What Raw Materials Do Auto Manufacturers Use?

Automobile manufacturing is resource-intensive, requiring a substantial amount of raw materials sourced from all over the globe. Their journey from extraction to your driveway is complex, and as more esoteric metals are needed for batteries in electric vehicles (EVs) and for other sophisticated features, it's becoming even more so. Below, we lead you through what you need to know, whether you're considering investing in the sector or want to know what's under and around your hood while you're on the road.

KEY TAKEAWAYS

- The automobile industry consumes raw materials from around the world in the production of cars and auto parts.
- Steel, rubber, plastics, and aluminum are the four most common commodities found in cars.
- The auto industry relies heavily on petroleum products, not just for gasoline for autos with internal combustion engines (ICE), but for synthesizing plastics and other synthetic materials.
- The rise of electric vehicles (EVs) has brought wide attention to the sources of materials for their batteries.

The sector uses more raw materials than just about any other industry.1 These include aluminum and glass, useful because it is lightweight and durable, and iron, which is converted into steel and employed for its strength and versatility. In addition, petroleum products aren't just used to power automobiles after production but are the basis for plastics, rubber, and specialized fibers found throughout cars.

Understanding What's In Your Car

The materials chosen for automobiles need to be relatively inexpensive, available in the vast quantities needed for mass production, meet regulatory standards that can span several continents, meet automotive company sustainability guidelines, and withstand punishing speeds and potential crashes. As some auto manufacturers look more like tech companies and as climate change forces increases in fuel efficiency, automobiles have grown ever more complicated. To understand what it takes to make today's automobiles, it's best to first look at the range of ways we power our vehicles since that affects many of the raw materials needed:

Battery Electric Vehicles (BEVs)

- Fuel type: Powered entirely by electricity, stored in batteries (typically lithium-ion). Some BEVs also have a regenerative braking system that can capture the energy lost during braking and store it for later use.
- Engine mechanics: Rapidly evolving with advances in battery technology, charging infrastructure, and vehicle efficiency. It uses electric motors and battery packs for propulsion; no internal combustion.
- Emissions: Zero tailpipe emissions, and overall emissions are indirect and depend on the electricity source for charging. The production of BEVs produces 8.8 metric tons of CO_2, 43 % for battery production.

- Charging and range: Requires charging at electric vehicle stations or through home charging setups. In 2023, the average BEV on American roads had a range of almost 300 miles when fully charged.

Fuel Cell Electric Vehicles (FCEVs)

- Fuel type: Powered by hydrogen gas used in a fuel cell to produce electricity. Many FCEVs have a regenerative braking system that can capture the energy lost during braking and store it for later use.
- Engine mechanics: FCEVs use propulsion like that of electric vehicles. Energy stored as hydrogen is transformed into electricity by a fuel cell.
- Emissions: Only emits water vapor; zero greenhouse gases from the vehicle. CO_2 from manufacturing is about the same as that from ICE vehicles.
- Fueling and range: Refueling with hydrogen is required at specialized hydrogen stations. The driving range is more than 300 miles.

Hybrid Electric Vehicles (HEVs)

- Fuel type: Combines a traditional internal combustion engine with an electric motor, but unlike PHEVs, they cannot be plugged in to recharge.
- Engine mechanics: The electric battery can be recharged by the internal combustion engine and sometimes by regenerative braking.
- Emissions: Generally lower emissions compared with traditional ICE vehicles because of improved fuel efficiency, about 2.16 metric tons of CO_2 annually.5
- Fueling and range: Requires refueling at gas stations. Range depends on the fuel tank capacity.

Internal Combustion Engine (ICE) Vehicles

- Fuel type: It uses gasoline or diesel, produced from crude oil, extracted from oil wells, and processed in refineries to separate out numerous components.
- Engine mechanics: One of the oldest automotive technologies with an extended and easily found infrastructure for repair and refueling. Fuel combustion generates power that drives the pistons and turns the crankshaft, propelling the vehicle.
- Emissions: Manufacturing an average ICE vehicle produces 5.6 tons of CO_2.23 They also emit carbon dioxide and other pollutants because of fuel combustion. The average passenger vehicle emits about 4.6 metric tons of CO_2 annually and has an average fuel economy of 22.2 miles per gallon. That's about 30% of total U.S. energy-related CO_2 emissions.67
- Fueling and range: Requires refueling at gas stations. Range depends on the fuel tank capacity.

Plug-in Hybrid Electric Vehicles (PHEVs)

- Fuel type: Combines an internal combustion engine with an electric battery that can be recharged by plugging into an external power source.

- Engine mechanics: Bridges the gap between traditional ICE and fully electric vehicles. Can switch between the electric motor and internal combustion engine for propulsion.
- Emissions: Lower emissions than ICE vehicles when operating in electric mode; produces emissions when using the combustion engine. These vehicles also generally produce more CO_2 during manufacturing than traditional ICE vehicles.68
- Fueling and range: Can be fueled at gas stations and charged at electric vehicle charging stations or with home outlets. It can operate as an electric vehicle for short distances, from 25 to 60 miles.8

Raw Materials in Automobiles

Since early on, the automotive industry has been used as a textbook case of modern, globalized manufacturing and raw material sourcing. The automotive supply chain spans several continents, with countries like Australia, China, Russia, the U.S., and several others playing significant roles for most of the materials needed for today's vehicles.

The availability of raw materials for automobiles is often dictated by geography and the geopolitical volatility of the supply chain. More specialized metals are often called upon as manufacturing needs change, and this brings still more countries into the global automotive supply chain. For example, rare earth elements are predominantly sourced from China, while countries like Indonesia and the Philippines are crucial for nickel, essential in EV battery production. Prices and demand for materials like palladium, platinum, and lithium are extremely volatile, and political stability, trade policies, and international relations significantly impact the supply chain. Issues like trade tensions can disrupt the flow of materials, and even local issues like a union strike or regional political crisis can affect production and prices globally.

The ecological effects of sourcing and processing these materials, such as the mining of lithium or cobalt, have brought sustainability and ethical sourcing to the forefront of the industry and the general public. The sector faces many challenges and changes, including weighing efficiency and cost-effectiveness with environmental responsibility and ethical practices. This means not just looking to source materials in more sustainable ways, but also working to ensure better practices are used when automobiles are no longer driveable.9 Today, the ultimate outcome is that 86% of the raw materials discussed here will be recycled for further use.10

Aluminum

- Sources (here and below, listed by the amount produced): Guinea, Australia, Vietnam, and Jamaica.11
- Found in: Engine blocks, transmission housings, wheels, and body parts of all vehicle types.

Bauxite, the primary ore for aluminum, and alumina are used to produce aluminum, which, year by year, is becoming the dominant metal in cars. Primarily because of its malleability and lightweight nature, it's suitable for increasing fuel efficiency or extending the EV battery range. The metal has replaced steel and iron in the construction of many critical auto parts, such as engine blocks.

In 1975, just 84 pounds of aluminum was used in the typical car. In 2020, the figure was about 466 pounds in 2020, with industry expectations that it'll reach 565 pounds by 2030.1213

Cobalt

- Sources: Democratic Republic of Congo, Indonesia, Australia, and the Philippines.14

- Found in: Batteries for BEVs and PHEVs.

The DRC dominates, producing about 73% of the world's cobalt supply.14 The most prominent use of cobalt in automobiles is for the lithium-ion batteries in electric vehicles since it's a key material in their cathodes. Aside from batteries, cobalt is an alloying element for several car parts, especially those that must withstand extreme conditions.

Copper

- Sources: Chile, Peru, China, and the U.S.15
- Found in: Electrical wiring, electronics, computer systems in all vehicle types; starters in ICE, PHEVs, and FECVs.

Copper's conductivity is essential for the vehicle's electrical systems, providing efficient power distribution and operation of complex electronics. It is thus used to operate everything from the radio to navigational systems and rearview cameras.

Fiberglass

- Sources: The raw material for fiberglass also trademarked as fiberglas is silica sand, which is abundant worldwide. China is the largest producer, manufacturing more than the next three major source countries combined.16
- Found in: Bumpers, car doors, and wheels of all vehicle types.

Fiberglass is a composite material made from extremely fine glass fibers. It's a light, noncorrosive material used instead of metals for certain applications. Combined with resin, it creates a light material that can't corrode, making it a good replacement for metals in bumpers, car doors, and wheels.

Glass

- Sources: The raw material is silica sand, abundant worldwide. However, China exports about 29% of the glass used in manufacturing.17
- Found in: Windshields, windows, and rearview and side view mirrors of all vehicle types.

Glass is common to all cars. From windshields and windows to rearview and side view mirrors, you need glass to build a vehicle. Glass is an incredibly common material that is used for many other purposes, with the global market being worth $106.44 billion in 2022.18

Lead

- Sources: China is the largest producer worldwide.19 There are also significant mining operations in Australia, Mexico, Peru, and the U.S. (Missouri).
- Found in: Wheel balancing weights (all vehicle types); car batteries (ICE and FECV).

Lead is a heavy metal that car manufacturers use to ensure cars stay balanced. Car wheels typically have some amount of lead to balance their weight, too. Batteries can include lead, which helps them remain at a lower temperature during use.

Lithium

- Sources: Australia, Chile, China, and Australia.

- Found in: Batteries of BEVs. Lithium-ion batteries are central to the operation of electric vehicles, offering high energy capacity and the ability to be recharged.

Lithium is one of the primary components of the batteries used to build electric cars. Lithium-ion batteries have a higher capacity than batteries with other metals that can be used in mass production, and they can be charged many times before they degrade. The use of lithium in auto manufacturing is expected to increase, with the number of EVs on the road expected to reach almost 150 million by 2030.20 Analysts estimate a CAGR of 12.8% between 2024 and 2030.21

Magnesium (magnesite)

- Sources: China is by far the major producer, more than the next nine countries combined.22
- Found in: Portions of a car's body, structure, engine.

The primary source of magnesium is seawater and underground deposits of minerals such as magnesite (magnesium carbonate) and dolomite (magnesium calcium carbonate). Magnesium can also be obtained from saltwater brines, which contain significant amounts of magnesium chloride. Lighter than steel or aluminum, magnesium is used in areas where weight reduction is needed without compromising strength.

Nickel

- Sources: Australia, Indonesia, Brazil, Russia, and the Philippines.23
- Found in: The cathodes of lithium-ion batteries, which are used in BEVs and PHEVs.

Nickel is added to other metals to create alloys with enhanced properties like strength at high temperatures, corrosion resistance, and toughness. These alloys are used in many automotive parts to ensure durability and reliability.

Petroleum

- Sources: U.S., Saudi Arabia, Russia, Canada, and Iraq.24
- Used in: Plastics and polymers found in dashboards, door handles, air vents, air bags, instrument panels, seats, and HVAC systems of all vehicle types.

Petroleum is the raw material for the many plastic components in cars. Chemical companies transform petroleum byproducts into plastic. Plastics are the challenger to steel for prominence in auto manufacturing. The typical new car is made with 151 kilograms of plastics and composite materials, accounting for about 8% of the vehicle's weight and 50% of the volume of materials.25 Among the countless car parts made from plastic are door handles, air vents, the dashboard, and air bags. The versatility, durability, and lightweight character of plastics make them an ideal material for automotive parts.

Platinum (palladium)

- Sources: South Africa, Canada, U.S., and Zimbabwe.26
- Found in: Used in catalytic converters (ICE, HEVs, and PHEVs).

Palladium and platinum are extracted from ore deposits, often found alongside nickel and copper ores. Both palladium and platinum are crucial components in catalytic converters, which are devices used to reduce harmful emissions in vehicle exhaust systems. They are catalysts, facilitating the

conversion of toxic gases from the engine (like carbon monoxide, nitrogen oxides, and hydrocarbons) into less harmful substances (like carbon dioxide, nitrogen, and water vapor).

Rare earth elements

- Sources: China, U.S., and Australia27
- Found in: Electric motors in all EVs. They are found in some batteries and electronic components of other vehicle types.

The importance of rare earth metals in the automotive industry, particularly for electric and hybrid vehicles, lies in their unique magnetic and electric properties. They are typically extracted from bastnaesite, monazite, and xenotime ores, which involve using acids and the causes of radioactive byproducts.28 Rare earth elements like neodymium are primarily sourced from China, which dominates the market. Other sources include Australia and the U.S. They are preferred for their strength and ability to operate efficiently at high temperatures. Because of their unique chemical properties, other rare earth elements like lanthanum and cerium can be used in battery electrodes and electronic components.

Rubber

- Sources: Natural rubbers are sourced in Thailand, Indonesia, and Vietnam.29 Synthetic rubber is derived from petroleum products (see above).
- Found in: Tires, belts, hoses, and seals.

Rubber is essential for cars, and the auto industry. Tires are one of the most important parts of a car. Rubber is also used for making numerous belts, hoses, and seals critical to the functioning of a car's engine in ICE, HEVs, and PHEVs. Like plastic, rubber is durable and easily molded into different shapes. Demand for natural rubber is forecast to reach $33.87 billion by 2027, up from $28.65 billion in 2019, with the automotive sector accounting for 65.3%.3031

Steel (iron ore)

- Sources: China, India, Japan, and the U.S.32
- Found in: Chassis, body, roof, door panels, and beams between doors for all vehicle types; mufflers and exhaust pipes for HEVs, ICE, and PHEVs.

Steel is produced from iron ore and is traditionally widely used in auto manufacturing. On average, 900 kilograms of steel is used in every car. Steel is used to construct a car's chassis and body, including the roof, body, door panels, and the beams between doors. Steel is also used in mufflers and exhaust pipes. Technological advances over the years have enabled automakers to deploy different types of steel with varying levels of rigidity or move away toward less dense materials altogether.

How Have the Materials Used in Cars Changed Over Time?

For most of their history, steel was the main material used to build cars. Only in the past quarter-century have more complex materials like aluminum, carbon fiber, and magnesium, begun to see use.33

How Long Does it Take to Manufacture a Car?

A typical car has about 30,000 different parts. Usually, each of those parts is manufactured at different facilities and sent to a final production plant where the vehicle is assembled. Depending on the complexity of the car, it can take 18 to 35 hours for an assembly line to assemble a car from start to finish.34

Why Are Lightweight Materials Important for Cars?

Recent trends in auto production have shown the importance of replacing heavier materials with lighter ones, such as fiberglass and magnesium. Reducing the weight of a car can improve or maintain safety and reduce the fuel used. For every 10% reduction in vehicle weight, drivers see a 6% to 8% fuel economy increase, which could help Americans save as much as 5 billion gallons of fuel each year by 2030.35

The Bottom Line

The automotive supply chain spans several continents, with countries like China, the U.S., Russia, Australia, and several others playing pivotal roles, in particular, for materials ranging from steel, aluminum, and rare earth elements to petroleum products and natural resources like rubber and silica sand. As technology and environmental considerations evolve, so does the automotive industry's approach to materials, as seen in the increased use of aluminum for lowering the weight of vehicles. There's also been a shift toward more sustainable sources of rubber and plastics.

Economic, ecological, and geopolitical changes greatly influence the sourcing of these materials. From metals to fibers to the sand and quartz used to make glass, automobile manufacturing uses more raw materials than just about any other industry. Since it first developed the assembly line process, the auto industry has always been the leading example of mass production, and its continued adaptive use of raw materials has been as important to the rise and central place of the automobile as the invention of the internal combustion engine.