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Use of Raw Materials in the United States From 1900 Through 2014

Introduction

The economic growth of an industrialized nation such as the United States requires raw materials for construction (buildings, bridges, highways, and so forth), defense, and processing and manufacture of goods and services. Since the beginning of the 20th century, the types and quantities of raw materials used have increased and changed significantly. This fact sheet quantifies the amounts of raw materials (other than food and fuel) that have been used in the U.S. economy annually for a period of 115 years, from 1900 through 2014. It provides a broad overview of the quantity (weight) of nonfood and nonfuel materials used in the economy and illustrates the use and significance of raw nonfuel minerals in particular as building blocks of society.

The estimation of materials used in the economy in physical terms is different than the estimation by monetary value. Raw materials are found in the environment, and the magnitude of a material's impact is estimated in physical terms (for example, the bulk of crushed stone is considered a benign material but materials such as arsenic, cadmium, and mercury can be considered toxic in certain forms and amounts). The extraction and use of raw materials could have detrimental effect on the environment and society if not managed carefully. The changes in the quantities of renewable and nonrenewable resources used during the period indicate that come increasingly dependent on nonrenewable materials to sustain its standard of living (the degree of wealth and material comfort available to a person or community), often seen as essential for the economic well-being of citizens and national security. This fact sheet supersedes U.S. Geological Survey Fact Sheet 2012–3140, which was published in December 2012 and covered the period 1900 through 2010.

These data have been compiled to help the public and policymakers understand the changing annual flow of raw materials put into use in the United States. Such information can be helpful in assessing the potential effects of materials use on the environment, assessing materials' intensity of use, and examining the role that these materials play in the economy. The data presented indicate the substitution and shift in materials usage from renewable to nonrenewable materials during the 20th century. The disaggregated quantities by commodity (not shown in this fact sheet) may be tested against supply adequacy and end of life issues.

For the purposes of this fact sheet, "usage" refers to the annual apparent inputs during the consumption phase of the material's cycle (which is calculated as the sum of a given material's domestic production, imports, and recycling, minus exports). The data are also only for raw materials that were ready for use directly by the domestic consumer or in the manufacture of products consumed domestically or exported: materials contained in imported finished goods were excluded. In an industrial economy such as the United States where the volume of goods flowing into and out of the country is large, tracking the flow of materials embedded in imported or exported products is challenging.

The data for usage of raw materials from 1900 through 2014 in the United States are based on available annual historical data from a variety of sources (see "Data Sources Used to Track Flows of Raw Materials Usage" section) and are presented in four ways. Figure 1 lists the raw materials put into use annually, divided into the following broad categories: agriculture, forestry, nonfuel minerals, and nonrenewable organics. Table 1 (in a separate spreadsheet) lists the aggregated quantities (by weight) of these raw materials and nonfuel minerals on an annual basis. Figure 2 is a graphical representation of the data in table 1—showing all raw materials and a focus on raw nonfuel minerals. Figure 3 shows the percentage of annual material usage of renewable and nonrenewable materials.

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Agriculture	Forestry	Nonfuel minerals			Nonrenewable organics
		Construction materials	Industrial minerals	Metals (includes recycled metals)	
Cotton Cottonseed Fishery Flax seed Fur Leather hides Mohair Natural rubber Raw wool Silk, raw and waste Tobacco	Paper and paperboard Recycled paper Wood Lumber Plywood and veneer Other forestry	Sand and gravel, construction Stone, crushed	Abrasives, manufactured Asbestos Barite Boron Bromine Cement Clays Diamond, industrial Diatomite Feldspar Fluorspar Garnet, industrial Gemstones Graphite, natural Gypsum Hafnium Helium Iron oxide pigments Kyanite and related materials Lime Lithium Magnesium compounds Mica Nitrogen Peat Perlite Phosphate rock Potash Pumice and pumicite Quartz crystal Salt Sand and gravel, industrial Soda ash Sodium sulfate Stone, dimension Strontium Sulfur Talc and pyrophyllite Thorium Titanium dioxide Vermiculite Wollastonite Zirconium	Aluminum Antimony Arsenic Beryllium Bismuth Cadmium Cesium Chromium Cobalt Copper Gallium Germanium Gold Indium Iron and steel Lead Magnesium Manganese Mercury Molybdenum Nickel Niobium (columbium) Platinum group Rare earths Rhenium Selenium Silicon Silver Tantalum Tellurium Thallium Tin Titanium Tungsten Vanadium Zinc	Asphalt and road oil Coal Coal for chemical use Liquefied petroleum gases Lubricants Miscellaneous oils, waxes, and other products Natural gas Pentanes plus Petro-chemical feedstock Petroleum coke Primary products from petroleum Special naphthas

Figure 1. Chart listing U.S. raw materials put into use annually from 1900 through 2014, by category.

Short- and medium-term trends in raw material usage correlate well with major economic and military events of the past 11 decades (fig. 2). These events have included World War I, the Great Depression of the 1930s, World War II and the subsequent post-war economic expansion, the oil crises of the 1970s, the economic recessions of the 1980s and early 1990s, the extended period of economic prosperity and technological growth at the end of the 20th century, and the great recession from 2007 through 2009. Although from 2009 through 2014 the U.S. economy has slowly recovered from the 2007–9 recession (with the exception of recycled metals, where consumption has continued to trend upward throughout the recession and recovery), U.S. total material usages have not reached their pre-recession levels. The great recession affected the country's financial and economic conditions and it severely affected materials usage.

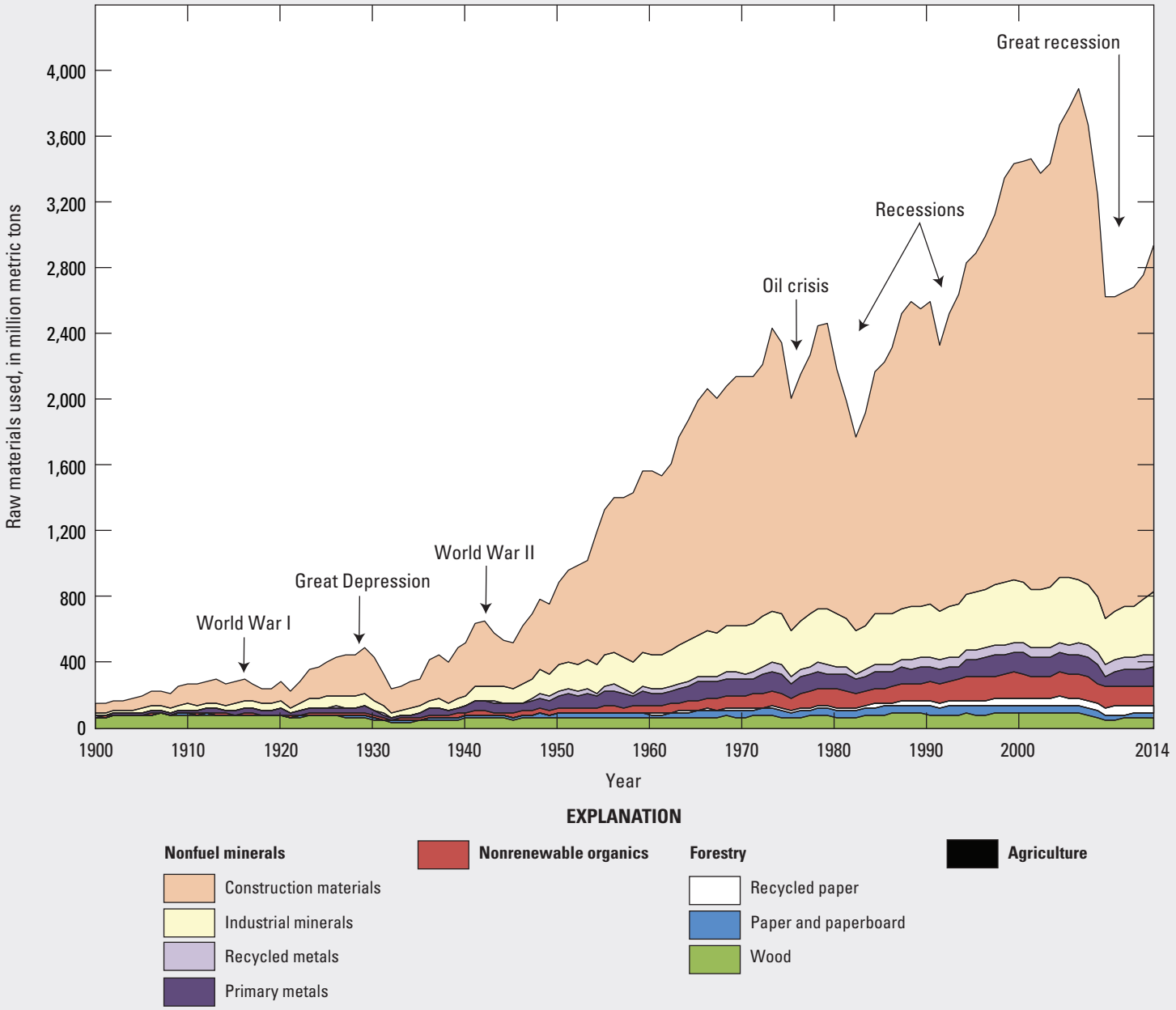

Figure 2. Graph showing amount of U.S. raw materials put into use annually from 1900 through 2014. Materials embedded in imported goods are not included.

Raw Materials

The raw materials summarized in this report can be divided into four broad categories—agriculture, forestry, nonfuel minerals, and nonrenewable organics.

Agriculture

The agriculture category includes nonfood materials derived from plant products (such as cotton, flaxseed, tobacco, and natural rubber); animal products (such as wool and leather); and fishery products (such as fish meal). This category is not significant by weight. The usage of the agricultural, wildlife, and fishery materials included in this category has been diminishing since 1993, to about 40 percent of the 1993 total in 2014, probably owing to increasing use of substitutes, such as synthetic fibers for natural fiber and synthetic oils for natural oils, and possibly more dependency on imported final or semifinal products (for which the embedded materials are not accounted) (Wagner, 2002).

Forestry

The forestry category includes nonfuel forest products, such as wood and paper, and includes recycled paper. In 2014, about 63 percent of paper and paperboard was recovered to make new paper products. Wood products, such as lumber, plywood, and veneer, and other nonfuel forestry products were used more intensely at the beginning of the century. Lumber was the primary building material. Following the Great Depression, many lumber companies were forced to shut down; wood products usage was lowest in 1932, at 27.5 million metric tons (Mt). Moreover, the steady decline of wood usage was intensified owing to the increased consumption of cement and steel products; and after 1990, paper and paperboard usage exceeded that of wood.

Nonfuel Minerals

Construction Materials.—On a gross weight basis, the construction materials category includes the bulk of mineral commodities: crushed stone and construction sand and gravel made up 72 percent, by weight, of new mineral materials put into use in the United States in 2014. Although consumption in 2014 remained well below the alltime, pre-recession peak in 2006, usage of these commodities is expected to increase owing to increasing construction activity in the country. Usage of these materials during the study period increased as a result of infrastructure growth (such as the creation of the Interstate Highway system), rebuilding and extending the road network to cities, and construction of other infrastructures (such as airports, dams, buildings, and housing) (Tepordei, 1997).

Although not shown separately, material usage among individual nonfuel minerals has evolved with technological innovations in both production and usage. As technology changes, new materials are developed or old materials are used in different applications (such as silicon for the semiconductor and solar energy industries, titanium for aerospace applications, and indium for electrical conductive purposes in flat-panel displays). These materials are not significant by weight but are extremely valuable in a society driven by computers and telecommunication systems.

Industrial Minerals.—The industrial minerals category includes materials for use in agricultural, construction, chemical, and industrial sectors of the economy. Industrial minerals are mineral commodities such as barite for oil and gas drilling; fertilizer materials such as nitrogen, phosphate rock, and potash; fluorspar for acid; lime for steelmaking; salt for ice control and chemicals; and an extensive range of other industrial minerals from abrasive materials to gypsum, mica, and zirconium. However, the industrial minerals category representation by weight is relatively small, accounting for just 13 percent of total materials used in 2014.

Metals.—The metals category includes commodities ranging from aluminum and antimony to vanadium and zinc. It includes traditional ferrous, nonferrous, and precious metals as well as specialty metals used for high-technology applications (such as indium, gallium, and lithium), and it is distributed by source as primary and secondary (recycled) materials. In 2014, recycled metals accounted for about 40 percent of metals use by weight. Total metals consumption has recovered from the recession in 2007–9, in spite of slow recovery of the construction sector.

Nonrenewable Organics

The nonrenewable organic materials category includes products derived from feedstocks of petroleum (including natural-gas liquids), dry natural gas, and coal for nonfuel applications (such as carbon blacks, coke, and olefins). These include asphalt and road oil, feedstocks used in the production of solvents and other petroleum and plastic products, lubricants, synthetic fibers, synthetic rubber, and miscellaneous waxes. Use of nonrenewable organics emerged gradually in the early part of the 20th century, accounting for 1.59 Mt in 1900. The use of these materials subsequently underwent nearly continual growth, to 155 Mt in 1999; currently, the use of commodities included in this category is recovering from the great economic recession of 2007–9, reaching about 123 Mt in 2014. The use of nonrenewable organic materials increased as a result of the development of new technologies and products that displaced more traditional materials. In some applications, synthetic fibers, plastic feedstocks, and lubricants replaced wood, metals, and other mineral-based commodities because of cost advantages and (or) more desirable properties. The National Asphalt Pavement Association is quantifying the use of recycled paving material through industry surveys. In 2014, more than 71.9 Mt of reclaimed asphalt pavement and nearly 2 Mt of recycled asphalt shingles were put to use in new pavements in the United States (National Asphalt Pavement Association, 2015). These data were not included in the study but possibly explain the decline in the overall use of nonrenewable organics.

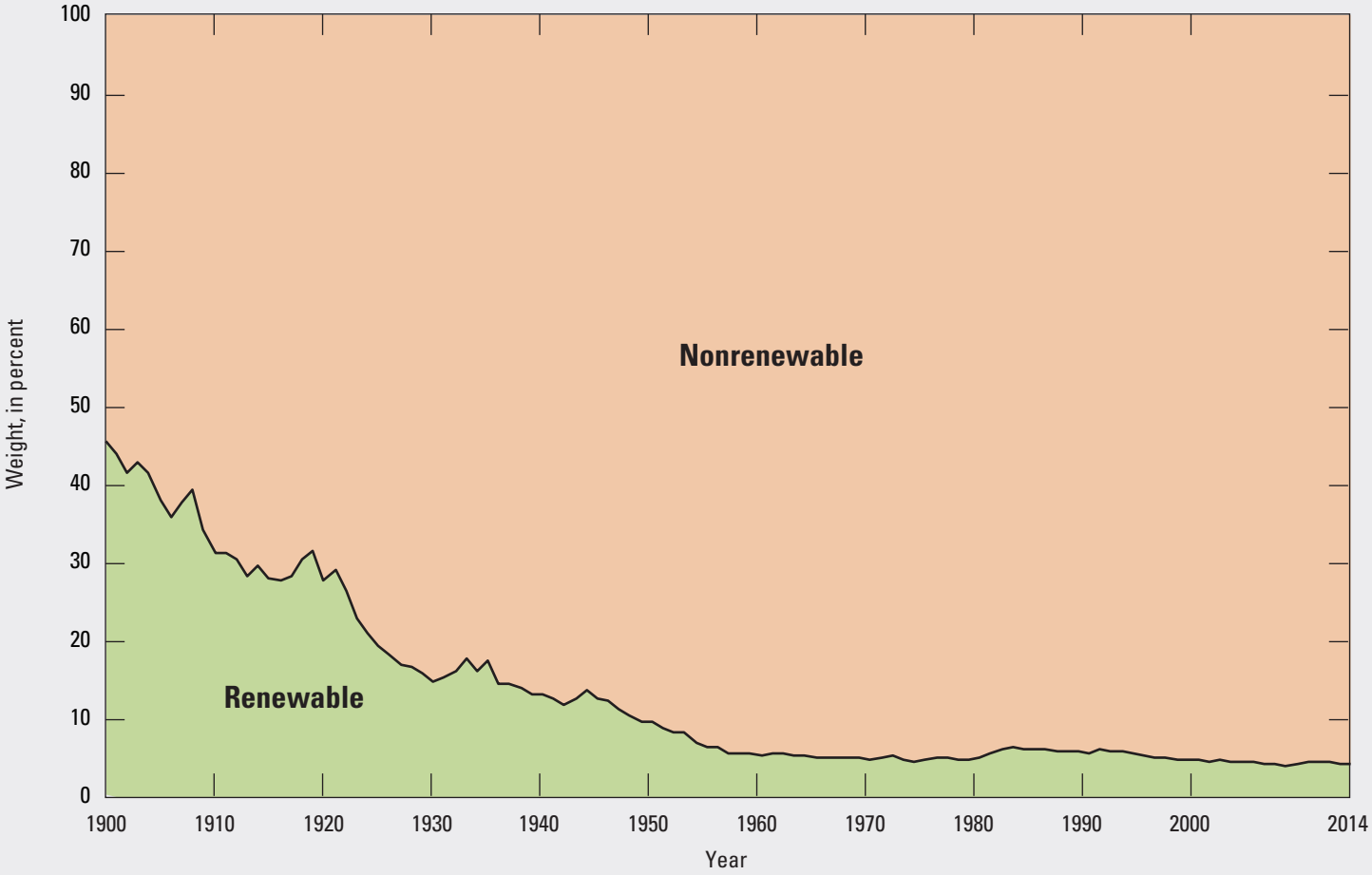

Figure 3. Graph showing percentage of U.S. annual material usage of renewable and nonrenewable materials from 1900 through 2014.

Renewable and Nonrenewable Resources

Raw materials or their products are natural resources that are either harvested or mined. These may be classified as renewable or nonrenewable resources. Renewable resources—such as products from agriculture, fishery, forestry, and wildlife—can regenerate, so long as they are not overharvested, overfished, or overhunted. Nonrenewable resources in this study include materials extracted from geologic deposits, such as nonfuel minerals and nonrenewable organics. In 2014, only 4 percent of the nearly 3,000 Mt of new materials entering the U.S. economy were renewable, a shift from 46 percent in 1900 (fig. 4). Of all the materials used during the study period, more than one-half were used during the past 30 years (Matos and Wagner, 1998).

The compilation of the material usages in the U.S. economy assists in understanding a global usage of renewable and nonrenewable natural resources to satisfy the needs and wants of society. Balancing resource extraction and usage and their environmental impact have implications that potentially could affect supply chains for industry and manufacturing sectors in the economy. However, advances in technology for the development of resource substitutes, improvements in technology for the discovery and extraction of mineral resources, and improved recycling efficiencies may reduce the possibility of exhausting the supply of nonrenewable resources and secure a sustainable supply of materials for society.

Data Sources Used to Track Flows of Raw Materials Usage

The following is a list of data sources used to track these flows:

- Food and Agriculture Organization of the United Nations; World Statistical Compendium for Raw Hides and Skins, Leather and Leather Footwear 1999–2015 (for animal and agricultural products)
- National Oceanic and Atmospheric Administration, National Marine Fisheries Service; Fisheries of the United States (for fisheries statistics)
- Resources for the Future; Natural Resource Commodities—A Century of Statistics (for agriculture statistics)
- U.S. Bureau of Mines and U.S. Geological Survey (for metal and mineral statistics)
  - Mineral Resources of the United States
  - Minerals Yearbook
- U.S. Department of Agriculture, National Agricultural Statistics Service (for agriculture statistics)
  - Annual Agricultural Statistics
  - Economic Research Service data products
- U.S. Department of Commerce, U.S. Census Bureau; Statistical Abstract of the United States (for agriculture statistics)
- U.S. Energy Information Administration; Annual Energy Review (for nonrenewable organics statistics)
- U.S. Forest Service; U.S. Timber Production, Trade, Consumption, and Price Statistics (for forestry and paper statistics)
- U.S. International Trade Commission
  - Interactive Tariff and Trade DataWeb (for agricultural products)
  - Synthetic Organic Chemicals publication (for nonrenewable organics statistics, and statistics on primary products made from petroleum and natural gas)

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