

2018 Manufacturing Energy and Carbon Footprints: Scope

The U.S. Department of Energy Advanced Manufacturing Office *Manufacturing Energy and Carbon Footprints* examine twenty individual manufacturing sectors that together consume 95% of U.S. manufacturing primary and account for 94% of U.S. manufacturing greenhouse gas (GHG) emissions. Manufacturing sectors are defined by their respective NAICS (North American Industry Classification System) codes.¹ Individual sectors were selected for analysis based on their relative energy use, contribution to the U.S. economy, and importance to energy efficiency programs. NAICS code definitions of the sectors considered by this analysis are shown in Table 1 below and described in more detail in the subsequent pages of this document. A twenty-first footprint has also been prepared that shows energy consumption and GHG emissions of the U.S. manufacturing sector (NAICS 31 – 33) as a whole.

Table 1. NAICS Codes and Descriptions for Manufacturing Sectors

Manufacturing Sector	NAICS Code and NAICS Definition
All Manufacturing	NAICS 31 – 33 Entire Manufacturing Sector
Food and Beverage	NAICS 311 Food Manufacturing NAICS 312 Beverage and Tobacco Product Manufacturing
Textiles	NAICS 313 Textile Mills NAICS 314 Textile Product Mills NAICS 315 Apparel Manufacturing NAICS 316 Leather and Allied Product Manufacturing
Forest Products	NAICS 321 Wood Product Manufacturing NAICS 322 Paper Manufacturing
Petroleum Refining	NAICS 324110 Petroleum Refineries
Chemicals	NAICS 325 Chemical Manufacturing
Petrochemicals	NAICS 325110 Petrochemical Manufacturing
Plastics Material and Resins	NAICS 325211 Plastics Material and Resin Manufacturing
Plastics and Rubber Products	NAICS 326 Plastics and Rubber Products Manufacturing
Glass and Glass Products	NAICS 3272 Glass and Glass Product Manufacturing NAICS 327993 Mineral Wool Manufacturing
Cement	NAICS 327310 Cement Manufacturing
Iron and Steel	NAICS 331110 Iron and Steel Mills and Ferroalloy Manufacturing NAICS 3312 Steel Product Manufacturing from Purchased Steel
Alumina and Aluminum	NAICS 3313 Alumina and Aluminum Production and Processing
Foundries	NAICS 3315 Foundries

¹ All NAICS codes and definitions can be found on the United States Census Bureau's 2017 North American Industry Classification System. <https://www.census.gov/naics/>

Manufacturing Sector	NAICS Code and NAICS Definition
Fabricated Metals	NAICS 332 Fabricated Metal Product Manufacturing
Machinery	NAICS 333 Machinery Manufacturing
Computers, Electronics, and Electrical Equipment	NAICS 334 Computer and Electronic Product Manufacturing NAICS 335 Electrical Equipment, Appliance, and Component Manufacturing
Semiconductors	NAICS 334413 Semiconductor and Related Device Manufacturing
Transportation Equipment	NAICS 336 Transportation Equipment Manufacturing
Automobile and Light Duty Motor Vehicle	NAICS 336111 Automobile Manufacturing NAICS 336112 Light Truck and Utility Vehicle Manufacturing
Aerospace Product and Parts	NAICS 3364 Aerospace Product and Parts Manufacturing

NAICS Code Descriptions²

31 – 33 Manufacturing Sector as a Whole

The Manufacturing sector comprises establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products. Establishments in the Manufacturing sector are often described as plants, factories, or mills and characteristically use power-driven machines and material handling equipment. However, establishments that transform materials or substances into new products by hand or in the worker's home and those engaged in selling to the general public products made on the same premises from which they are sold, such as bakeries, candy stores, and custom tailors, may also be included in this sector. Manufacturing establishments may process materials or may contract with other establishments to process their materials for them. Both types of establishments are included in manufacturing.

311 – Food Manufacturing

Industries in the Food Manufacturing subsector transform livestock and agricultural products into products for intermediate or final consumption. The industry groups are distinguished by the raw materials (generally of animal or vegetable origin) processed into food products. The food products manufactured in these establishments are typically sold to wholesalers or retailers for distribution to consumers, but establishments primarily engaged in retailing bakery and candy products made on the premises not for immediate consumption are included.

312 – Beverage and Tobacco Product Manufacturing

Industries in the Beverage and Tobacco Product Manufacturing subsector manufacture beverages and tobacco products. Beverage Manufacturing includes three types of establishments: (1) those that manufacture nonalcoholic beverages; (2) those that manufacture alcoholic beverages through the fermentation process; and (3) those that produce distilled alcoholic beverages. Ice manufacturing, while not a beverage, is included with nonalcoholic beverage manufacturing because it uses the same production process as water purification. Tobacco Manufacturing includes two types of establishments: (1) those engaged in redrying and stemming tobacco and, (2) those that manufacture tobacco products, such as cigarettes and cigars.

² All definitions from the United States Census Bureau. <https://www.census.gov/naics/>

313 – Textile Mills

Industries in the Textile Mills subsector group establishments that transform a basic fiber (natural or synthetic) into a product, such as yarn or fabric that is further manufactured into usable items, such as apparel, sheets, towels, and textile bags for individual or industrial consumption. The further manufacturing may be performed in the same establishment and classified in this subsector, or it may be performed at a separate establishment and be classified elsewhere in manufacturing. The main processes in this subsector include preparation and spinning of fiber, knitting or weaving of fabric, and the finishing of the textile. The NAICS structure follows and captures this process flow. Major industries in this flow, such as preparation of fibers, weaving of fabric, knitting of fabric, and fiber and fabric finishing, are uniquely identified. Texturizing, throwing, twisting, and winding of yarn contains aspects of both fiber preparation and fiber finishing and is classified with preparation of fibers rather than with finishing of fiber.

314 – Textile Product Mills

Industries in the Textile Product Mills subsector group make textile products (except apparel). With a few exceptions, processes used in these industries are generally cut and sew (i.e., purchasing fabric and cutting and sewing to make non-apparel textile products, such as sheets and towels).

315 – Apparel Manufacturing

Industries in the Apparel Manufacturing subsector group have two distinct manufacturing processes: (1) cut and sew (i.e., purchasing fabric and cutting and sewing to make a garment), and (2) the manufacture of garments in establishments that first knit fabric and then cut and sew the fabric into a garment. The Apparel Manufacturing subsector includes a diverse range of establishments manufacturing full lines of ready-to-wear apparel and custom apparel: apparel contractors, performing cutting or sewing operations on materials owned by others; jobbers performing entrepreneurial functions involved in apparel manufacture; and tailors, manufacturing custom garments for individual clients are all included. Knitting, when done alone, is classified in the Textile Mills subsector, but when knitting is combined with the production of complete garments, the activity is classified in Apparel Manufacturing.

316 – Leather and Allied Product Manufacturing

Establishments in the Leather and Allied Product Manufacturing subsector transform hides into leather by tanning or curing and fabricating the leather into products for final consumption. It also includes the manufacture of similar products from other materials, including products (except apparel) made from "leather substitutes," such as rubber, plastics, or textiles. Rubber footwear, textile luggage, and plastics purses or wallets are examples of "leather substitute" products included in this group. The products made from leather substitutes are included in this subsector because they are made in similar ways leather products are made (e.g., luggage). They are made in the same establishments, so it is not practical to separate them. The inclusion of leather making in this subsector is partly because leather tanning is a relatively small industry that has few close neighbors as a production process, partly because leather is an input to some of the other products classified in this subsector and partly for historical reasons.

321 – Wood Product Manufacturing

Industries in the Wood Product Manufacturing subsector manufacture wood products, such as lumber, plywood, veneers, wood containers, wood flooring, wood trusses, manufactured homes (i.e., mobile homes), and prefabricated wood buildings. The production processes of the Wood Product Manufacturing subsector include sawing, planing, shaping, laminating, and assembling of wood products starting from logs that are cut into bolts, or lumber that then may be further cut, or shaped by lathes or other shaping tools. The lumber or other transformed wood shapes may also be subsequently planed or smoothed, and assembled into finished products, such as wood containers. The Wood Product Manufacturing subsector includes establishments that

make wood products from logs and bolts that are sawed and shaped, and establishments that purchase sawed lumber and make wood products. With the exception of sawmills and wood preservation establishments, the establishments are grouped into industries mainly based on the specific products manufactured.

322 – Paper Manufacturing

Industries in the Paper Manufacturing subsector make pulp, paper, or converted paper products. The manufacturing of these products is grouped together because they constitute a series of vertically connected processes. More than one is often carried out in a single establishment. There are essentially three activities. The manufacturing of pulp involves separating the cellulose fibers from other impurities in wood or used paper. The manufacturing of paper involves matting these fibers into a sheet. Converted paper products are made from paper and other materials by various cutting and shaping techniques and includes coating and laminating activities.

324110 – Petroleum Refineries

This subsector comprises establishments primarily engaged in refining crude petroleum into refined petroleum. Petroleum refining involves one or more of the following activities: (1) fractionation; (2) straight distillation of crude oil; and (3) cracking.

325 – Chemical Manufacturing

The Chemical Manufacturing subsector is based on the transformation of organic and inorganic raw materials by a chemical process and the formulation of products. This subsector distinguishes the production of basic chemicals that comprise the first industry group from the production of intermediate and end products produced by further processing of basic chemicals that make up the remaining industry groups.

325110 – Petrochemical Manufacturing

This industry comprises establishments primarily engaged in (1) manufacturing acyclic (i.e., aliphatic) hydrocarbons such as ethylene, propylene, and butylene made from refined petroleum or liquid hydrocarbons and/or (2) manufacturing cyclic aromatic hydrocarbons such as benzene, toluene, styrene, xylene, ethyl benzene, and cumene made from refined petroleum or liquid hydrocarbons.

325211 – Plastics Material and Resin Manufacturing

This U.S. industry comprises establishments primarily engaged in (1) manufacturing resins, plastics materials, and nonvulcanizable thermoplastic elastomers and mixing and blending resins on a custom basis and/or (2) manufacturing noncustomized synthetic resins.

326 – Plastics and Rubber Products Manufacturing

Industries in the Plastics and Rubber Products Manufacturing subsector make goods by processing plastics materials and raw rubber. The core technology employed by establishments in this subsector is that of plastics or rubber product production. Plastics and rubber are combined in the same subsector because plastics are increasingly being used as a substitute for rubber; however the subsector is generally restricted to the production of products made of just one material, either solely plastics or rubber.

3272 – Glass and Glass Product Manufacturing

This industry comprises establishments primarily engaged in manufacturing glass and/or glass products. Establishments in this industry may manufacture glass and/or glass products by melting silica sand or cullet, or purchasing glass.

327993 – Mineral Wool Manufacturing

This industry comprises establishments primarily engaged in manufacturing mineral wool and mineral wool (i.e., fiberglass) insulation products made of such siliceous materials as rock, slag, and glass, or combinations thereof.

327310 – Cement Manufacturing

This industry comprises establishments primarily engaged in manufacturing portland, natural, masonry, pozzolanic, and other hydraulic cements. Cement manufacturing establishments may calcine earths or mine, quarry, manufacture, or purchase lime.

331110 – Iron and Steel Mills and Ferroalloy Manufacturing

This industry comprises establishments primarily engaged in one or more of the following: (1) direct reduction of iron ore; (2) manufacturing pig iron in molten or solid form; (3) converting pig iron into steel; (4) making steel; (5) making steel and manufacturing shapes (e.g., bar, plate, rod, sheet, strip, wire); (6) making steel and forming pipe and tube; and (7) manufacturing electrometallurgical ferroalloys. Ferroalloys add critical elements, such as silicon and manganese for carbon steel and chromium, vanadium, tungsten, titanium, and molybdenum for low- and high-alloy metals. Ferroalloys include iron-rich alloys and more pure forms of elements added during the steel manufacturing process that alter or improve the characteristics of the metal being made.

3312 – Steel Product Manufacturing from Purchased Steel

This industry group comprises establishments primarily engaged in manufacturing iron and steel tube and pipe, drawing steel wire, and rolling or drawing shapes from purchased iron or steel.

3313 – Alumina and Aluminum Production and Processing

This industry comprises establishments primarily engaged in one or more of the following: (1) refining alumina; (2) making (i.e., the primary production) aluminum from alumina; (3) recovering aluminum from scrap or dross; (4) alloying purchased aluminum; and (5) manufacturing aluminum primary forms (e.g., bar, foil, pipe, plate, rod, sheet, tube, wire).

3315 – Foundries

This industry group comprises establishments primarily engaged in pouring molten metal into molds or dies to form castings. Foundries may perform operations, such as cleaning and deburring, on the castings they manufacture.

332 – Fabricated Metal Product Manufacturing

Industries in the Fabricated Metal Product Manufacturing subsector transform metal into intermediate or end products, other than machinery, computers and electronics, and metal furniture, or treat metals and metal formed products fabricated elsewhere. Important fabricated metal processes are forging, stamping, bending, forming, and machining, used to shape individual pieces of metal; and other processes, such as welding and assembling, used to join separate parts together. Establishments in this subsector may use one of these processes or a combination of these processes.

333 – Machinery Manufacturing

Industries in the Machinery Manufacturing subsector create end products that apply mechanical force, for example, the application of gears and levers, to perform work. Some important processes for the manufacture

of machinery are forging, stamping, bending, forming, and machining that are used to shape individual pieces of metal. Processes, such as welding and assembling are used to join separate parts together. Although these processes are similar to those used in metal fabricating establishments, machinery manufacturing is different because it typically employs multiple metal forming processes in manufacturing the various parts of the machine. Moreover, complex assembly operations are an inherent part of the production process.

334 – Computer and Electronic Product Manufacturing

Industries in the Computer and Electronic Product Manufacturing subsector group establishments that manufacture computers, computer peripherals, communications equipment, and similar electronic products, and establishments that manufacture components for such products.

334413 – Semiconductor and Related Device Manufacturing

This U.S. industry comprises establishments primarily engaged in manufacturing semiconductors and related solid-state devices. Examples of products made by these establishments are integrated circuits, memory chips, microprocessors, diodes, transistors, solar cells and other optoelectronic devices.

335 – Electrical Equipment, Appliance, and Component Manufacturing

Industries in the Electrical Equipment, Appliance, and Component Manufacturing subsector manufacture products that generate, distribute and use electrical power. Electric Lighting Equipment Manufacturing establishments produce electric lamp bulbs, lighting fixtures, and parts. Household Appliance Manufacturing establishments make both small and major electrical appliances and parts. Electrical Equipment Manufacturing establishments make goods, such as electric motors, generators, transformers, and switchgear apparatus. Other Electrical Equipment and Component Manufacturing establishments make devices for storing electrical power (e.g., batteries), for transmitting electricity (e.g., insulated wire), and wiring devices (e.g., electrical outlets, fuse boxes, and light switches).

336 – Transportation Equipment Manufacturing

Industries in the Transportation Equipment Manufacturing subsector produce equipment for transporting people and goods. Transportation equipment is a type of machinery. An entire subsector is devoted to this activity because of the significance of its economic size in all three North American countries.

33611 – Automobile and Light Duty Motor Vehicle Manufacturing

This industry comprises establishments primarily engaged in (1) manufacturing complete automobile and light duty motor vehicles (i.e., body and chassis or unibody) or (2) manufacturing automobile and light duty motor vehicle chassis only.

3364 – Aerospace Product and Parts Manufacturing

This industry comprises establishments primarily engaged in one or more of the following: (1) manufacturing complete aircraft, missiles, or space vehicles; (2) manufacturing aerospace engines, propulsion units, auxiliary equipment or parts; (3) developing and making prototypes of aerospace products; (4) aircraft conversion (i.e., major modifications to systems); and (5) complete aircraft or propulsion systems overhaul and rebuilding (i.e., periodic restoration of aircraft to original design specifications).