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Electronics Supply Chain Overview

Intro

Electronics are sophisticated products with an equally complicated supply chain. Within the consumer electronics industry, revenue is forecast at 1.82% annual growth, with user penetration climbing from an estimated 29.7% in 2022 to 36.8% by 2025.[1]

Because electronics are so popular (and potentially expensive), there is also a growing market for used electronics and their recycled parts. The growth of this sector is critical for sustained development, as the raw materials necessary for future production are in short supply and electronic waste (e-waste) has a major impact on the environment. In 2019, the world generated a striking 53.6 metric tons of e-waste, and this figure is projected to grow to 74.7 metric tons by 2030 (see **Figure 1**).[2]

The process depicted on the left of **Figure 1**—materials moving from mines to smelters and into manufacturing—is known as the *forward supply chain*. Similarly, the *reverse supply chain,* pictured on the right, refers to materials moving back down the chain (from product, into components, and so forth) as part of reuse and recycling. The forward supply chain is a well-developed process that looks very similar across products and companies. At certain points (e.g., recovery of metals), the reverse chain is also well-established; however, the first step in the reverse chain—collecting end-of-use products to reuse or recycle them—is highly individualized. Companies have different approaches and profit potentials on these products and many unrelated third parties are also involved in collection and resale.

[1] "Consumer Electronics," Statista, https://www.statista.com/outlook/dmo/ecommerce/electronics/consumer-electronics/worldwide (accessed Jul. 19, 2022).

[2] Vanessa Forti, Cornelis Peter Baldé, Ruediger Kuehr, and Garam Bel, "The Global E-waste Monitor 2020: Quantities, Flows and the Circular Economy Potential," United Nations University (UNU)/United Nations Institute for Training and Research (UNITAR)—co-hosted SCYCLE Programme, International Telecommunication Union (ITU), and International Solid Waste Association (ISWA), 2020.

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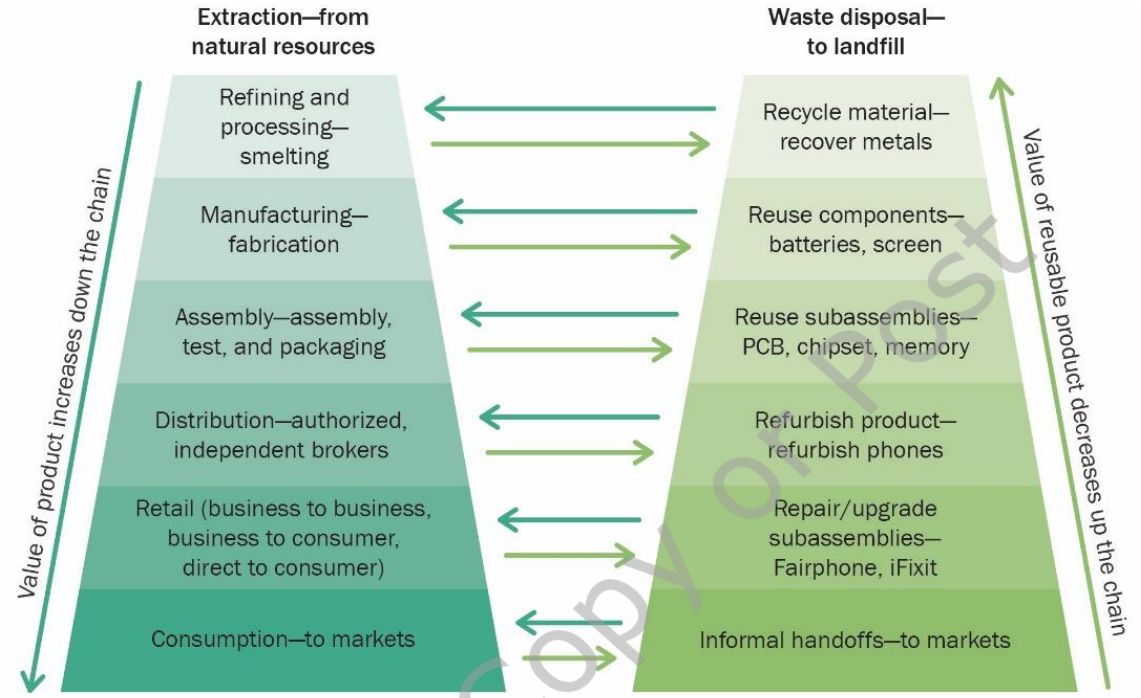
Figure 1. Electronics value chain—material flow and value added in the forward and reverse supply chains.



Source: Created by authors.

Forward Supply Chain

Mines

At the base of any supply chain are raw materials. The electronics industry relies on a number of precious metals to craft and protect its hardware—from lithium in batteries to aluminum in exterior cases. Thus the first step in the supply chain begins underground, in mines (**Exhibit 1**).[3] Common precious metals used in electronics are listed in **Table 1**.

[3] For more detail on mine and mineral location, see "Mineral Resources Online Spatial Data," US Department of the Interior, US Geological Survey, https://mrdata.usgs.gov/general/map-global.html (accessed Jun. 21, 2022).

Table 1. Common precious metals.

Metal	Purpose	Price
Gold	Found mainly in printed circuit boards (PCBs) and integrated circuits. Highly efficient current conductor; helps prevent corrosion	$1,392 per troy ounce
Tin	Used for bonding materials when soldering	$21,000 per metric ton
Tungsten	High heat tolerance makes it useful as an interconnect material in integrated circuits	$270 per metric ton
Copper	Strong electrical conductor	$6,000 per metric ton
Cobalt	Key material in rechargeable batteries	$32,000 per metric ton
Neodymium	Made into magnets that are used in audio equipment such as speakers, headphones, and microphones	$45,000 per metric ton
Lithium	Key material in batteries	$17,000 per metric ton
Plastic	Used for insulation, as it does not conduct electricity	$3,000 per ton

Source: Created by authors with input from Statista and "Digital Economy Growth and Mineral Resources: Implications for Developing Countries," United Nations Conference on Trade and Development technical note, December 2020, https://unctad.org/system/files/official-document/tn_unctad_ict4d16_en.pdf (accessed Jul. 19, 2022).

While the overall amount of each metal per product depends on product weight, many of these precious elements (such as gold) appear in very small quantities per product. The average cell phone,[4] for example, includes the following (in grams):

- Gold: 0.024
- Tin: 1.515
- Tungsten: 0.44
- Copper: 9.08
- Cobalt: 6.48
- Neodymium (Rare Earth): 0.14
- Lithium: 4.21
- Plastic: 32

[4] Based on the Fairphone 2. See "We're Here: Impact Report Vol. 1," Fairphone, 2018, https://www.fairphone.com/wp-content/uploads/2018/11/Fairphone_Report_DEF_WEB.pdf (accessed Jun. 21, 2022). For more on Fairphone, please see Vidya Mani, Doug Thomas, and Alexandra Medack, "Fairphone (A): Can a Start-Up Change an Industry?," UVA-OM-1712 (Charlottesville, VA: Darden Business Publishing, 2022).