

Critical Raw Materials and Supply Risks:

Why they matter, are essential for a sustainable future and why some are “Critical”.

By the end of this Lesson, you will know about:

- What makes a raw material “critical”
- The key characteristics of critical raw materials
- The importance of critical raw materials in modern technology
- Where and how they are mined
- Supply chain risks related to critical raw materials & how they occur

Click to start



How to study this DTM

Your path through the DTM:

1. Start at the EV-component hub and click a car part to see the raw materials it needs.
2. Use the “Return” buttons to jump back to a hub at any time.
3. Open the World Map hub to see where each mineral is mined and refined.
4. Click a country or a mineral to open its detailed profile page.
5. Visit the Critical Raw Materials Act hub to explore the EU’s response.
6. Finish with the Key Takeaways.

Time needed

About 30–45 minutes

Format

Self-study

How to explore

Click to explore

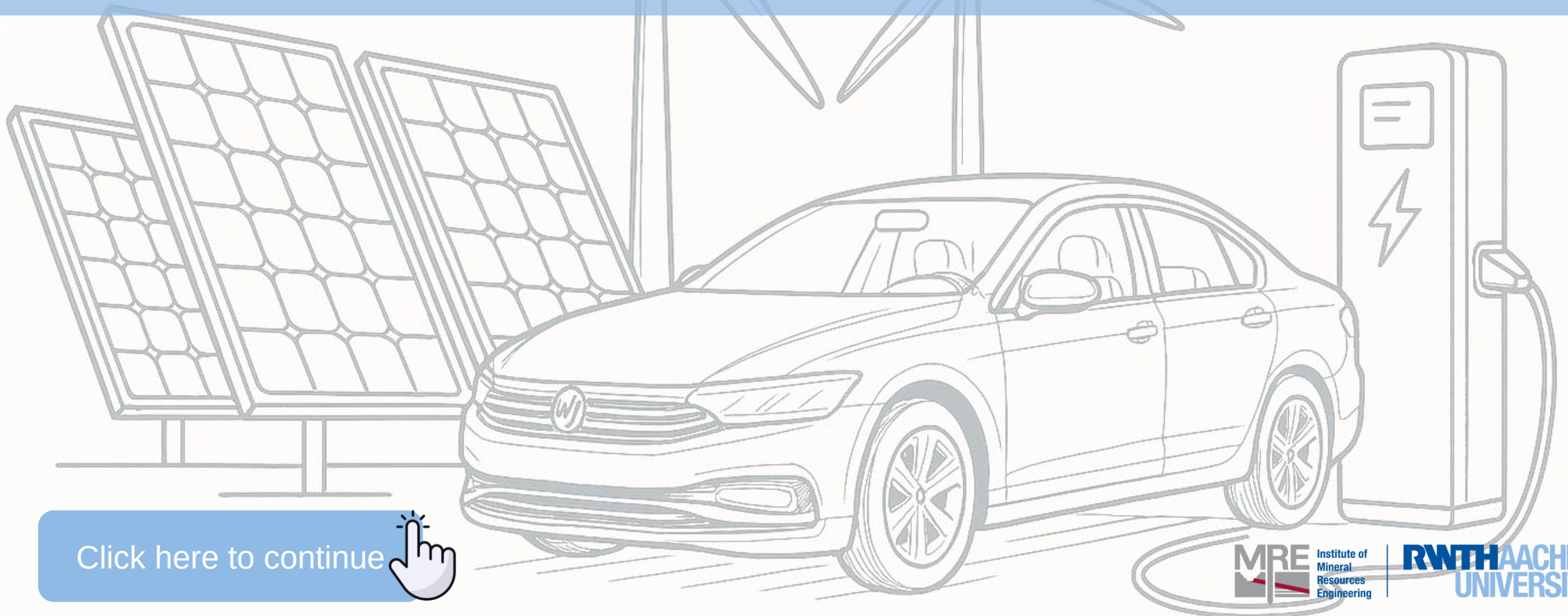
Files

PDF + H5P

Click to continue



The Low-Carbon Paradox: Fighting Climate Change With Resource-Intensive Tech

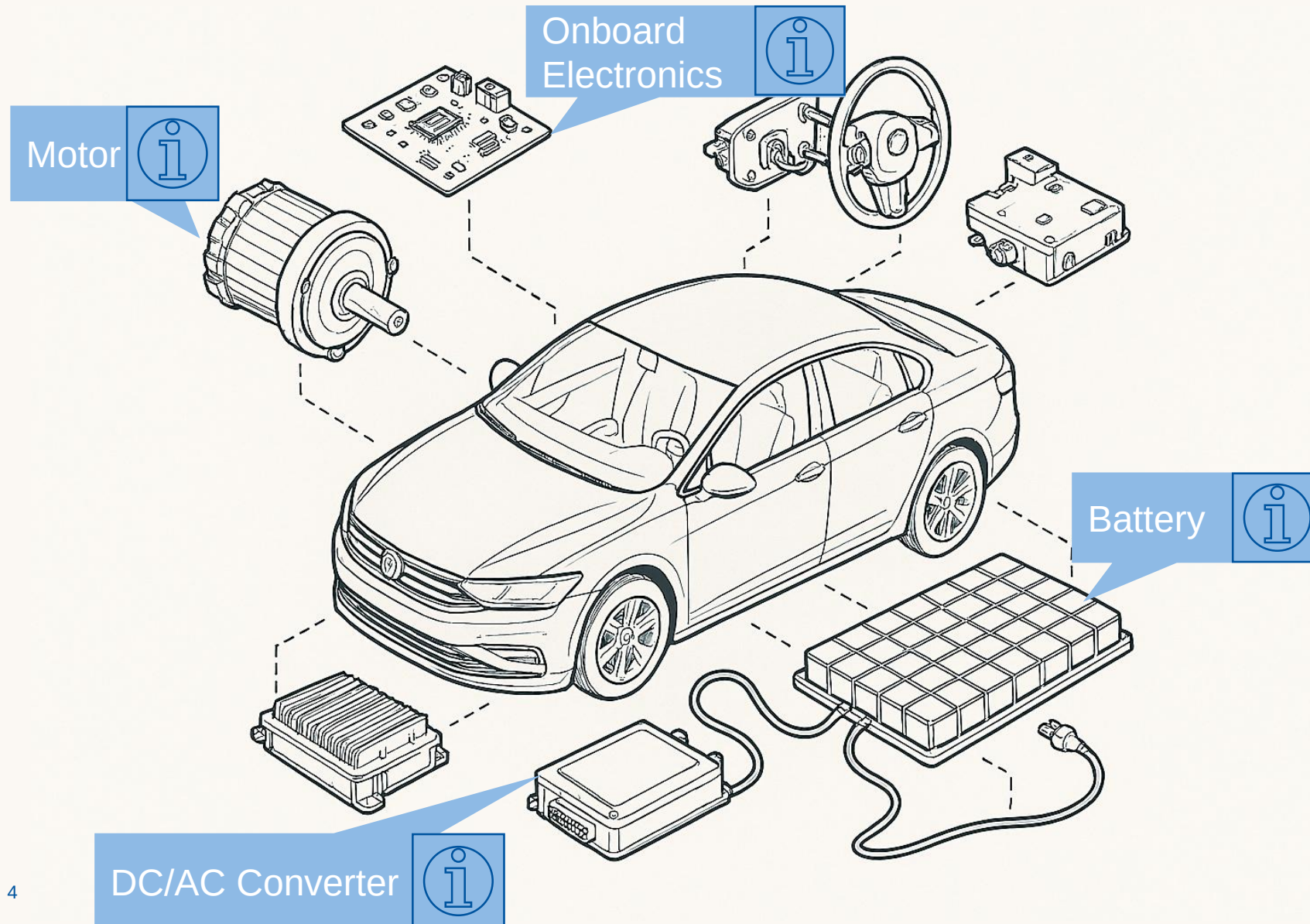


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Click here to continue



The Electric Car: Clean, but Resource-Hungry



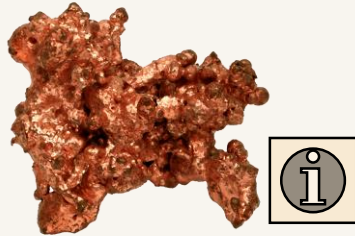
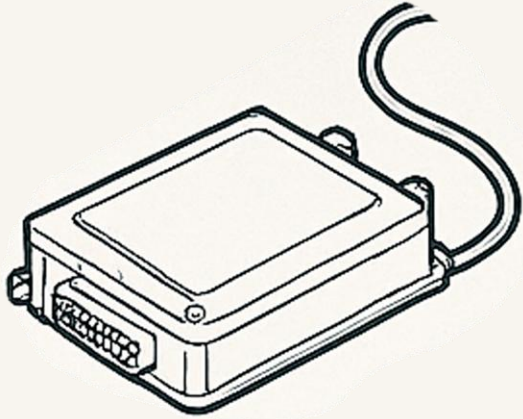
What does it take to run an electric car?

It's not just energy, but also **lots of materials**.

Click on the components to explore which **critical raw materials** are inside.

See What's Inside an EV

DC/AC Converter – The Power Switch



Do you recognize the different Minerals? Click on the Minerals to see their names and Purposes!

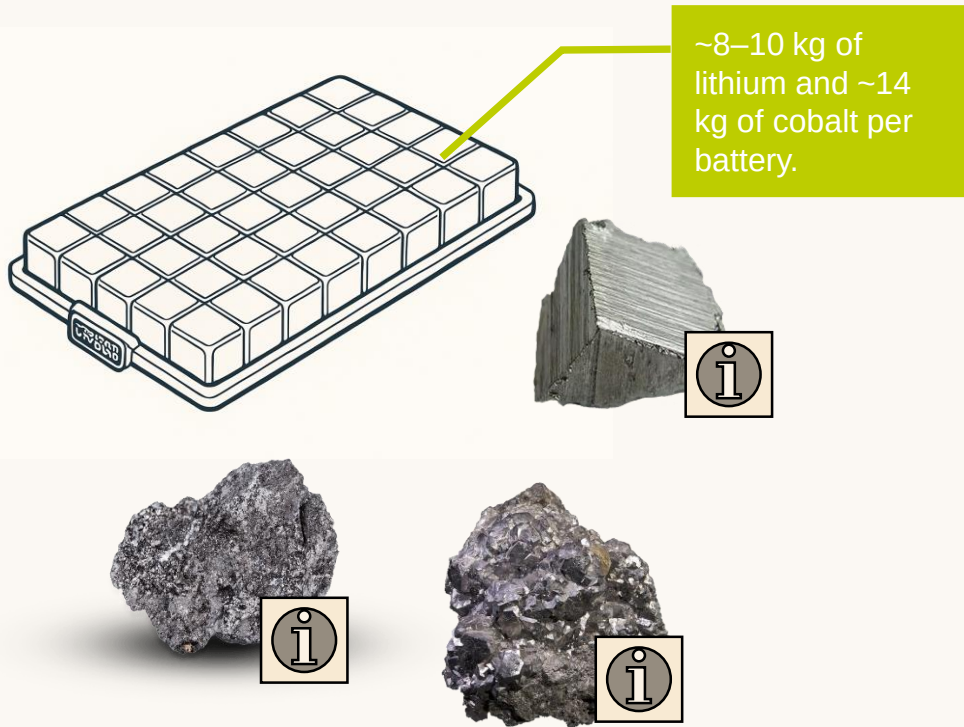
Short Facts:

- Converts battery's DC power into AC to drive the motor.
- Needs **Gallium**, **Copper**, and sometimes **Rare Earths**.
- **Gallium Nitride** (Ga N) makes power chips more efficient and smaller.

Gallium melts in your hand – its melting point is only ~30 °C.



The Heart of the Car: The Battery Pack



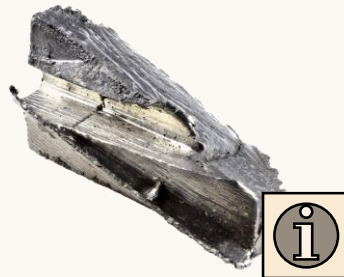
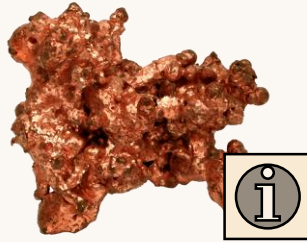
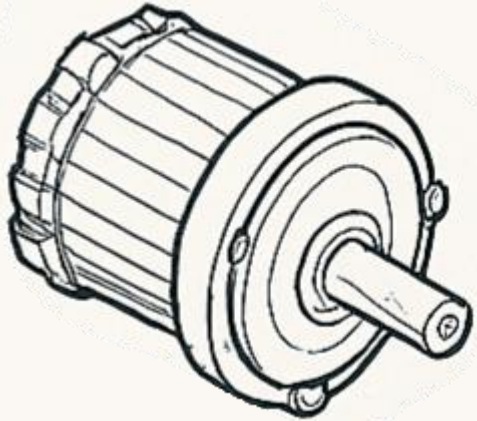
Short Facts:

- The EV battery is the largest single consumer of raw materials.
- Contains: Lithium, Cobalt, Nickel, Graphite
- Up to 40–50% of all critical materials in an EV are here.

Do you recognize the different Minerals? Click on the Minerals to see their names and Purposes!



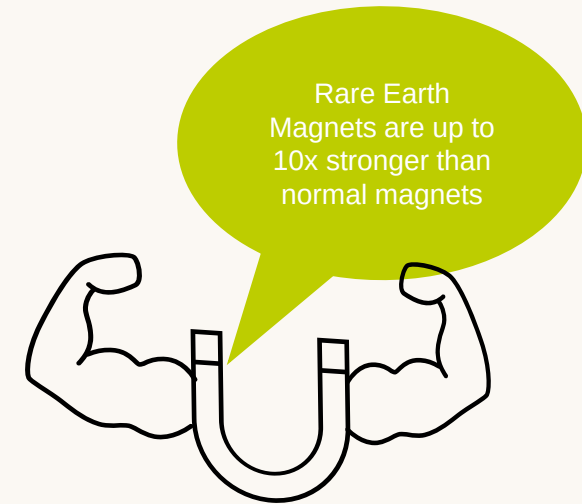
The Muscle: Electric Drive Motor



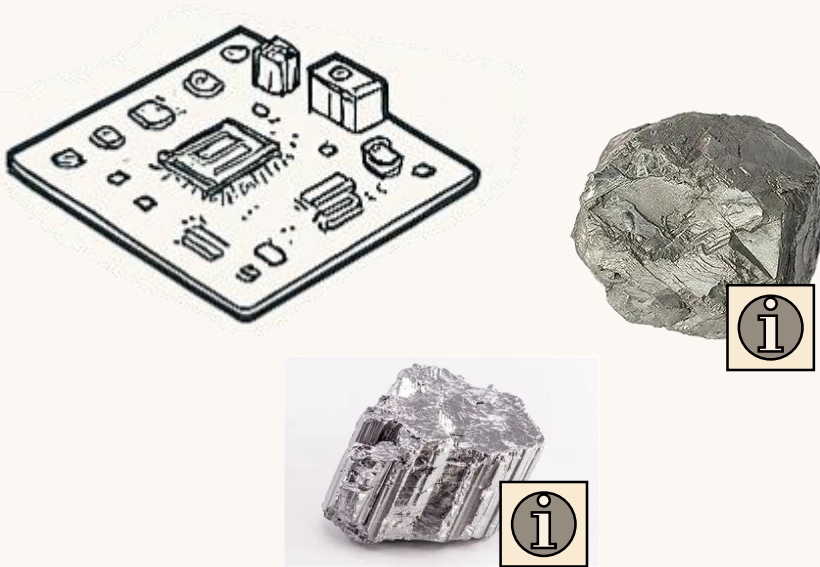
Do you recognize the different Minerals? Click on the Minerals to see their names and Purposes!

Short Facts:

- Many EVs use **permanent magnet motors**
- Core materials: **Neodymium, Dysprosium, Copper**



The Brain – Onboard Electronics



Short Facts:

- Includes computers, sensors, infotainment, safety systems.
- Contains **Gallium, Rare Earths, Tantalum, Tin.**
- Up to **3,000 chips** per car!

Do you recognize the different Minerals? Click on the Minerals to see their names and Purposes!



Minerals in Electric Cars vs. Fossil-Fuelled Cars

Mineral content kg/vehicle *Steel and aluminum not included.*

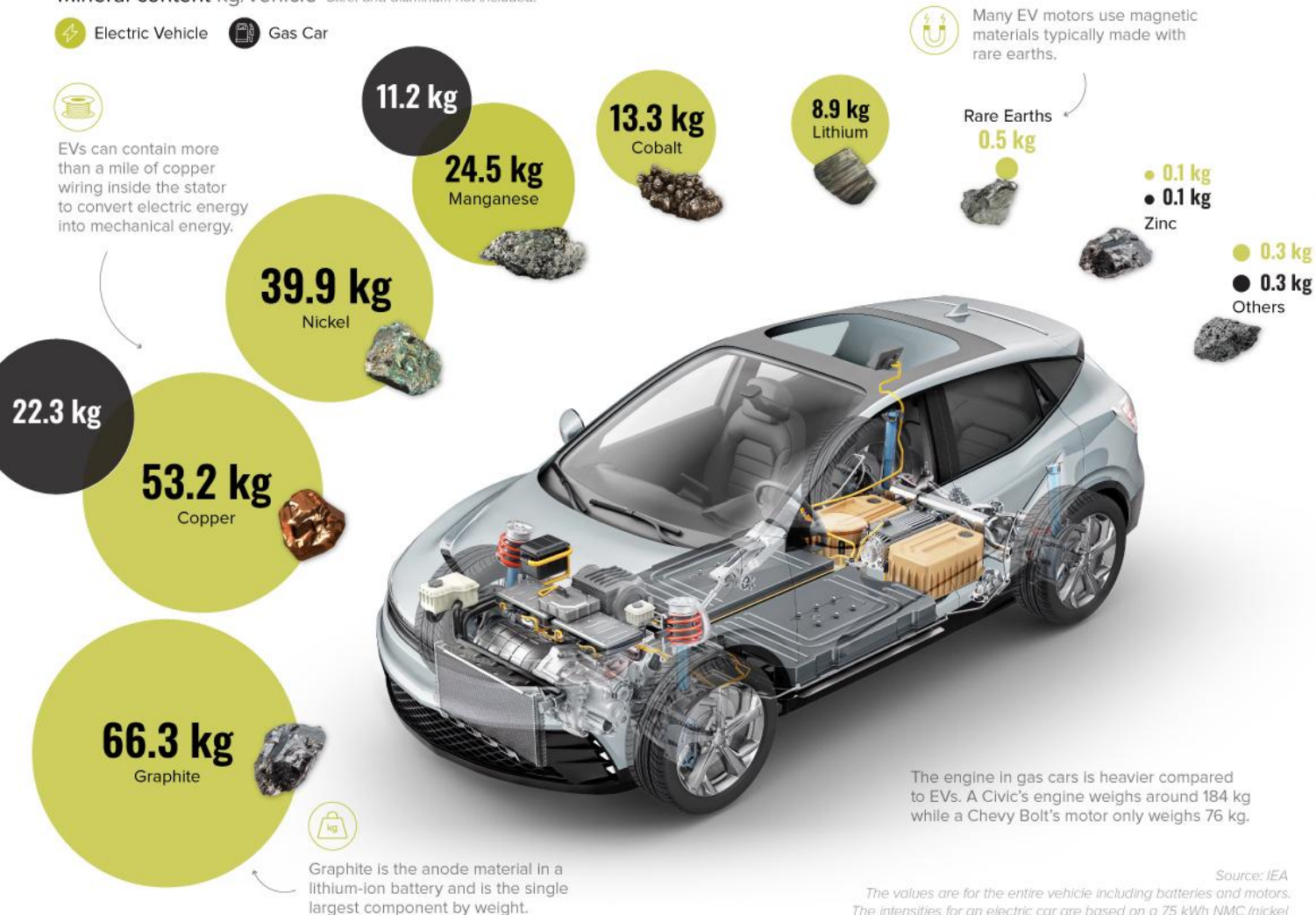
 Electric Vehicle  Gas Car



EVs can contain more than a mile of copper wiring inside the stator to convert electric energy into mechanical energy.



Many EV motors use magnetic materials typically made with rare earths.



Electric vehicles require a wider range of Minerals for their motors and batteries compared to fossil-fuelled cars



In fact: An EV contains up to 6 times more Minerals!

See Where our Resources come from



But where do our most important Resources come from?

Click on the Countries to
learn about the CRMs
Origins.



What makes a Mineral Critical?
Click here to see

Brazil



- **Key Raw Materials:**

- **Niobium (>90 % of Global Supply)**
- Bauxite (Aluminum) and Iron Ore
- Growing Graphite, Lithium and Rare Earth Sector

- **Other mined Critical Minerals:**

- Manganese, Tantalum, Nickel

Mining Type:

- **Industrial** for niobium, iron ore
- **Artisanal Mining is common for gold & tantalum** – with **Amazon-related ESG issues**

Learn more about LSM





- **Key Raw Materials:**

- **Rare Earths** (mining and >85% global processing)
- **Graphite** (mining & nearly all global refining)
- **Gallium** (95% of global production)
- Lithium refining (dominates processing of imported lithium)

- **Other mined Critical Minerals:**

- Tungsten, Magnesium, Fluorspar, Antimony

- **Why is it a supply risk?**

- Bottleneck: **Refining capacity & export control**
- Heavy **state control of supply chains**: Imposed **export bans** on gallium & germanium (2023)

Mining Type:

- **Fully industrialized and state-controlled**
- Strict central coordination, but **regional environmental issues**
- Especially relevant for **REE processing**

Learn more about LSM





- **Key Raw Materials:**
 - **Lithium**
 - Also: Nickel, Rare Earths (growing), Bauxite (Aluminium)
- **Other mined Critical Minerals:**
 - Cobalt, Graphite, Manganese (exploration stage)
- **Why is it a supply risk?**
 - **Bottleneck: Processing/export dependence on China**
 - Australia mines → **China refines**
 - Geographic distance and limited refining capacity

Mining Type:

- **Large-scale industrial mining only**
- Mined from Spodumene Rocks in Open Pit Mines
- **High ESG standards** and transparency

Learn more about LSM



South Africa



- **Key Raw Materials:**

- Platinum Group Metals (PGMs) (world leader)
- Also: Vanadium, Manganese, Chromium

- **Other mined Critical Minerals:**

- Rare Earths (exploration), Titanium

- **Why is it a supply risk?**

- Bottleneck: Political risk, energy shortages, unstable labor conditions
- High export dependency

Mining Type:

- **Industrial** operations dominate
- ASM exists (gold, illegal mining), but **not key for CRMs**
- **Energy shortages** affect Operation

Learn more about LSM



Congo



- **Key Raw Materials:**
 - Cobalt (~**76% of global mine production**)
 - Also: Copper (major producer)
- **Other mined Critical Minerals:**
 - Tantalum, Tin, Gold (often in informal mining)
- **Why is it a supply risk?**
 - Bottleneck: Mining conditions & ESG risks
 - Linked to child labor, human rights issues
 - Politically unstable region
- **China controls much of the refining, even of Congolese ore & mines**

Mining Type:

- ~**20–30% of cobalt** comes from **ASM**
- Often **unsafe** and involves **child labor**
- Remaining production is **industrial (Chinese-owned)**
 - **High ESG risk**, low transparency

Learn more about LSM





- **Key Raw Materials:**

- **Lithium** (2nd largest producer, from brines)
- **Copper** (world's largest producer)

- **Other Critical Minerals:**

- Molybdenum (important for steel)

- **Why is it a supply risk?**

- **Bottleneck:** Water-intensive lithium production in **fragile ecosystems** (Atacama)
- High reliance on **foreign processing**
- Political debates on nationalization & royalties

Mining Type:

- **Industrial mining (Salar de Atacama)** for lithium (brine)
- **Environmental conflicts** with Indigenous communities

Learn more about LSM



Artisanal (Small-Scale) Mining — ASM

Key Facts:

- Often informal mining operations
- Low capital
- Labor intensive

Challenges:

- Dangerous working conditions
- Child labor
- No regulations & controls



See Mining realities in Congo



[Learn](#) more about LSM



Industrial (Large-Scale) Mining — LSM

Key Facts:

- Industrial mining operations
- Multi-national companies
- High skill levels and investments required

Challenges:

- Deforestation
- Meeting ESG-standards
- Large scale tailings & mine waste



See Mining realities in Congo



Learn more about ASM

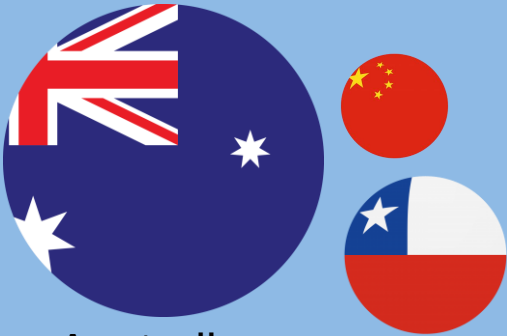


Lithium



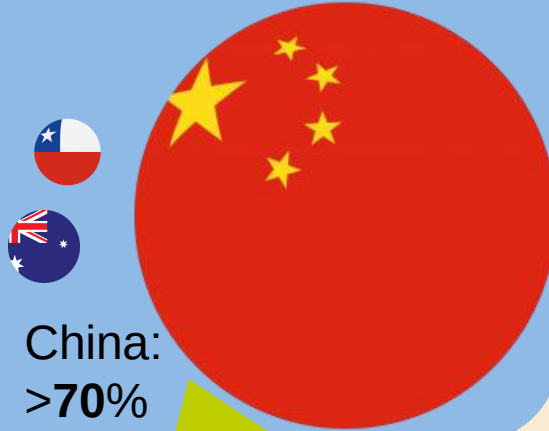
Why am I a Critical Raw Material?

Top Producers 2024:



Australia:
~**33%**

Top Refiners 2024:



China:
>**70%**

Why is this a supply risk?



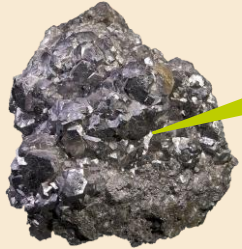
Key Facts:

- Essential for **high energy density** in lithium-ion batteries
- Key for EVs, phones, grid storage
~**8–10 kg** per EV battery

- EU imports almost 100% of its lithium
- Refining dominated by China
- Demand expected to increase 5x by 2030



Cobalt



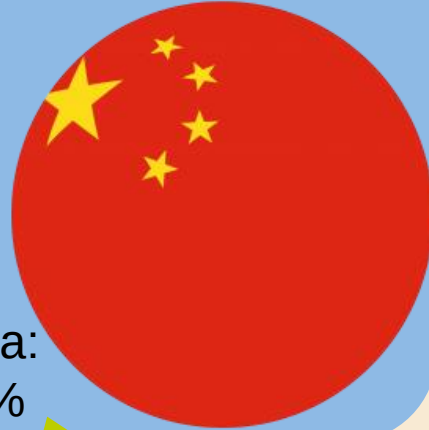
Why am I a Critical Raw Material?

Top Producers 2024:



DRC ~76 %

Top Refiners 2024:



China:
>70%

Why is this a supply risk?



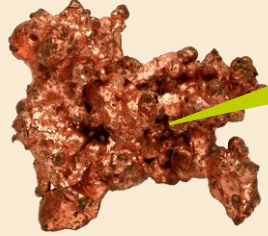
Key Facts:

- Stabilises the cathode and improves battery lifespan and thermal safety
- One of the most Critical & geopolitical sensitive Raw Materials

- 70% is mined in Congo (DRC)
- Value Chain is dominated by Chinese Companies
- Mining under harsh conditions



Copper



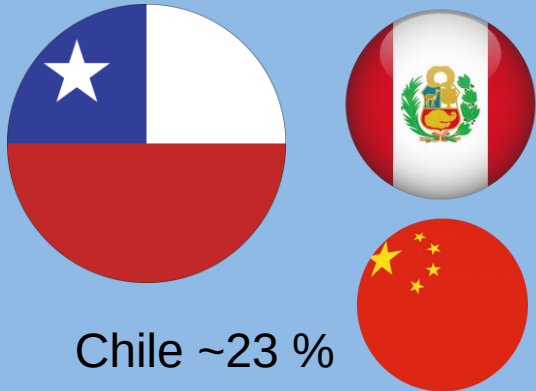
Why am I a Critical Raw Material?

Typical EV content: ~50 kg

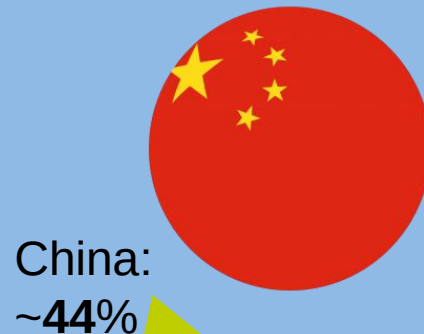
Key Facts:

- Essential for electric wiring, due to the highest electrical conductivity of all non-precious metals.
- Critical for energy transmission in the green transition.

Top Producers 2024:



Top Refiners 2024:



Why is this a supply risk?



- The EU is highly import-dependent for refined copper
- China is the largest copper smelter & refiner (~44%)
- Demand is rising fast with power grids, renewables & EVs

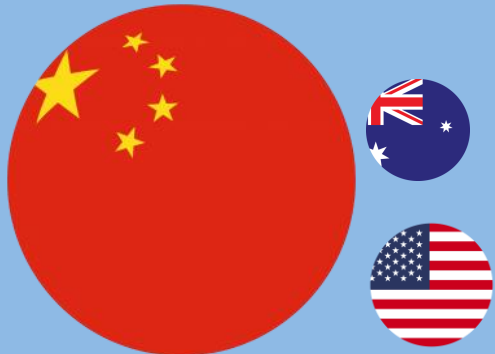


Rare Earth Elements



Why am I a Critical Raw Material?

Top Producers 2024:



China: ~70%

Top Refiners 2024:



China: ~90%

Why is this a supply risk?



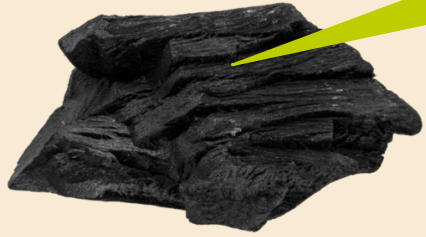
Key Facts:

- Group of 17 metals, key ones for EVs: Neodymium, Dysprosium, Praseodymium.
- Used in permanent magnets for EV motors, wind turbines, electronics.

- The EU imports almost 100% of its rare earths
- Refining dominated by China
- Magnet demand is rising sharply with EVs & wind power



Graphite



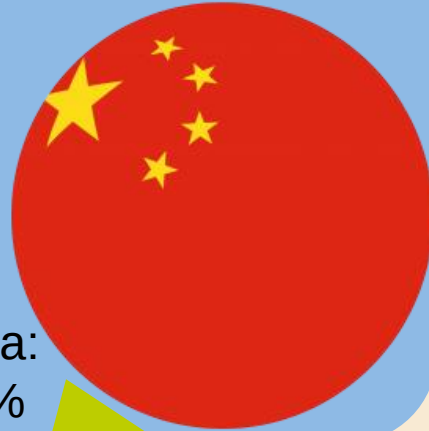
Why am I a Critical Raw Material?

Top Producers 2024:



China ~78 %

Top Refiners 2024:



China:
~90%

Why is this a supply risk?



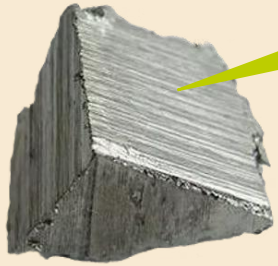
Key Facts:

- Anode in **lithium-ion batteries**.
- Natural graphite is light, conductive, heat-resistant.
- Needed for **battery capacity & stability**.

- EU imports nearly 100% of battery-grade graphite.
- China controls **>90% of battery grade refining (most important)**
- Demand expected to increase 5x by 2030



Gallium



Why am I a Critical Raw Material?

Top Producer and Refiner 2024:



China with
~98%

Why is this a supply risk?



Key Facts:

- Used in high-tech semiconductors
- Enables high-efficiency power electronics, LEDs, solar cells, 5G

- Mined as a by-product of **bauxite and zinc refining**.
- China (>95% global output).
- EU imports >90% of gallium from China



Nickel

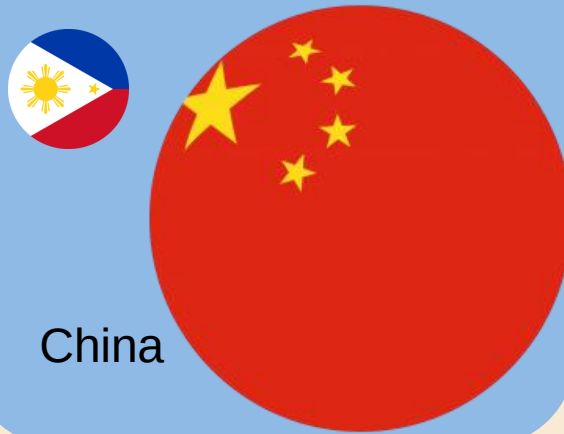


Why am I a Critical Raw Material?

Top Producers 2024:



Top Refiners 2024:



Key Facts:

- Used in **battery cathodes** to **increase energy density**
- Major Use also in **stainless steel** production

- **Top Producers:** Indonesia (~50%), Philippines, and Russia.
- “Class 1 Nickel” for batteries is refined **mainly in China**.
- high dependence on a few producers

Why is this a supply risk?

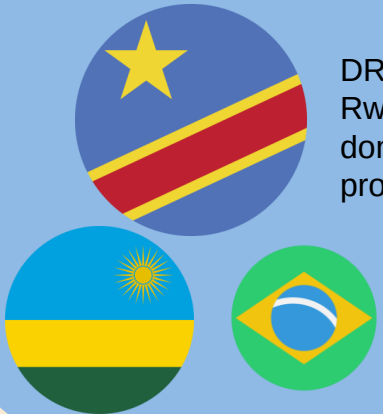


Tantalum



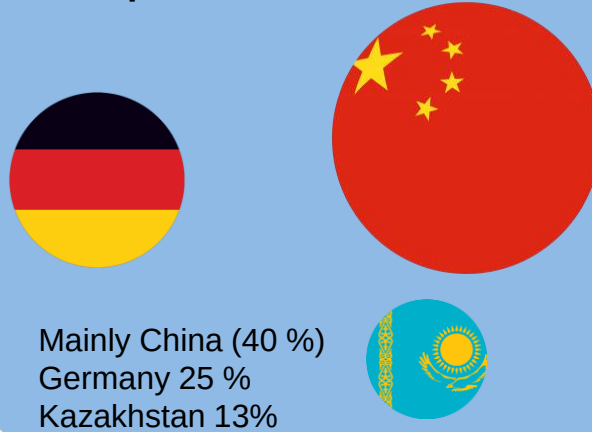
Why am I a Critical Raw Material?

Top Producers 2024:



DR Congo 40% & Rwanda 25 % dominate production

Top Refiners 2024:



Mainly China (40 %)
Germany 25 %
Kazakhstan 13%

Key Facts:

- Stores and regulates charge in tiny high-performance capacitors
- Found in phones, laptops and EV electronics – hard to substitute
- Also used in superalloys for jet engines

- A “conflict mineral” (3TG group: tin, tantalum, tungsten, gold)
- The EU imports almost all of its tantalum
- Supply is concentrated in Central Africa

Why is this a supply risk?



Deep Dive: Precious metals for Energy transmission & Climate Change

Example on Cobalt & Rare earth Elements

The **DRC** supplies **most** of global cobalt.

Processed mainly in **China**, which dominates the global refining market.

Raises questions about **ethics**, **sustainability**, and **dependency**.

Cobalt Mining in DRC

LSM Mining in DRC

China supplies ~70% of mining and ~**90% of refining**.

In 2025, **China restricted exports**, causing supply fears in the EU.

Their dominance gives China **strategic leverage** in global trade.

Rare Earth Elements



Cobalt

Mining Realities in DRC



Mining

~76% of global cobalt mine production

Many Mines are Chinese-Owned



Refining

>70% of global refining capacity

Chinese Companies buy from artisanal Miners



Consumption

imports almost all cobalt

The cobalt price rises each step in the Value chain

refining is **energy-intensive, costly, concentrated in one country**

EU relies on **foreign Cobalt** and can't intercept the current market

[Return to World map](#)



[Deep Dive Overview](#)

Artisanal Mining

Mining Realities in DRC

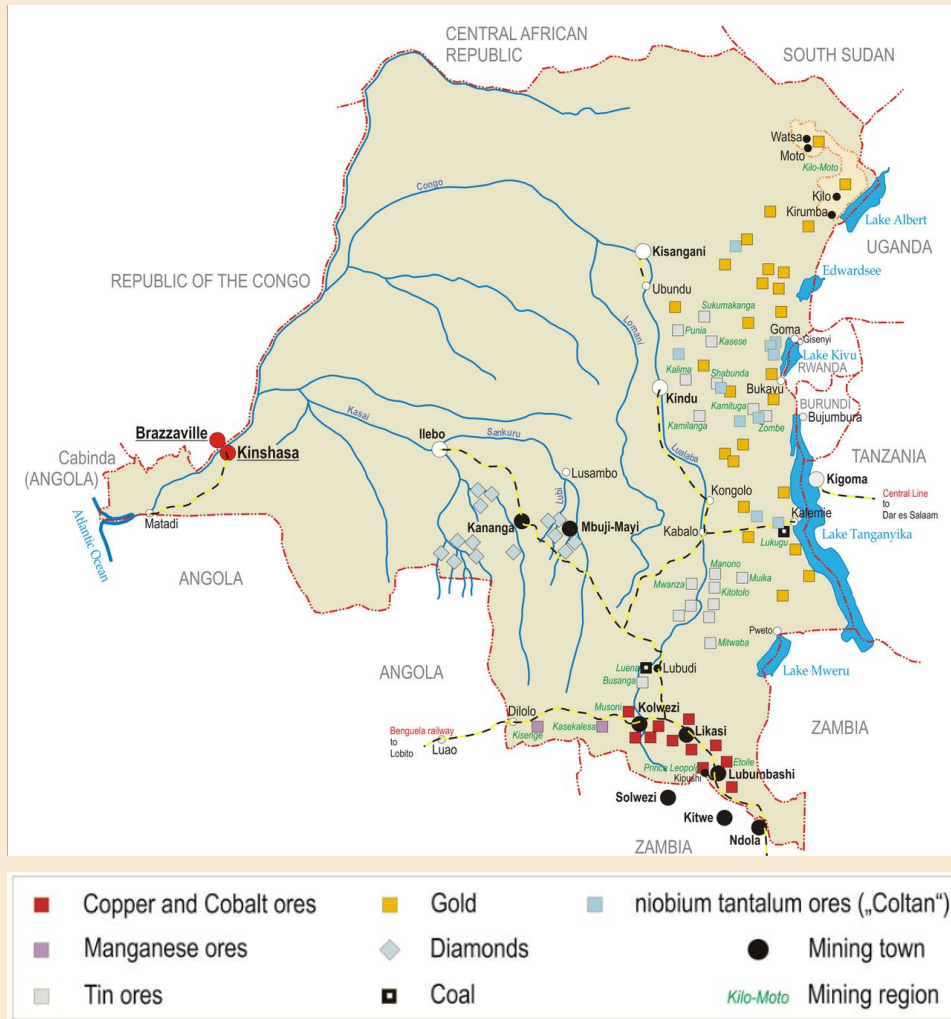
- Provides income for hundreds of thousands of people
- Very labor-intensive, often unregulated
- Manual tools, no safety gear, no contracts
- Risks: child labor, cave-ins, toxic wastes
- Wages: only a few dollars per day



Artisanal and informal mining **is not inherently illegal**. In politically unstable or conflict-affected areas these operations are more vulnerable to criminal exploitation and environmental or social harms, as in the case of the Democratic Republic of the Congo



Mining Sites in DRC



- Not all copper deposits contain significant cobalt, but nearly all cobalt in the country is sourced from copper deposits
- Cobalt, vital for electric vehicle batteries, is sourced from both industrial and artisanal mines.
- The government created Entreprise Générale du Cobalt (EGC) to regulate artisanal cobalt production.
- The DRC produces about 76% of the world's cobalt (USGS, 2024),
 - with about 80% from **industrial copper mines**,
 - and the remaining 20% gathered by **artisanal mining**.



Large Scale Mining

Mining Realities in DRC



- Industrial (large) Companies operating
- Chinese-owned Cobalt mines
- Heavy Machinery and Tools
- Mine Waste & Pollution
- Most profits leave DRC

The largest shareholders in most copper mines in the DRC are foreign corporations.

Chinese companies have become major holders in various copper mines in the DRC

- **China Nonferrous Metal Mining Group**
- **China Railway**
- **Jinchuan Group**
- **Zhejiang Huayou Cobalt**



Rare Earth Elements

What are REEs?

Group of 17 critical metallic elements used in magnets, wind turbines, EV motors, and electronics and other modern technologies.

Supply Chain Overview:

- REEs are **mined** in several countries, but **almost all** are **processed** in China.
- Refining is complex, **energy-intensive**, and **environmentally challenging**, which makes relocation difficult.

REE Overview



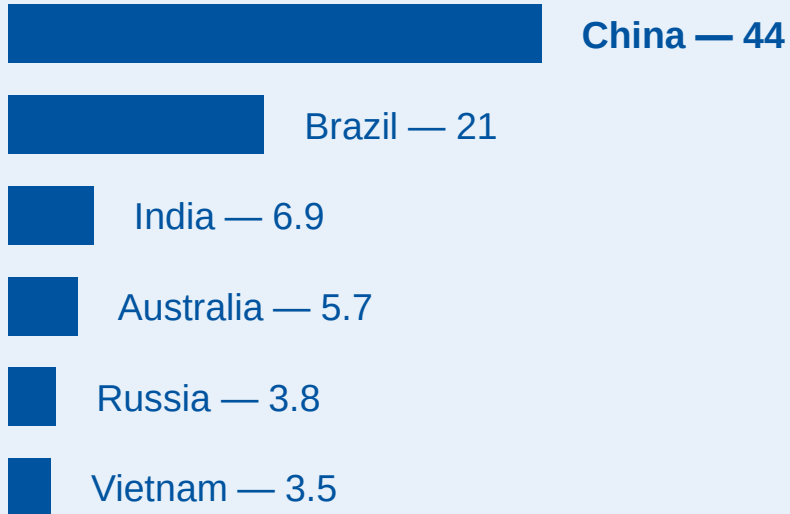
Return to [World](#) map



Back to Deep Dive Overview

Rare Earth Elements: Why are they so critical?

Rare earth reserves by country (million t)



Source: USGS Mineral Commodity Summaries 2026 — reserves, million t REO. World total ≈ 92 Mt.

Reserves are spread across many countries.
Yet China refines ~90%.
The bottleneck is processing capacity.

Geopolitical Leverage & Export Controls:

- Recent export Controls on REES led to shortage in EU
- The EU and Japan depend heavily on Chinese exports for high-performance magnets used in **EVs, wind turbines, and defense technology.**

Concentration & Environmental Barriers:

China controls the global refining capacity. Refining is energy-intensive and producing waste, few other countries are willing to build such plants.

Even if mining is diversified (USA, Australia, Myanmar), refining bottlenecks remain.
Establishing new facilities takes years and billions of euros

[Return to World map](#)



[Back to Deep Dive Overview](#)

[What makes a Mineral Critical?
Click here to see](#)

Key Bottlenecks in the Global CRM Supply Chain

Cause: Geographic Concentration & Geopolitical Risk

What does this mean?



A few countries hold **monopolies on production**, creating supply dependencies and vulnerability to political decisions or trade restrictions.

Exemplary CRM:

Cobalt

- Democratic Republic of Congo

Cause(s):

- Geographic Concentration
- Monopoly on Production
- Politically Unstable
- ESG Risks



Reasons for Criticality & Key Bottlenecks in the Global CRM Supply Chain

Cause: Monopoly on Processing & Refining

What does this mean?



Even when mining is diversified, **refining is often concentrated** in a single country. Processing is complex, energy-intensive, and costly to relocate.

Exemplary CRM:

Rare Earths

- China (>85% of global refining capacity)

Cause(s):

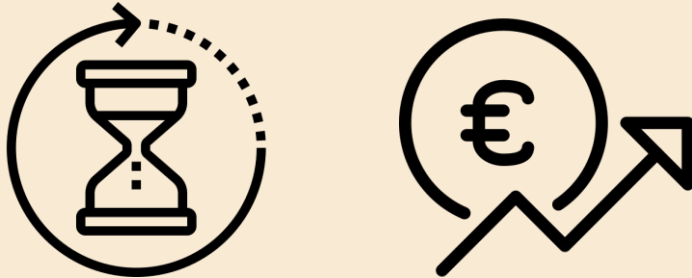
- Monopoly on Refining
- Environmental Constraints elsewhere



Reasons for Criticality & Key Bottlenecks in the Global CRM Supply Chain

Cause: Long Lead Times & High Capital Costs

What does this mean?



! New mining projects require **immense capital investment** and **take >10 years** to develop, creating a significant lag in supply response to rapidly **growing demand**.

Exemplary CRM:

Lithium, Graphite

Origin:

- Australia, Chile (lithium);
China, Mozambique (graphite)

Cause(s):

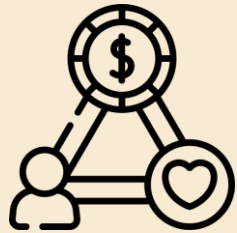
- Long lead times, high capital costs
- New mines take >10 years



Reasons for Criticality & Key Bottlenecks in the Global CRM Supply Chain

Cause: Technical, Environmental & Social Challenges

What does this mean?



CRM extraction and processing can have severe environmental impacts (**toxic waste, water use**).

Social conflicts, ESG violations, and permitting delays can halt projects.

Exemplary CRM:

Nickel

Origin:

- Indonesia (rapid mining growth, ESG concerns)

Cause(s):

- Environmental damage, social conflict, lack of transparency



What makes a mineral critical?

Currently the **accessible resources** for EV Batteries are **concentrated** in very few countries.

This is a concern for supply chain distribution and could lead to **geopolitical conflicts** similar to oil in the 20th century



Raw Materials and especially critical ones are important for climate neutral Energy & Transport Technologies

A critical raw material is one that is both; economically important and has a high risk of supply disruption.

So how can we ensure secure Supply?



Ensuring secure Supply: The EU- Critical Materials Act

The EU reacted and set up the Critical Raw Materials Act.

EU CRM Act: Four Main Goals

Click to learn
what this is
about!



Diversify CRM Imports to reduce dependencies



Substitute for other Materials



Strengthen own Value Chain



Improve CRM sustainability and circularity



Lesson key takeaways



EU Critical Raw Materials Act

Diversify CRM Imports to Reduce Dependencies

- By 2030, no more than **65%** of any strategic CRM should come from one non-EU country.
- Reduces vulnerability to political instability, trade bans, or conflicts.
- Encourages strategic partnerships with multiple suppliers.



EU to-do:

- Build strategic partnerships with resource-rich countries
- Improve infrastructure for secure transport & logistics
- Monitor dependency levels

Example:

- **Today:** 98% of EU's rare earths from China
- **Goal:** Source e.g. from Canada, Australia, Norway and Sweden



EU Critical Raw Materials Act

Improve CRM sustainability and circularity

- At least **25%** of EU annual consumption from recycling.
- Reduce environmental footprint & dependency on imports.
- Support design for recyclability and advanced recovery tech.



EU to-do:

- **Boost Recycling & Secondary Sourcing:**
- Invest in collection infrastructure for batteries, magnets
- Incentivize urban mining and material recovery

Example:

- **Umicore:** large-scale EV battery recycling
- **Cylib (Aachen):** lithium-ion battery recycling
- **HyProMag:** recycling permanent magnets



EU Critical Raw Materials Act

Strengthen own Value Chain: From Mine to Market – in the EU

- At least **10% extraction** of own consumption inside the EU.
- At least **40% processing** within the EU.
- **Shorter** and more **resilient supply chains**.



EU to-do:

- **Regulatory & Funding Tools:**
- CRM Action Plan (annual reviews)
- Start critical-material mining projects

Example:

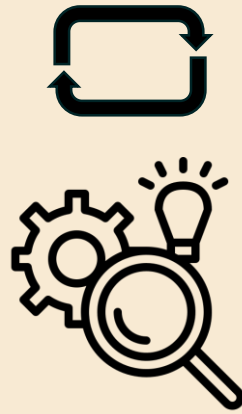
- **Lithium mining projects in Portugal**
- **Processing plants in France & Germany**



EU Critical Raw Materials Act

Substitute for Other Materials

- Develop and deploy alternative materials to reduce CRM demand.
- Innovation in battery chemistries, magnets, and alloys.
- Lower dependency on high-risk CRMs.



EU to-do:

R&D & Substitution:

- Develop alternative materials
- Improve material efficiency in products

Example:

- Tesla using cobalt-free LFP batteries in some models



What to remember

Critical Raw Materials are the “new oil” of the 21st century.

They power the **green transition** – but **supply chains are fragile**.

Geographic & processing monopolies = biggest vulnerabilities.

The EU wants to **diversify, recycle, and strengthen its own value chain**.

Responsible sourcing must **balance economy, environment & society**.

Key takeaways



CRMs are **relevant for everyday technology** and the **green transition**



A material **becomes critical** when it is **economically important**, and **supply is at risk**



Supply chains are **vulnerable** due to **geographic concentration** and **limited processing**



The EU aims to **diversify supply**, **ramp up recycling** and **cut dependence on single countries**



Responsible sourcing must **balance economic, environmental and social factors**

Click here for sources & further readings



Back to [start](#)



Sources & further reading

Data sources

- USGS – Mineral Commodity Summaries 2025 (mining & refining shares)
- IEA – Global Critical Minerals Outlook 2025 (demand & supply trends)
- European Commission – Critical Raw Materials Act (EU policy & CRM list)

Learn more / videos

- U.S. Geological Survey: minerals.usgs.gov
- IEA, Critical Minerals: iea.org/topics/critical-minerals
- EU Critical Raw Materials Act: single-market-economy.ec.europa.eu
- EU Raw Materials Information System: rmis.jrc.ec.europa.eu

Back to start

