Table showing critical elements, their uses and recyclability

An average mobile phone contains around 30 different elements, including gold, silver, copper and magnesium. It is predicted that the earth's natural supplies of six them will come under serious threat within the next 100 years. These are gallium, arsenic, yttrium, silver, indium, tantalum (also a conflict element).

See EuChemS Periodic Table of Element Scarcity

The table below shows their uses and some of the challenges of recycling for each.

Element	Approximate Abundance *	How it is used in EEE?	Can it be recycled?
Gallium (Ga)	16.9 ppm	Gallium is a soft, silvery metal used primarily in electronic circuits, semiconductors and light-emitting diodes (LEDs). It can also be used in photovoltaic cells. Gallium nitride is used in mobile phones.	End-of-life recycling is challenging due to the dissipative use of gallium.[1,2] Recycling rate: <10%
Arsenic (As)	2.5ppm	Minute amounts of arsenic are used in the electronics industry. It is added to germanium and silicon to make transistors. A compound of arsenic, gallium arsenide (GaAs), is also used to make light-emitting diodes (LEDs).	Small volumes of arsenic are recovered in electronic scrap such as used circuit boards, relays, switches etc. Gallium-arsenide scrap is also recovered from semiconductor manufacturing.[3] Recycling rate: <10%
Yttrium (Y)	33ppm	Used in white LED lights, and Yttrium Oxide is added to the glass used to make camera lenses to make them heat and shock resistant.	Remains difficult to separate. Recycling rate: <10%
Silver (Ag)	0.08 ppm in earths crust, usually combined with other metals.	A large proportion of the silver used in industry is in electronics, mainly in circuitry. One of the fastest growing uses is in photovoltaic tiles. It is also a component of some batteries.	Silver can be recovered from industrial scraps and end-of-life applications like electronic and electrical scrap.[4] Up to this point, precious metals such as silver or gold have been the focus for electronics recycling methods. Recycling rate: >30%
Indium (In)	0.05 ppm	Indium tin oxide is used in most touch screens, and is seen as a ‘technology critical element’	Indium is recovered from targets that are used for conductive coatings. Recovery of indium from dissipative uses like flat panel displays and

[1] https://www.umicore.com/en/about/our-metals/gallium/
[2] http://www.criticalrawmaterialrecovery.eu/wp-content/uploads/2019/10/LIFE14_ENV_UK_000344-Final-Technical-Report-Webcopy.pdf
[3] https://www.umicore.com/en/about/our-metals/arsenic/
[4] https://www.umicore.com/en/about/our-metals/silver/

			photovoltaics remains very challenging.[5,2] Recycling rate: <10%
Tantalum (Ta)	0.7 ppm	Used to make capacitors which are smaller than with conventional materials, allowing for smaller devices. These can also be used safely in medical devices.	It is recovered from powder sweepings and wire scrap from capacitor manufacturing, from end-of-life capacitors.[6] Has high potential to increase recovery.[2] Recycling rate: <10%

*** for comparison, Aluminium is the third most abundant element in the earth's crust and exists at 84,149 ppm**

Information taken from: https://www.rsc.org/periodic-table/ unless otherwise stated

[5] https://www.umicore.com/en/about/our-metals/indium/
[6] https://www.umicore.com/en/about/our-metals/tantalum/

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