic equipment.

Introduction

WEEE (waste electrical and electronic equipment), or e-waste, is one of the fastest-growing waste streams worldwide. WEEE is a major challenge due to the rapidly increasing quantities, and due both to its hazardous and precious components [1,2,3,4]. A very strong coupling between e-waste quantities and economic development stages of countries exist, as was shown in detail for countries of the pan-European region (Figure) [5]. The Sustainable Development Goals (SDGs) among others aim to achieve economic growth. Considering the high economic elasticity of WEEE (strong coupling between WEEE quantities and economic development stage of a country), rapid further increase in WEEE quantities will occur throughout the coming years and decades worldwide.

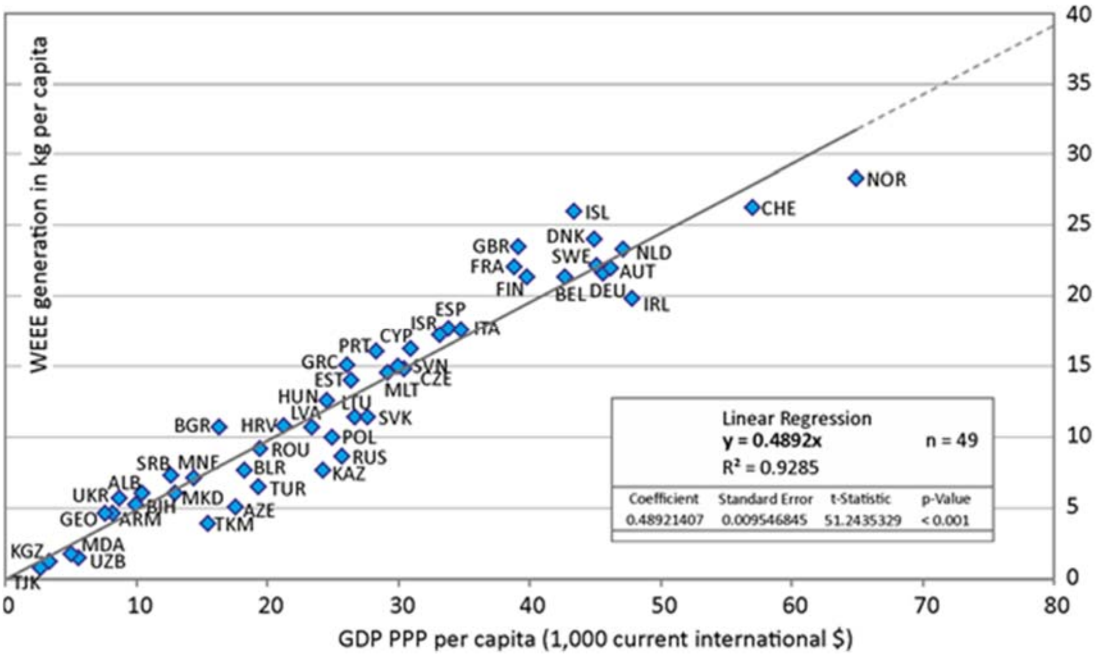

Figure: Linear correlation of domestic e-waste generation and GDP PPP (year 2014, 49 countries of pan-European region) [5]

Challenges

The large e-waste quantities, and the fact that quantities continue to grow very rapidly, is itself a key challenge. In many countries, no specific e-waste management regulations are in place, and then general waste management regulations apply. Significant shares of WEEE do not enter official collection schemes even when WEEE regulations and collection schemes are in place, as in the European Union [3,4]. WEEE is often subject to informal waste schemes, and it is a highly mobile flow of materials, with complex movements across and between regions [4,6]. Flows can be the result of legal or illegal movements [2,6]. Detrimental effects caused by hazardous WEEE components are common throughout countries with insufficient legal regulations, and such effects often arise from e-waste moved from high-income countries to downstream destinations in Asia and Africa. Rudimentary methods used in the informal WEEE processing pose serious environmental and health risks [2,7].

At the same time, e-waste contains a wealth of valuable components, including rare earth elements and other critical raw materials (e.g. indium, gallium) that are of vital importance for modern economies, and many of which represent potential bottlenecks in more widespread implementation of green technologies (renewable energies, highly-efficient technologies) [8, 9]. Recycling of WEEE has potential to generate significant economic wealth from recovered rare and important metals [10], however, WEEE recycling is a complex task requiring effective technical infrastructures and managerial frameworks. In absolute quantities, the amounts of rare and precious metals present in WEEE are relatively high with respect to worldwide demand [11]. However, a major challenge is that in the single WEEE item, rare and important metals are present in concentrations that are much lower compared to bulk components, and in addition, precious metals are closely connected to other metals or components or are used in complex material mixtures. The example of end-of-life photovoltaic panels shows that it is common that recycling schemes recuperate only bulk components of WEEE, while minority components, despite their potentially high value and their critical role in further economic progress, often get lost [9].

A specific challenge in building up advanced recycling infrastructures is the particularly high diversity among WEEE. Short lifetimes of electronic equipment, rapid changes of technology, business models of providers, demand patterns of consumers for the most recent equipment, are factors that continue to further increase diversity. All rapid technological change in the course of achieving the SDGs will result into even more diversity among e-waste.

In addition to recycling challenges, there is also a need to assess better the potential contributions of remanufacturing, refurbishment, repair and direct reuse, and to advance such schemes [2]. Here as well, the high diversity of WEEE represents a major challenge.

Planned obsolescence deliberately wastes resources by purposely reducing useful lifetime of technical equipment [12]. Planned obsolescence needs to be ended with priority. This will require a better understanding of underlying technical and business issues, and identification of ways to influence these, as well as implementation of methods to reveal and to ban such practices. Without determined intervention, there is risk that processes of rapid technological change will increase usage of planned obsolescence as strategic business element.

Key Challenges in Managing WEEE

- Rapidly growing quantities of e-waste flows, closely coupled to economic growth
- Complex movements across and between regions, as result of legal or illegal movements, make WEEE a challenge that requires attention under a global perspective
- In many countries worldwide, no specific regulations on management of e-waste are in place
- Significant shares of WEEE do not enter official collection schemes, and informal schemes are common
- Rudimentary methods used in the informal processing of WEEE pose serious environmental and health risks, often in countries other than where e-waste generation occurs
- WEEE contains a wealth of precious metals or other components that are key for modern economies and more widespread implementation of green technologies, however, recycling schemes often focus on bulk components, while valuable components remain without recuperation
- Circular economy schemes today do not sufficiently consider potential contributions of remanufacturing, refurbishment, repair and direct reuse
- The high diversity of WEEE items, and the further increasing diversity, complicate implementation of high-value circular economy schemes
- Planned obsolescence deliberately wastes precious resources and requires determined intervention to reveal and to end such business practices

Required Policy Response

WEEE is a global challenge, due to both the quantities involved and the transboundary nature of material flows. Rapid technological changes on the pathway towards achieving the SDGs will not only result into further increasing e-waste quantities, but they will also further raise diversity among end-of-life electrical and electronic equipment, with potentially negative impacts on implementation of high-value circular economy schemes, such as recycling, remanufacturing, refurbishment and repair. The scale of WEEE challenges calls for an urgent response in the form of coordinated action at a global level and the establishment of transnational WEEE governance principles and structures. The scope of the circular economy and the need to limit detrimental health and environmental effects caused by hazardous substances in electrical and electronic equipment need to be both integrated. Business practices of planned obsolescence need to be ended with priority.

In addition to efforts focusing on the global dimension of the e-waste challenge, globally connected regional circular economy centres could function not only as key knowledge institutions and contact points for public entities, the private sector and civil society, but could also ensure that coordination of WEEE management can indeed be achieved at a global level, while implementation in practice is in line with individual regional circumstances.

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