A lanthanum mine Nancheng County, Jiangxi
Lithium mining in Bolivia
Growing Demand

By 2050, low-carbon technologies will demand a higher percentage of the world’s mineral production. To meet this demand, sustainable and reliable production will need to keep up.

- **Current Production (2017, Annual):**
  - Lithium: 143 Kt
  - Cobalt: 110 Kt
  - Graphite: 120 Kt
  - Indium: 0.39 Kt
  - Vanadium: 80 Kt
  - Nickel: 2100 Kt
  - Silver: 25 Kt
  - Neodymium: 23 Kt
  - Molybdenum: 290 Kt
  - Aluminum: 66,000 Kt
  - Copper: 19,760 Kt
  - Manganese: 14,000 Kt

- **Future Demand:**
  - Lithium: 965% (644 Kt)
  - Cobalt: 585% (444 Kt)
  - Graphite: 383% (686 Kt)
  - Indium: 241% (1.73 Kt)
  - Vanadium: 173% (158 Kt)
  - Nickel: 108% (2268 Kt)
  - Silver: 60% (75 Kt)
  - Neodymium: 37% (8.8 Kt)
  - Molybdenum: 11% (33 Kt)
  - Aluminum: 9% (5583 Kt)
  - Copper: 7% (1576 Kt)
  - Manganese: 6% (696 Kt)

- **2050 Demand in Supplying Each Energy Technology (2050, Projected, Annual):**

  - **Energy Demand by Technology:**
    - 36.4% Energy Storage
    - 11.6% Geothermal
    - 11.4% Solar PV
    - 10.9% Hydro
    - 7.8% Wind
    - 6.6% Other

  - **Copper Demand by Technology:**
    - 37.4% Wind
    - 25.1% Solar PV
    - 15.3% Hydro
    - 11.6% Other

Copper is key for the clean energy transition. In the last 5000 years, about 550 Mt of copper has been produced. The world will need about three times the amount of copper in the next 25 years to meet global demand.

Source: World Bank 2019
However, while mining is crucial to the clean energy transition, it also accounts for up to 11% of global energy use.

To benefit from the increase in mineral demand, developing countries and emerging economies must adopt mining practices that minimize carbon and material footprints.

These countries will need good governance, knowledge, capacity and strategy to do so.
HISTORICAL AND PROJECTED GLOBAL PRODUCTION OF RARE EARTH ELEMENTS (1950-2014)

Together, just 4 countries mine the majority of the world's supply of rare earth elements. China, which produced 130,000 metric tons in 2010, dwarfs all other production yields by claiming 97% of the share.

SHARE OF GLOBAL RARE EARTH ELEMENT PRODUCTION

- China: 97%
- India: 2%
- Brazil: 0.42%
- Malaysia: 0.27%
- Other: 0.31%

Sources: Congressional Research Service, Institute for Energy Research, U.S. Geological Survey
How can we sustainably and responsibly source green technology metals to address climate change?
1) Repatriate
2) Recycle
3) Repair
A Federal Strategy To Ensure Secure and Reliable Supplies of Critical Minerals

By the authority vested in me as President by the Constitution and the laws of the United States of America, it is hereby ordered as follows:

Sec. 3. Policy. It shall be the policy of the Federal Government to reduce the Nation's vulnerability to disruptions in the supply of critical minerals, which constitutes a strategic vulnerability for the security and prosperity of the United States. The United States will further this policy for the benefit of the American people and in a safe and environmentally responsible manner, by:

(a) identifying new sources of critical minerals;

(b) increasing activity at all levels of the supply chain, including exploration, mining, concentration, separation, alloying, recycling, and reprocessing critical minerals;

(c) ensuring that our miners and producers have electronic access to the most advanced topographic, geologic, and geophysical data within U.S. territory to the extent permitted by law and subject to appropriate limitations for purposes of privacy and security, including appropriate limitations to protect critical infrastructure data such as those related to national security areas; and

(d) streamlining leasing and permitting processes to expedite exploration, production, processing, reprocessing, recycling, and domestic refining of critical minerals.
Minerals deposits in Northern Minnesota

**Bounday Waters Canoe Area Wilderness**
Largely motorless wilderness area covering about 1,700 square miles.

**Proposed Twin Metals mine site**

**Mesabi Iron Range**
A vast deposit of iron ores discovered in the 1860s.

**Virginia**
Significant deposits of copper and nickel, along with gold, platinum, silver, and palladium have been discovered along the edge of the Duluth Complex.

**Duluth Complex**
A large bedrock formation that emerged about 1.1 billion years ago.

Data source: University of Minnesota MPR News Graphic
<table>
<thead>
<tr>
<th>Location</th>
<th>Metals</th>
<th>Developer</th>
<th>Level of Controversy*</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bear Lodge Mine</strong></td>
<td>Dysprosium, Europium, Neodymium</td>
<td>Rare Element Resources, Ltd.</td>
<td>High</td>
<td>Stalled</td>
</tr>
<tr>
<td><strong>Bokan Mtn. Mine</strong></td>
<td>Dysprosium, Terbium, Yttrium</td>
<td>Ucore Rare Metals Inc.</td>
<td>Moderate</td>
<td>Construction Underway</td>
</tr>
<tr>
<td><strong>Elk Creek Mine</strong></td>
<td>Niobium, Scandium, Titanium</td>
<td>NioCorp Developments</td>
<td>High</td>
<td>Permitting Underway</td>
</tr>
<tr>
<td><strong>Lemhi Pass Mine</strong></td>
<td>Neodymium, Thorium</td>
<td>US Rare Earths Inc</td>
<td>Moderate</td>
<td>Stalled</td>
</tr>
<tr>
<td><strong>NorthMet Mine</strong></td>
<td>Copper and Nickel</td>
<td>PolyMet</td>
<td>High</td>
<td>Permitting Underway</td>
</tr>
<tr>
<td><strong>Pea Ridge Mine</strong></td>
<td>Cerium, Dysprosium, Lanthanum, Thorium, Yttrium</td>
<td>MFC Industrial Ltd. / Alberici Constructors</td>
<td>Moderate</td>
<td>Stalled</td>
</tr>
<tr>
<td><strong>Round Top Mtn. Mine</strong></td>
<td>Beryllium, Dysprosium, Thorium, Uranium, Yttrium</td>
<td>Texas Mineral Resources Corporation</td>
<td>High</td>
<td>Stalled</td>
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<tr>
<td><strong>Silver Peak Mine</strong></td>
<td>Lithium Carbonate</td>
<td>Albemarle Corporation</td>
<td>Low</td>
<td>Complete</td>
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</tbody>
</table>
RECYCLING

~95% semiconductor material for thin-film PV panels can be recycled
Cumulative waste volumes of top five countries for end-of-life PV panels in 2050

- **China**: 20 million
  - Regular-loss scenario: 13.5 million
  - Early-loss scenario: 10 million

- **US**: 10 million
  - Regular-loss scenario: 7.5 million
  - Early-loss scenario: 4.5 million

- **Japan**: 7.5 million
  - Regular-loss scenario: 6.5 million
  - Early-loss scenario: 4.4 million

- **India**: 7.5 million
  - Regular-loss scenario: 4.5 million

- **Germany**: 4.3 million
  - Regular-loss scenario: 4.4 million

**2050**

60-78 million tonnes of PV panel waste globally

Source: IRENA 2016
1,000 blades entering the Casper Regional Landfill in Wyoming
RIGHT TO REPAIR
Stand up for your Right to Repair!

State Legislators have the power to protect you from unfair and deceptive policies that make it difficult, expensive, or impossible for you to repair the things you own.

Right to Repair or Fair Repair Bills are being prepared for 2019 in many states. All it takes in most places is for one person to start the ball rolling.

Write, Call, or Meet with your state legislators and make Right to Repair happen.
Right-to-repair bill appears headed for first time to floor of Minnesota House

The bill has been a long-sought goal of a consortium of independent repair shops, environmentalists, the Minnesota Farmers Union and others.

MARCH 24, 2019 — 3:41PM

Star Tribune

Technician Alonzo Nelson repaired a flat-screen TV panel for resale at Tech Dump’s used-electronics retail business in St. Paul.
“Metals are gifts from the stars that were generated over billions of years; we should treat them with the awe and respect they deserve and devise ways to recycle them over and over. Only then will sustainability become a reality”

Source: Gradel et al. 2011