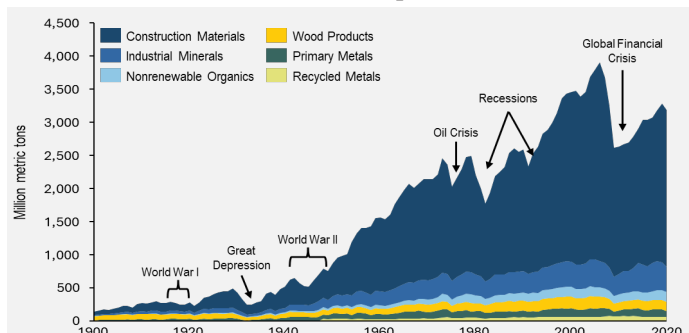


U.S. Material Use

Patterns of Use

Raw materials are extracted, converted to engineered and commodity materials, and manufactured into products. After use, they are disposed of or returned to the economy through reuse, remanufacturing, or recycling. Sustainability in material use has three components: the relationship between resource consumption rates and resource stocks; the efficiency of resource use in providing essential services; and the proportion of resources leaking from the economy and impacting the environment. The first two reflect supply sustainability, while the third affects ecosystem sustainability. Global resource use has increased significantly over the past 50 years. In 2020, global flows reached 9.3 Bt (non-fuel and food), four times the consumption in 1970, while population only doubled during the same period.¹ The U.S. is a primary user of natural resources, including fossil fuels and materials.

U.S. Nonfuel Materials Consumption, 1900-2020¹



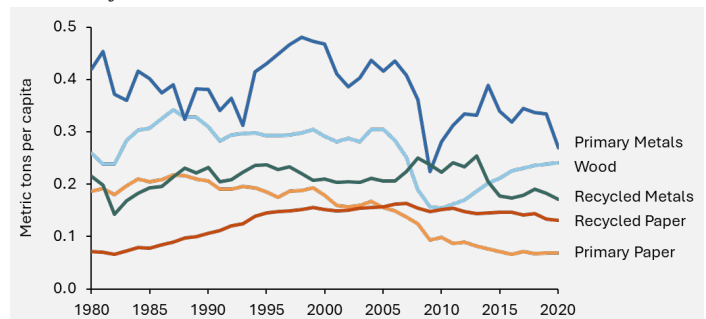
- U.S. raw material use (non-fossil fuel or food) grew 3.17 times faster than population did from 1910 to 2020.^{1,2,3}
- After rising 54% from 1970-2005, U.S. material use (including fuels) reached 7.8 Gt in 2019, 34% higher than in 1970.⁴
- In 2022, U.S. per capita material use (including fuels) was 23.5 t, 33% higher than the OECD average.⁵
- U.S. raw material use increased 30% from 1996-2006, then decreased 32% from 2006-2010 following the global financial crisis. By 2020, total raw material use had increased 20% to over 3 Gt, about twice the world's total materials production on a per capita basis.¹
- Construction materials, including stone, gravel, and sand, account for around three-quarters of raw materials use.¹
- The use of renewable materials decreased dramatically over the last century, from 41% to 5% of total materials by weight, as the U.S. economy shifted from agriculture to industrial production.⁶
- Mineral supply adequacy is measured by the ratio of global reserves to production, ranging from several decades (copper and gold) to a few centuries (aluminum, chromium, iron, lithium, platinum, phosphate rock).⁷

- Rare earth elements (REEs) are 17 elements used in metal alloys, batteries, ceramics, and catalysts.⁸ Substitutes for REEs are available but often less effective. China controlled 69% of REE production in 2024.⁷

Intensity of Raw Materials Use

- Material intensity of use refers to the amount of material used per unit of economic output, generally measured by the gross domestic product (GDP) of a country.¹⁰ The domestic processed output—total weight of materials and emissions produced by the domestic economy—per unit of GDP declined 44% over recent decades, similar to other industrialized nations.¹¹
- 44% of materials used in the U.S. economy are added to long-term (+30 years) domestic stock, 2% remain in stock 2-30 years, 39% remain in stock less than 2 years, and 15% are recycled back into the economy.¹¹
- Of materials remaining in domestic stock less than 30 years, 73% are released into the atmosphere (mostly through fossil fuel combustion), 18% are disposed of in controlled areas (landfills, tailings ponds), and 9% are dispersed directly into land or water environments.¹¹
- Use of plastics, synthetic fibers and rubbers grew from 1.59 Mt in 1900 to 150 Mt by 2020, displacing traditional materials like wood and metals due to cost advantages and durability.¹
- On a per capita basis, metals consumption peaked in 1950 and has since declined, reflecting trends toward lighter materials and reduced use of metal-intensive manufactured goods.¹ In 2020, recycled metals accounted for nearly 40% of metals consumption by mass.¹
- The composition of materials in the U.S. economy has become less dense—less iron and steel, more lighter metals, plastics, and composites.¹³

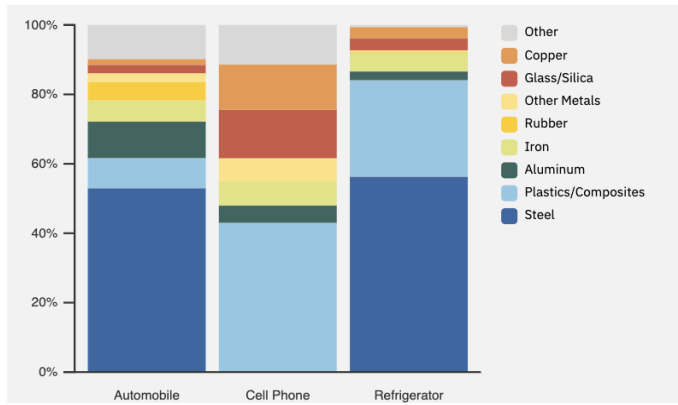
Intensity of Use of Selected Materials in the U.S.^{1,14}



Environmental Impacts

- In 2017, only 8% of disposed plastics in the U.S. were recycled, while 2% “leaked” into the environment—often as microplastics from tire abrasion and synthetic textiles—raising global concerns due to organism impacts and unknown human health consequences.¹⁵

Material Composition of Select Products^{16,17,18}



- Mines and quarries (including coal, excluding oil and gas) occupy 0.3% of U.S. land area, with 60% used for excavation and the remainder for overburden and mining waste disposal.¹⁹
- As higher-grade metal reserves deplete, ore quality degrades, requiring greater energy for extraction and processing, thus increasing emissions that contribute to climate change and acid precipitation.²⁰
- The primary metals and mining sectors accounted for 54% of the total 3.4B lbs of toxic releases in 2023.²¹
- In 2023, 32 Mt of Resource Conservation and Recovery Act (RCRA) regulated hazardous waste were generated in the U.S., primarily from chemical manufacturing (61%) and petroleum/coal products manufacturing (15%).²²
- In 2022, material-intensive sectors used significant energy: chemical manufacturing (7.5 quads), petroleum/coal products (4.5 quads), primary metals (1.4 quads), and nonmetallic minerals like stone, clay, glass, or cement (1.2 quads).²³ Total U.S. consumption was 95 quads.²⁴
- Energy-related CO₂ emissions from industry have fallen 26% since 2000, mainly due to a shift away from energy-intensive manufacturing in the U.S.²⁴
- Human health risks arise from emissions and residues over a material's life cycle. Regulation has substantially reduced many toxic pollutants e.g., mercury from gold mining, volatile organic compounds from paints, and lead from gasoline.²⁵ However, over 342,000 tons of lead and lead compounds were released in 2023; 93% from metal mining, 3.2% from metal production, and 0.3% from electric utilities.²¹
- New chemicals have been introduced that persist in the environment, bioaccumulate (move up the food chain), and/or are toxic, e.g., per- and polyfluoroalkyl substances (PFAS) which are used to make products heat, water, and oil resistant.^{25,26,27}

Solutions and Sustainable Actions

- Conserve materials:** "Reduce, Reuse, Remanufacture, and Recycle." In 2018, 32.1% of municipal solid waste in the U.S. was recovered for recycling and composting.²⁸ U.S. recycling and remanufacturing supported over 681,000 jobs and more than \$5.4B in tax revenue in 2012, diverting over 93M tons of material from landfills and incinerators.^{28,29}
- Change material composition of products:** Create products using less toxic, more recyclable, and less energy-intensive materials.
- Reduce material intensity:** Technological advances can reduce the raw material intensity of products while making them lighter and more durable. Aluminum beverage cans are 38% lighter today than they were three decades ago, allowing more cans to be produced from the same amount of aluminum.³⁰ These cans are made with an average of 71% recycled aluminum, representing huge decreases in energy requirements and greenhouse gas emissions compared to using virgin materials.³¹
- Promote product stewardship:** Appropriate policy and regulatory frameworks can help ensure product manufacturers' responsibility for the environmentally conscious management of retired products. The European Union's waste electrical and electronic equipment (WEEE) regulations target an 85% increase in proper WEEE collection and disposal.³² The EU's Extended Producer Responsibility (EPR) policy shifts responsibility for life cycle environmental impacts from governments to producers.³³
- Encourage renewable material use:** Biobased materials such as polylactic acid (PLA), a biodegradable polymer, can provide performance similar to petroleum-based plastics. Manufacturing these materials may require less energy and emit fewer GHGs, but the use of land and chemicals required to grow the feedstock may have adverse environmental consequences.¹²

U.S. Recovery of Municipal Solid Waste²⁸

