Center for Sustainable Systems

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factsheets

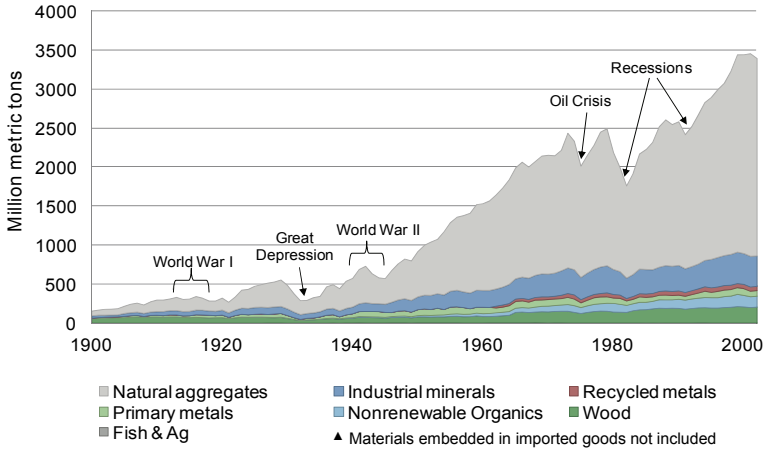
U.S. Material Use

Patterns of Use

Raw materials are extracted and converted to engineered and commodity materials, and manufactured into products before use. After use they are disposed of or returned to the economy through reuse, remanufacturing or recycling. Sustainability in use of resources has three components: (1) relationship between rate of resource consumption and the overall stock of resources, (2) effectiveness of resource use in providing essential services, and (3) the proportion of resources that leak from the economy and their impacts on the environment. The first two topics reflect the sustainability of supply, and the third affects the sustainability of the receiving ecosystems. The United States is a primary user of natural resources, including fossil fuels and materials. The increase in our use of renewable materials – agriculture, wood products, primary paper – and nonrenewable materials – nonrenewable organic, primary metals, industrial minerals, and construction materials – during the 20th century is illustrated in the figure below.

- U.S. raw material (non-fossil fuel or food) use rose 5.1 times more than population in the last century.[1]
- When fuels and other materials are included, total material consumption in the U.S. rose 57% from 1970 to 2000, reaching 6.5 billion tons.[2]
- In 2000, the per capita total material consumption (including fuels) was 22.7 metric tons, which is 50% higher than the European average. [2]
- From 1992 to 2002, U.S. raw material use increased by more than one third.[2]
- Construction materials, including sand, gravel and stone comprise the largest component of the raw materials consumption.[3]
- On a weight basis, the use of nonrenewable materials has increased dramatically (from 59% to 95% over the last century) as the U.S. economy shifted from an agricultural to industrial base.[3]

U.S. Nonfuel Materials Consumption (1900-2002)[3]▲

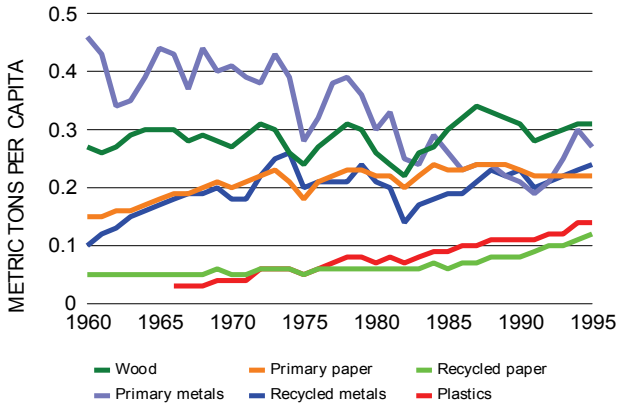


- The ratio of global reserves over present consumption rates is an indicator of the adequacy of mineral supply and ranges from over a millennium (aluminum), to a few centuries (platinum, phosphorus, chromium), to within a decade (terbium, indium, hafnium).[4]

Intensity of Raw Materials Use

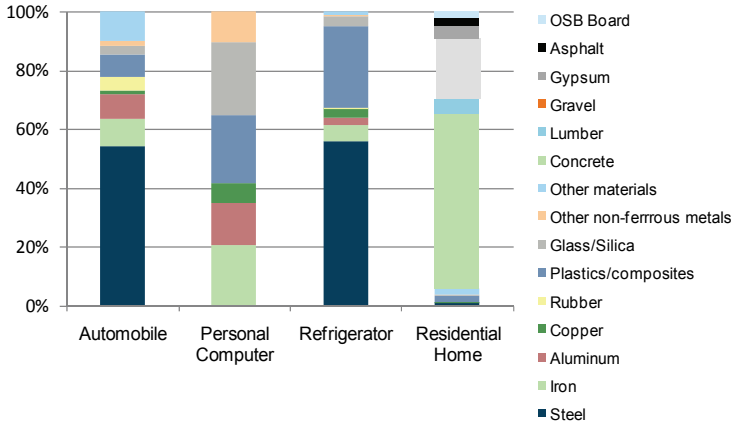
- Intensity of materials use is defined as the amount of materials consumed every year, either on a per capita basis or per unit of economic output measured by the total gross domestic product (GDP) of a country.
- 40% of the consumed materials are added to the domestic stock, 40% are released into the atmosphere (mostly fossil fuel combustion products), 3% are dissipated directly into the environment, 5% are recycled, and the remaining portion is directed through standard trash waste procedures.[5]
- There is an appreciable decline in the intensity of use of primary metals, except aluminum, whereas the use of plastics continues to grow.[5]
- Trends in the composition of materials used in the U.S. economy have changed from dense to less dense, i.e., from iron and steel to light metals, plastics, and composites (see figure on right).[6,7]
- The domestic processed output, or total weight of materials and emissions disposed of in the domestic economy, including imports, has declined per unit of GDP by about 25% in the U.S. over the last few decades, similar to other industrialized nations.[8]

Intensity of Use of Selected Materials in U.S.[7]
(per capita per year)



Environmental Impacts

Material Composition of Selected Products[9,10,11,12]



Raw material extraction and use can create significant environmental impacts. The figure shows the material demands of some common manufactured products.

- Mines, including coal but excluding oil and natural gas, occupy 0.26% of the land area in the U.S. – of which 60% is used for excavation and the rest for disposal of overburden and other mining wastes, accounting for 40% of the total U.S. solid wastes.[13]
- The primary metals and mining sectors accounted for 40% of the total 4.25 billion pounds of toxic releases in 2006.[14]
- In 2005, the chemical manufacturing and primary metal manufacturing sectors accounted for approximately two-thirds of the total 38 million metric tons of Resource Conservation and Recovery Act (RCRA) regulated hazardous waste.[15]
- In 2002, energy consumed by primary metal industries (2.1 quad), stone, clay, and glass products including cement manufacturing (1 quad), and paper and allied products (2.4 quad), rank next only to chemicals (6.5 quad) and petroleum and coal products (6.8 quad).[16] [1 quad = 10^{15} BTU]
- The manufacturing sector (excluding agriculture, mining, and construction) accounted for 84% of energy-related carbon dioxide emissions of the total U.S. industrial sector in 2002, although transportation emissions were much higher.[17]
- Human health risks arise from emissions and residues over the material life cycle. In many cases, pollutant releases have been substantially reduced from historical levels, e.g., mercury released by gold mining, fugitive volatile organic compound emissions from paints, and lead from combustion of gasoline. However, 2002 total releases of lead and its compounds from U.S. Toxics Release Inventory and Canadian National Pollutant Release Inventory facilities was 211,000 tons, of which the primary metal sector had the largest on-site air and land emissions and the electric utilities had the largest surface water discharges.[18] Furthermore, new chemicals have been introduced that subsequently have been found to persist in the environment, bioaccumulate (move up the food chain), and/or are toxic, e.g., polybrominated biphenyl ethers that are widely used as flame retardants in consumer and industrial products.

Solutions

- *Material conservation* – Reduce, reuse, recycle, and remanufacture should be the motto of producers and consumers. A 2001 study showed that U.S. recycling and remanufacturing industries account for over 1.1 million jobs and more than $236 billion in revenue.[19] In 2006, 32.5% of municipal solid waste in the U.S. was recovered for recycling or composting, diverting 82 million tons of material from landfills and incinerators.[20]
- *Change material composition of products* – Consumer products should be made with materials that are less toxic, can be recycled easily, and are less energy intensive during production and manufacturing. There are over 24 million commercially available chemical compounds.[21]
- *Reduce material intensiveness – Advance*s in technology can help reduce the raw material intensity of products and make them lighter and more durable. Aluminum cans are 36% lighter today than they were three decades ago, thus permitting more cans to be produced from the same amou*nt of aluminum – increasing f*rom 22 cans per pound of aluminum in 1972 to 34 in 2005.[22]
- *Encourage use of renewable materials* – Increase the use of renewable materials for construction materials and packaging. A biodegradable polymer derived from corn, polylactic acid, can provide performance characteristics similar to petroleum-based plastics with lower environmental impacts.[23]
- *Promote product stewardship* – Appropriate policy and regulatory measures should be taken similar to the European Union (e.g., waste electronic and electrical equipment (WEEE), packaging) to make product manufacturers responsible for environmentally conscious management of consumer goods at their end of life.

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