Minerals and the Renewable Energy Transition

The ongoing transition to sustainable (or "green") energy sources will require significant amounts of mineral resources critical to make the batteries, solar panels, transmission lines, wind turbines, and other infrastructure required for this transition. While consumption of coal and other fossil fuels may decrease as more environmentally sustainable energy sources are built, requirements for other minerals—such as those in this kit, and many others—will continue to increase dramatically as demands continue to rise. Read on to learn how the minerals in this kit are essential in the transition.

The links below show just how many minerals are required for LED light-bulbs, solar panels, wind turbines, and hybrid cars.

MEC_Fact_Sheet_LED_Bulbs.pdf
MEC_Fact_Sheet_Solar_Panel.pdf
MEC-Fact-Sheet-Wind-Turbines.pdf
MEC_Fact_Sheet_Hybrid_Car.pdf

A Brief Note about Grade in Mining:
In mining, grade is the determining factor on if a mineralized rock is economic to mine. Grade is commonly expressed as the amount of metal over the rock mass; for instance ounces of silver per ton of rock ("opt"). Grade can also be expressed as the percent of the rock mass. While not all of our samples have information about grade, the samples illustrate how a relatively small amount of metal can pay for the cost of mining operations.

Mineral Resources Kit

Learn about some of the minerals required for the Green Energy Transition

1: Lithium – Albemarle – Kings Mountain, North Carolina USA

Geological Description:

Pegmatites are a type igneous rock with distinctive large crystals. This pegmatite contains the mineral spodumene, a silicate mineral with aluminum and lithium. Spodumene pegmatites are an important source of lithium along with lake brines and playa evaporites.

End Use in the Green Energy Transition:

More than 80% of lithium mined is used in batteries. This use has recently increased rapidly spurring an increase in lithium mining to provide the lithium for batteries. It is estimated that there's about 63 kg (139 lb) of lithium in a 70 kWh Tesla Model S battery pack, which weighs over 1,000 lbs (~453 kg)(from Electrek).
Lithium
Minerals in my state

2: Copper – Hudbay Minerals – Copper Mountain Mine, British Columbia, Canada

Geological Description:

The Copper Mountain deposit is hosted in a type of intrusive igneous rock known as a porphyry. Porphyries supply approximately 60% of the world's copper (usgs.gov). Minerals in this specimen are likely to include
chalcopyrite (copper, iron), bornite (copper, iron), chalcocite (copper), and pyrite (iron).

End Use in the Green Energy Transition:

In pure form, copper is drawn into wires or cables for power transmission (wind farms), building wiring, motor (especially electric vehicle motors) and transformer wiring, wiring in commercial and consumer electronics and equipment. Recycled copper, predominantly from scrap metal, supplies approximately one-third of the United States' annual copper needs.
Copper in our Electrical World Video
Copper

3: Bauxite (Aluminum, Al) – SEMCOA & Others – Bauxite, Arkansas, USA

Geological Description

As might be expected of the third most common element in the Earth's crust, aluminum is present in a great number of minerals, and is relatively rich in clay, alunite and mica minerals. It is currently uneconomical to extract it from them, however. Aluminum is chiefly obtained from the minerals diaspore, boehmite, and gibbsite, which comprise bauxite ore.

End Use in the Green Energy Transition

About 85% of all the bauxite mined worldwide is used to produce alumina for refining into aluminum metal. Aluminum is easily recycled and is used in a variety of renewable technologies including electric vehicles and wind turbines. Learn more about how bauxite is turned into aluminum products through electrolysis by watching this video.
Extraction of Aluminium from Bauxite (The Science Chef Academy on YouTube)
Aluminum: Saving Energy to Make More

4: Molybdenum (Mo) – Climax Molybdenum: A Freeport-McMoRan Company – Henderson/Climax Mine, Colorado USA

Geological Description:

The Henderson and Climax mines are a porphyry molybdenum deposit, with molybdenite as the primary sulfide mineral. Climax has the capacity to produce approximately 30 million pounds of molybdenum per year. Henderson has the capacity to produce approximately 18 million pounds of molybdenum per year. These pellets contain approximately 15% molybdenum. (United States of America | Climax Molybdenum - A Freeport-McMoRan Company)

End Use in the Green Energy Transition:

Molybdenum is primarily used as an alloy to increase the strength of steel. Steel is a critical component for wind turbines and other green energy infrastructure.
Molybdenum: Helping to Build a Strong Future

5: Silica (Si) – Madagascar, Africa

Geological Description:

These quartz crystals contain silicon. There are hundreds of silicon-bearing minerals, including quartz, probably the second most common mineral on Earth. Silicon is chiefly obtained from quartz, which is not much more difficult to mine than scooping up sand. Silicon is also obtained from the minerals mica and talc.

End Use in the Green Energy Transition:

Semiconductor-grade silicon is used in the manufacture of silicon chips and solar cells. Ferrosilicon alloys are used to improve the strength and quality of iron and steel products. Tools, for instance, are made of steel and ferrosilicon. In addition to tool steels, an example of “alloy steels,” ferrosilicon is used in the manufacture of stainless steels, carbon steels, and other alloy steels. Silicon is used in the aluminum industry to improve cast-ability and weld-ability.
Silica
Sifting-Stones.pdf

6: Silver Polymetallic Ore (Ag, Zn, Pb) – Hecla – Greens Creek Mine, Alaska, USA

Geological Description:

The Greens Creek Mine primarily produces silver, with accompanying zinc, gold, and lead extracted from sediment and volcanic hosted sulfide deposits using underground mining methods. Ore minerals are dominantly comprised of sphalerite (zinc), galena (lead), tetrahedrite (copper, iron, zinc, silver), electrum (gold, silver), and proustite (silver). Other minerals on the property include bornite (copper, iron), covellite (copper), chalcocite (copper) and stromeyerite (copper, silver) (SLR International Corporation, 2022). These samples are dominantly sphalerite and galena. Average grade for this sample is 18.22opt silver, 0.166opt gold, 10.31% lead, and 13.64% zinc.

End Use in the Green Energy Transition:

Silver:
Silver is the best conductor of electricity and is used in solar panels to efficiently transfer electricity generated by the photovoltaic cells for immediate use or for battery storage. (Silver and Solar Technology | (silverinstitute.org)

Zinc:
Zinc is a minor component of an electric vehicle battery (Minerals used in electric cars compared to conventional cars – Charts – Data & Statistics - IEA) More commonly, zinc is used as a coating to protect iron and steel from corrosion (galvanized metal) (usgs.gov). Car frames use galvanized steel because of its anti-corrosive attribute.
Zinc
Everything is Made from Something Poster

7: Gold Ore (Au) – Newmont, Cripple Creek Victor Mine – Colorado, USA

Geological Description:
The Cripple Creek gold ore is associated with igneous rocks. Gold in this sample occurs principally as disseminated calaverite, a gold telluride mineral. Also visible in the sample is the iron sulfide mineral pyrite, also known as fool's gold. The average grade for this sample material is approximately 0.01opt gold. Chapter 17: Epithermal Gold Deposits Related to Alkaline Igneous Rocks in the Cripple Creek District, Colorado, United States | Geology of the World's Major Gold Deposits and Provinces | GeoScienceWorld Books | GeoScienceWorld (USGS)

End Use in the Green Energy Transition:
Gold performs critical functions in computers, communications equipment, spacecraft, jet aircraft engines, and a host of other products (usgs.gov).
Gold
Mining & Money Timeline and Catcher activity

8: Iron (Fe) – U.S. Steel – Mountain Iron, Minnesota, USA

Geological Description:

Most iron in the United States is derived from the mining of a sedimentary rock called Taconite. Taconite (iron ore) features two very important iron-bearing minerals. The first is a heavy, blue-grey magnetic mineral called magnetite; the second is a heavy, silvery to reddish non-magnetic mineral called hematite. Vast deposits of iron-bearing Taconite are found in Northern Minnesota and the Upper Peninsula of Michigan.

End Use in the Green Energy Transition:

These pellets are created from concentrated iron ore and are used to make a wide variety of primary steel products. These steel products can end up in consumer products such as appliances, bridges, power generation, tin cans and cars. Steel is an environmentally friendly commodity because it is easily recycled.

Iron in Our Electrical World Video

Iron

9: Graphite (C) – Northern Graphite – Lac-des-Îles Mine, Quebec, Canada

Geological Description:

Pure graphite is a mineral form of the element carbon forming as veins and disseminations of the metamorphism of organic material included in limestone deposits. This results in an extremely soft mineral which breaks into minute, flexible flakes that easily slide over one another which accounts for graphite's distinctive greasy feel making it a good "dry" lubricant. Graphite is the only non-metal element that is a good conductor of electricity.

End Use in the Green Energy Transition

Natural graphite is used mostly in refractory applications, which involve extremely high heat with materials that will not melt or disintegrate; for example, crucibles used in the steel industry, which accounts for the majority of the usage of graphite. Graphite represents almost 50% of the materials needed for batteries by weight, regardless of the chemistry. In Li-ion batteries specifically, graphite makes up the anode, which is the negative electrode responsible for storing and releasing electrons during the charging and discharging process.

Make a "Pencil" Lead

Graphite: An Essential Material in the Battery Supply Chain (visualcapitalist.com)

What other information does MEC provide for you?

- MEC website
- K-12 Education Resources Database: K-12 educational resources database with free downloadable hands-on activities, lessons, demonstrations, coloring pages, experiments, educational videos, and more.
- Education Standards Correlation search tool for teachers has correlations to national and all state standards for MEC educational materials
- Mining and minerals information: Mining and minerals statistics, reclamation examples, mineral resources database, periodic table of elements, and more.
- Careers: careers in mining resources including booklets, videos, flyers, a link to a list of mining schools and more.
- Earth Science Week: Watch the SME “Jobs of Tomorrow” docuseries and complete the related activities to understand how innovation is changing the jobs required to meet the growing demand for minerals.
- MEC Store: Supplemental materials including posters, activity sheets, teacher guides, gold panning kits, and more.

The successful transition to green energy, as well as other aspects of modern life, remains dependent on the extraction of minerals from the Earth’s subsurface. The mining and minerals industry continues to evolve technology and practices, including mine reclamation and remediation, to extract these minerals. The “MEC Mineral Baby” below shows the demand a person is expected to have on the minerals and mining industry throughout their life based on level of current use.

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Learn more: **MineralsEducationCoalition.org**

NORTHERN GRAPHITE CORPORATION
SEMCOA
Hecla MINING COMPANY
HAZEN
HARRISON WESTERN
Newmont
Climax Molybdenum A Freeport-McMoRan Company
USS United States Steel Minnesota Ore Operations
HUDBAY
Albemarle

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