


# SECURE AND RESPONSIBLE SUPPLY OF CRITICAL RAW MATERIALS

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

Géosciences pour une Terre durable
brgm

**B**ureau de **R**echerches **G**éologiques et **M**inières (BRGM)
NOTOM Paul – Mineral Intelligence Unit

**ICG spring school – April 2024**

# BRGM in brief

Géosciences pour une Terre durable
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**Scientific Research (35%)**

**Public Policy Support (35%)**

Created in 1959, the BRGM is the France's reference public institution for Earth Science applications.
It carries out the mission of the National Geological Survey

**Management of ex-mining sites (20%)**

**Commercial activities France & International (10%)**

## 6 strategic challenges:

- Geology and knowledge of the subsurface
- Groundwater management
- Risks and spatial planning
- Mineral resources and the circular economy
- Subsurface potential for the energy transition
- Digital data, services and infrastructures

OFREMI

# The various types of mineral resources

**Energy resources:**
- Uranium
- Coal
- Gas
- Oil

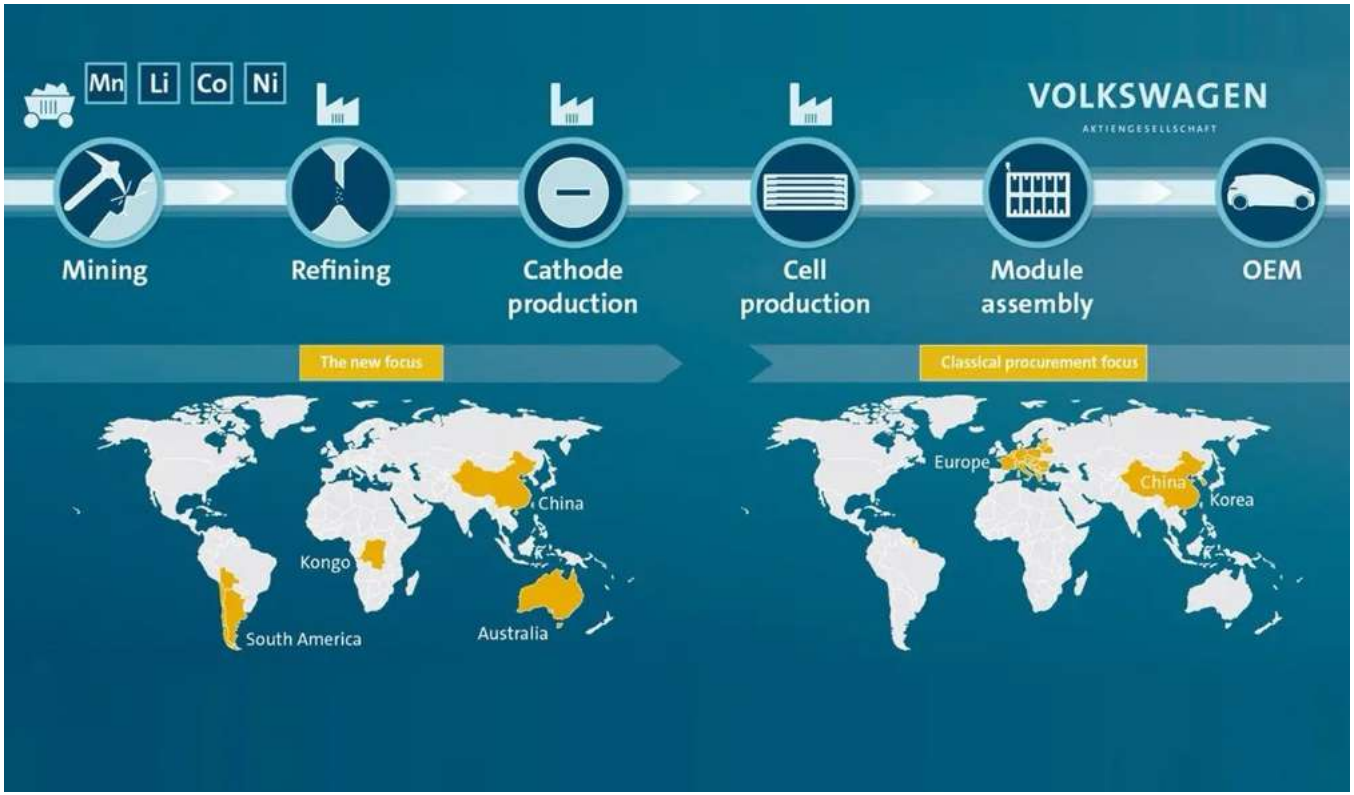
**Building materials**
- Aggregates (sands for example)
- Ornamental stone
- Clay soil (roof tiles, bricks)
- Etc.

**Gems and precious stones:**
- Sapphire
- Ruby
- Diamond

**Quarry minerals / industrial minerals:**
- Diamond: hardness (cutting tool)
- Barite: Ba chemistry, mineral filler
- Talc: paper, pharmaceuticals
- Halite: snow clearing, food
- Quartz: glassmaking, electronics
- Clay: ceramics
- Andalusite: refractory
- Gypsum: plaster

**Metal ores**:
Rock or mineral from which one or more metals can be profitably extracted:
- Ferrous base metals (e.g. Fe, Mn, Mo)
- Non-ferrous base metals (e.g. Cu, Pb, Zn)
- Alloy metals (e.g. Co, Al, Ni, Ti)
- Precious metals (Au, Ag, Pt)
- High-tech special metals (e.g. Sb, In, Ge, rare earths)

# What is a supply chain ?




*Lithium battery supply chain (source : Huntkey)*

primary supply

1) **Mining extraction**
   → ore

2) **Mining treatment**
   → concentrate

3) **Chemical or metallurgical transformation**
   → semi-finished product

4) **Industrial use**
   → consumption product

5) **Recycling**
   → Reusable semi-finished product

secondary supply

# Summary

## 1. Increasing demand for raw materials…

- Resources needed for the energy transition
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- Dependence for your supplies
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## 3. …requires you to secure your supplies…

- Raw materials criticality assessment
- European initiatives
- Solutions to secure our supply

## 4. …and more and more in a responsible way.

- The challenge of the mining industry
- Responsible mining and responsible supply
- Example of the aluminum GES emissions management

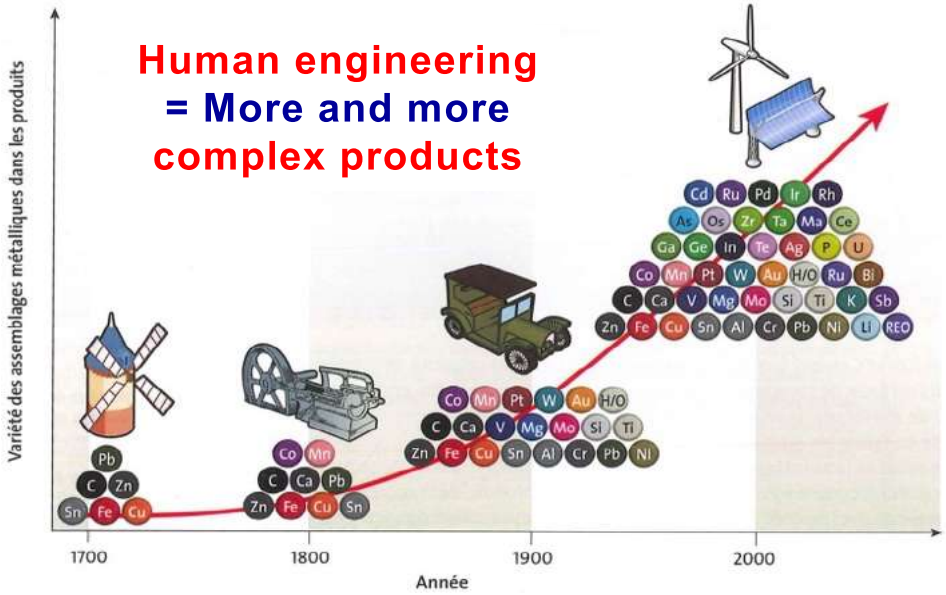
# The need for raw materials is growing and will continue


*environment and energy transition*

*digital transition*

*economic growth*

- New technologies are mineral-intensive → **strong increase in demand**
- Innovative technologies are based on more and more complex finalised materials → minor or rare metals, purity requirements



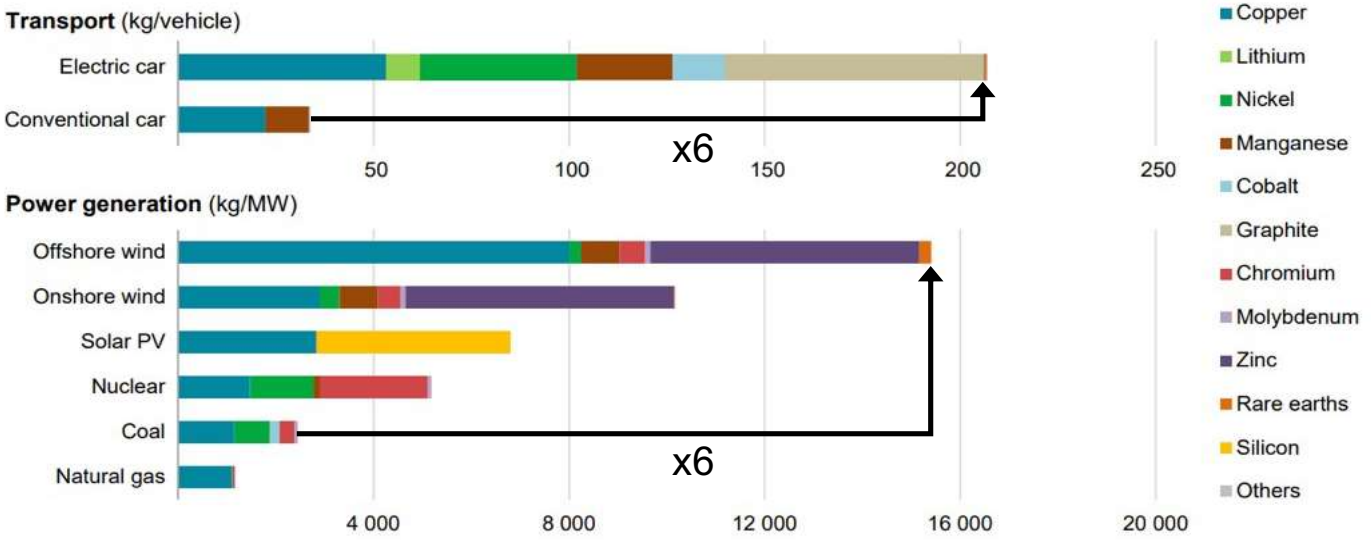

*Evolution of the quantity of mineral substances used in some major technologies (source : Van Schaik et Reuter, 2012)*

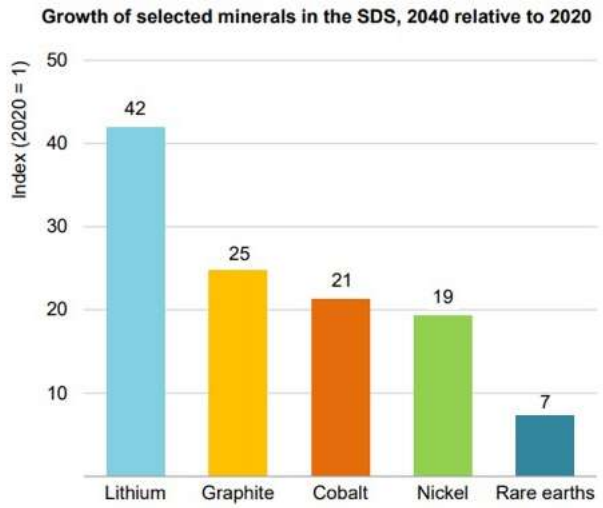
# Raw materials needs for the energy transition

**Keys to the energy transition:**

- improving energy efficiency
- low-carbon energy production
- development of smart grids and storage capacities

- The energy transition (clean energy production & electric mobility) results in a strong increase in the need for metals, both "historical" (Cu, Al...) and "new" (Li, Mn, Co...)




*Mineral demand for low-carbon energy use by scenario (source IEA)*

# Example of raw materials for battery market

| kg/kWh | Li | Ni | Co | Mn |
|---|---|---|---|---|
| NCA | 0,10 | 0,67 | 0,13 | 0,00 |
| NMC 111 | 0,15 | 0,40 | 0,40 | 0,37 |
| NMC 433 | 0,14 | 0,47 | 0,35 | 0,35 |
| NMC 532 | 0,14 | 0,59 | 0,23 | 0,35 |
| NMC 622 | 0,13 | 0,61 | 0,19 | 0,20 |
| NMC 811 | 0,11 | 0,75 | 0,09 | 0,09 |

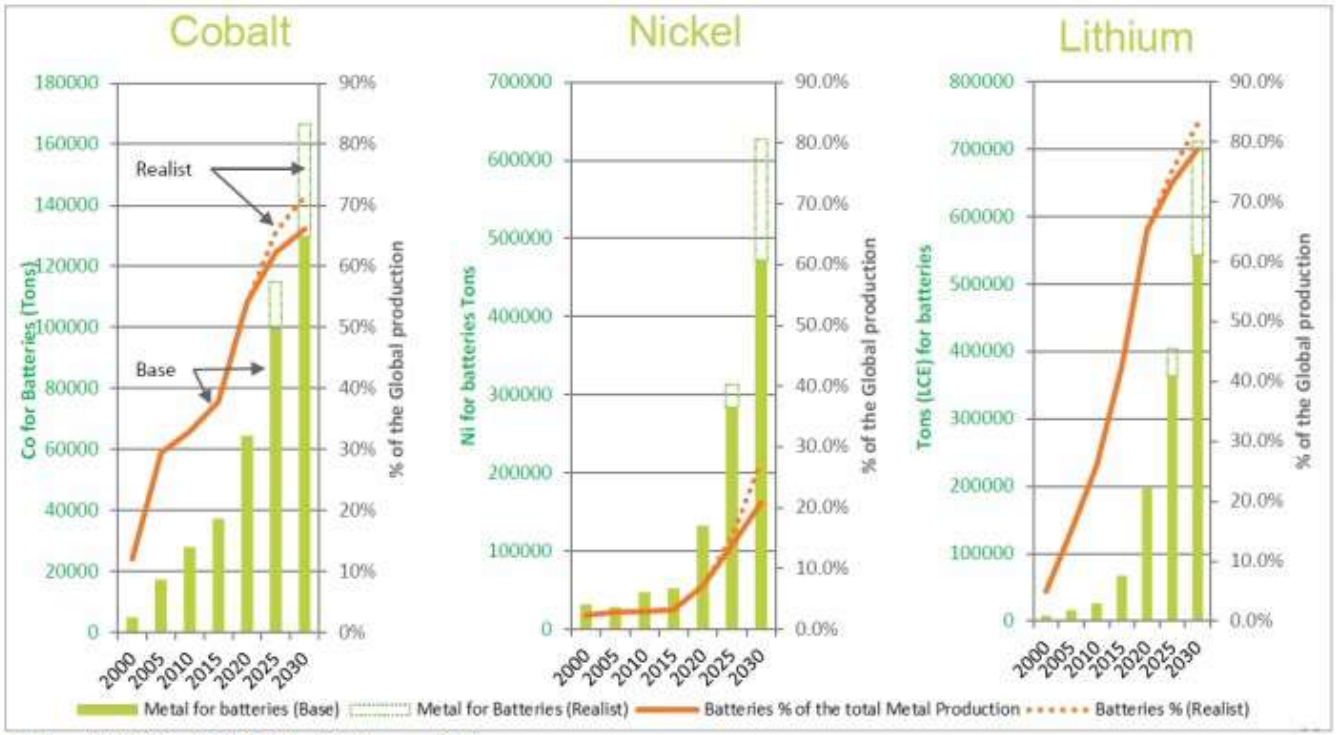
*Raw material footprint for some battery chemistries*

- Raw material footprint
- Scenario for electric vehicle deployment based on different technologies development

→ Global material needs

- But really difficult to estimate future needs:

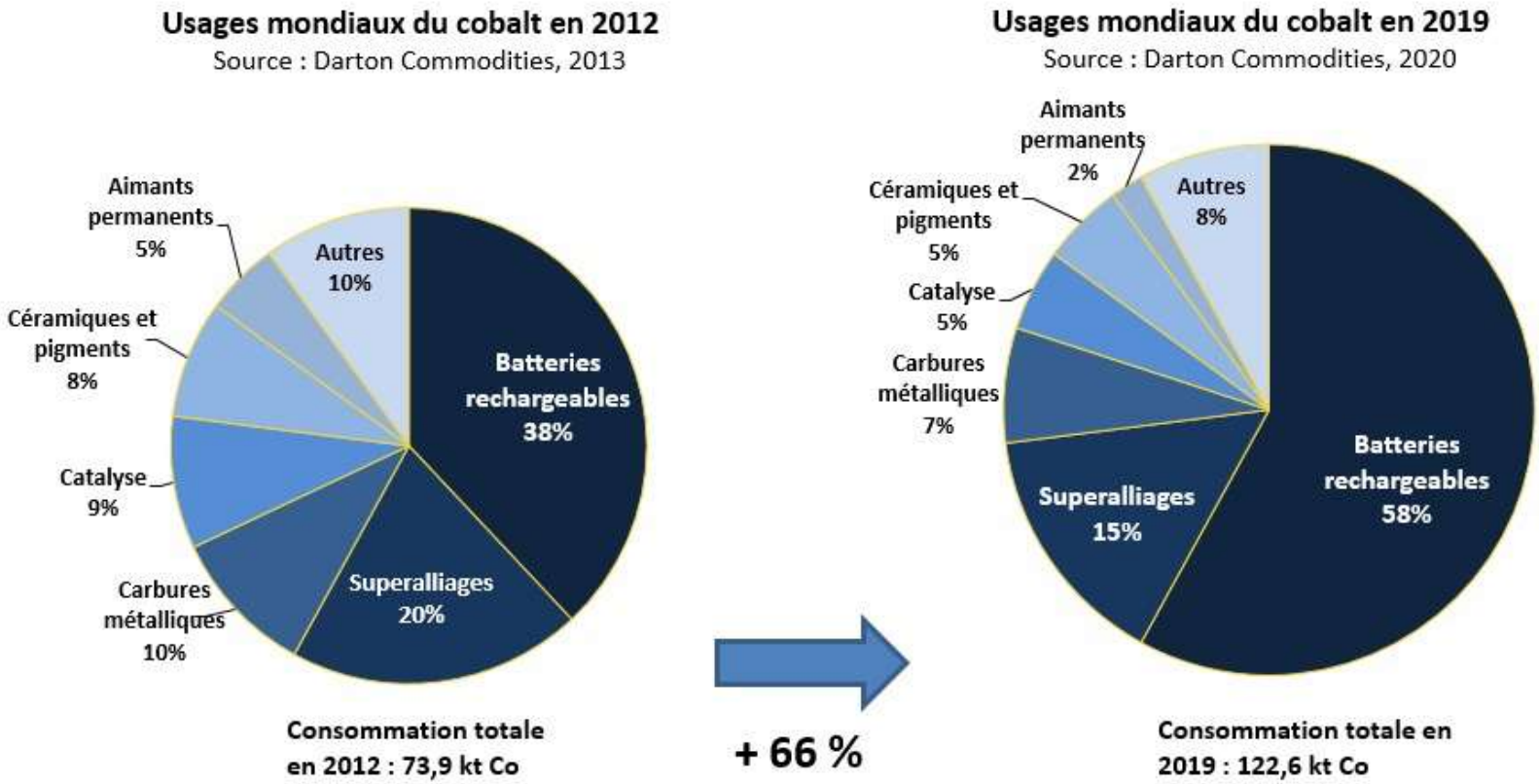
Today lithium technologies…
Tomorrow sodium technologies ?




*Note : 1 tLCE = 0,188 t de lithium métal.*
*Source : Avicenne*

*Trends in demand for critical materials for batteries worldwide*

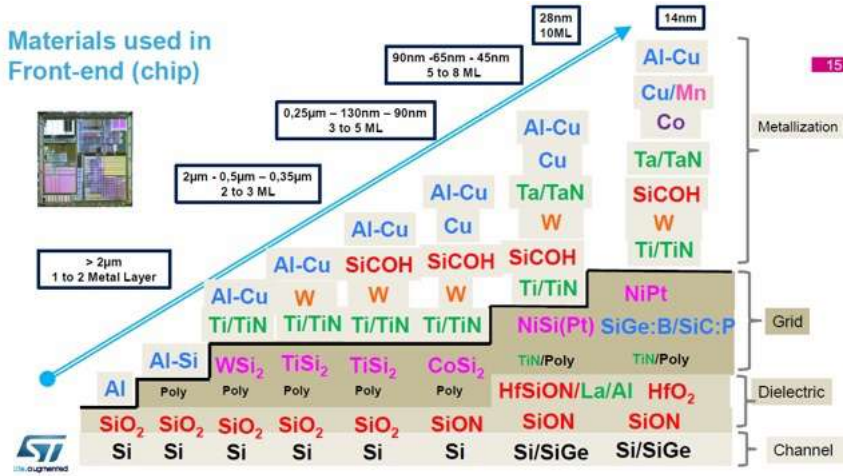
# Consequences for the cobalt market



# Raw materials also needed for the digital transition

- Digital technologies are based on a physical structure that needs metals: cables, data centres, semi-conductors, smartphones, etc.…
- Development of the internet, of the data storage and exchange, of the smart grids…

→ **raw material consumption**
→ **energy needed → raw materials to clean energy production**

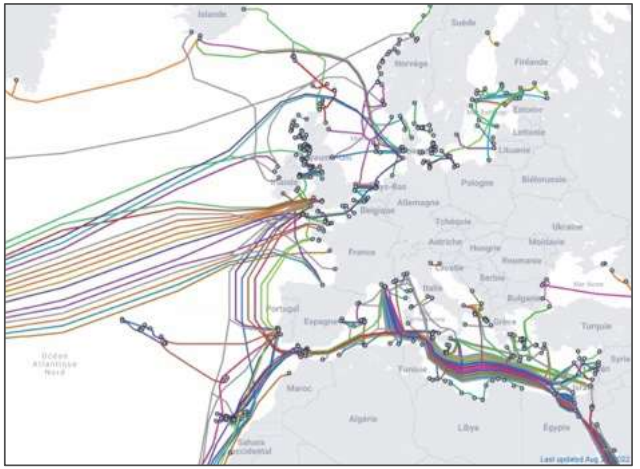


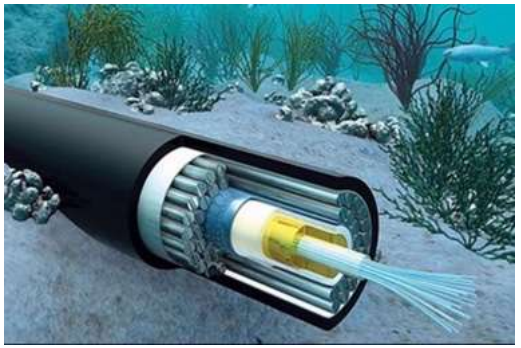

*Materials used in the fabrication of electronic chips (source ST microélectronics)*

- For microprocessors, silicon remains the material of first choice, combined more and more with various minor elements to miniaturise

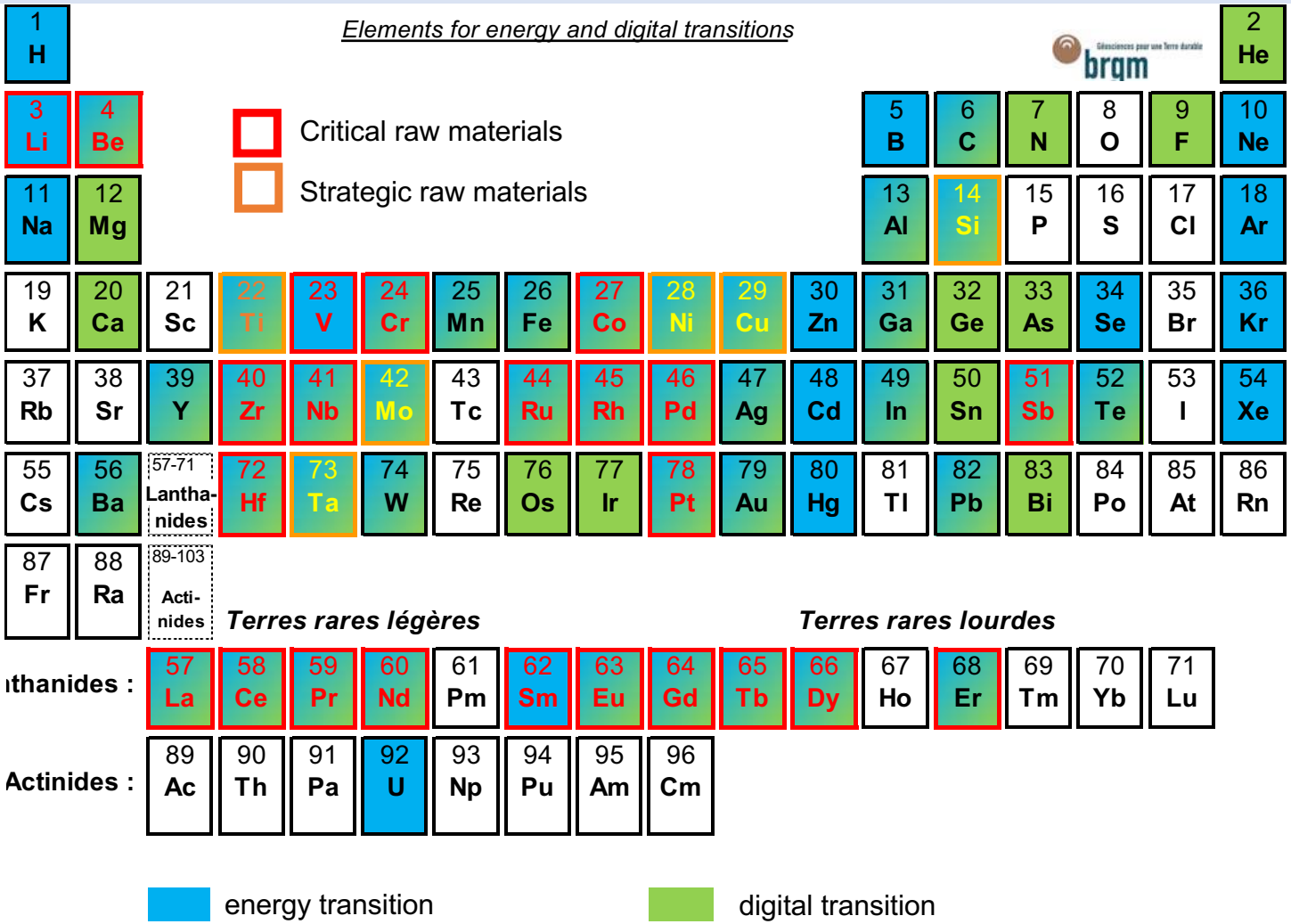
→ **use of new metals**

*Map of submarine telecommunication cables (source www.submarinecablemap.com, Télégéographie)*





# Converging needs for energy and digital transitions




- **Diversity:** Many various metals needed for new technologies.
- **Quantity:** More mineral produced by 2050 than since the beginning of Mankind.
- **Quality:** more and more complex substances
- **Conflict of use:** different technologies for different applications using the same resources.

→ **Metal-intensive transitions, which will affect all countries.**

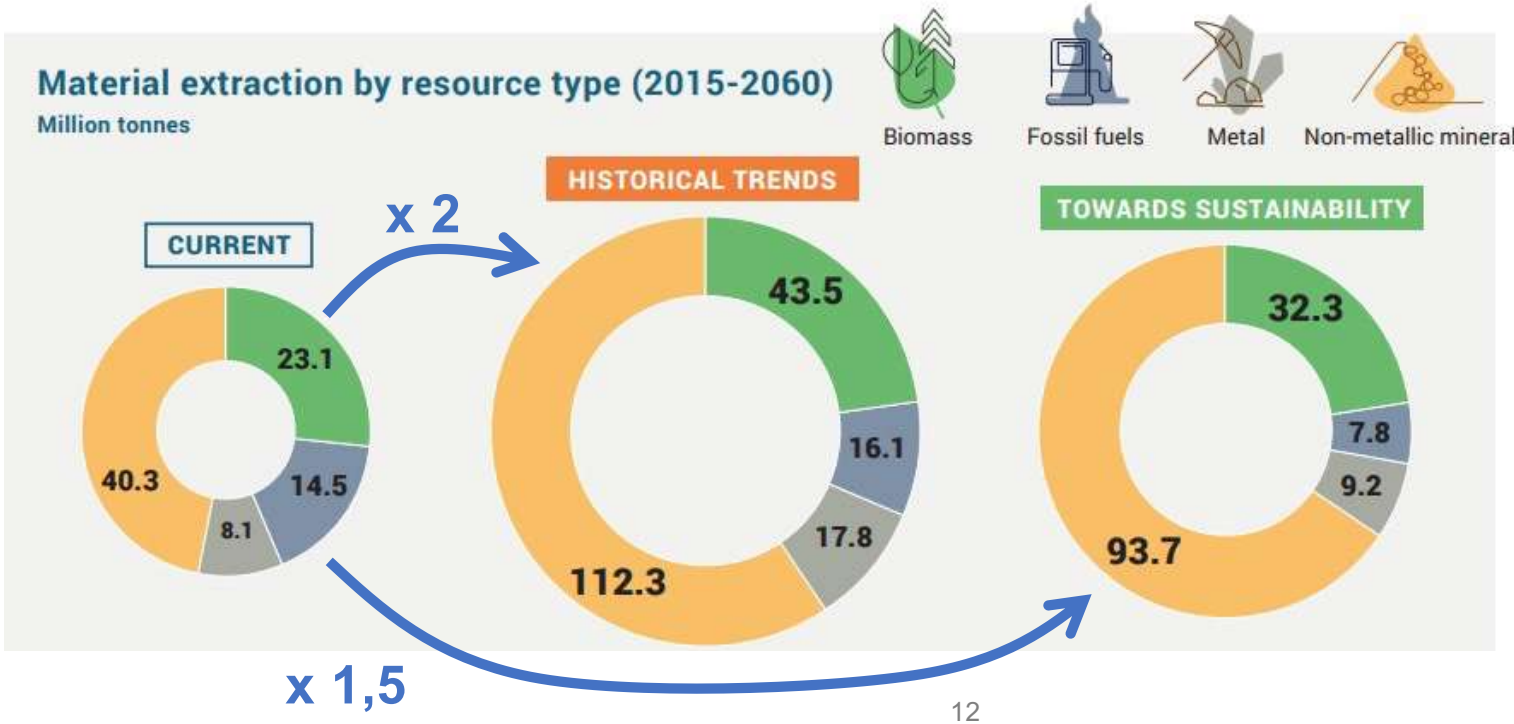
# Demand intensified by the global economic growth

Over the past five decades:

- World population **x 2**
- Material extraction **x 3**
- Gross Domestic Product **x 4**

« towards sustainability » hypothesis:

- Responsible resource consumption in emerging/developing economies
- Absolute reduction in resource use in developed countries




*Evolution of the amount of material extracted in the world between 2015 and 2060 (source Global Resources Outlook 2019, International Resources Panel, UN)*

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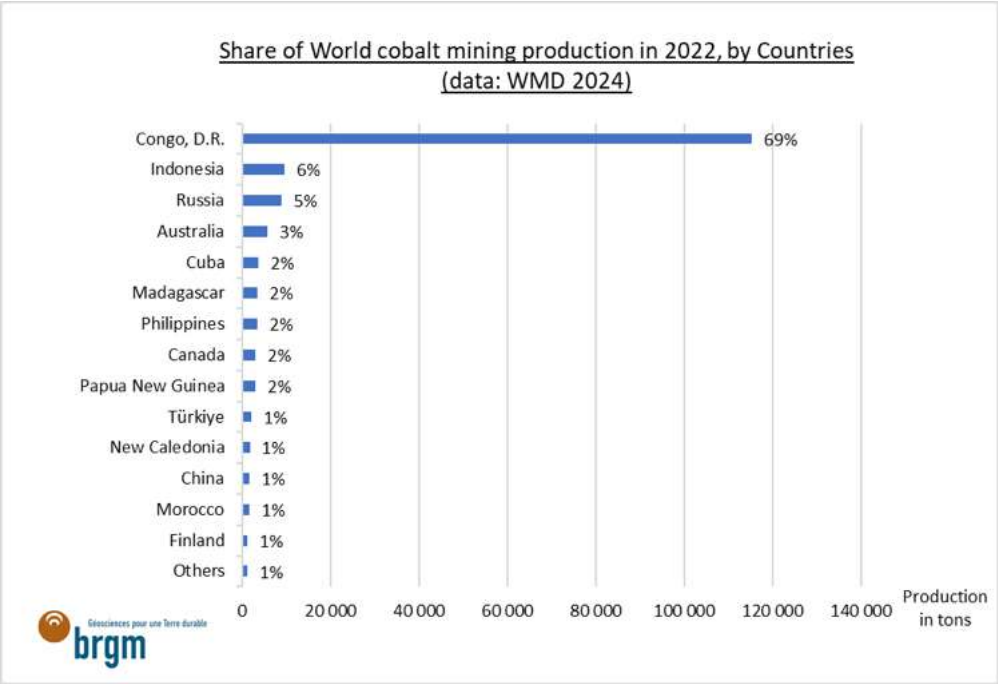
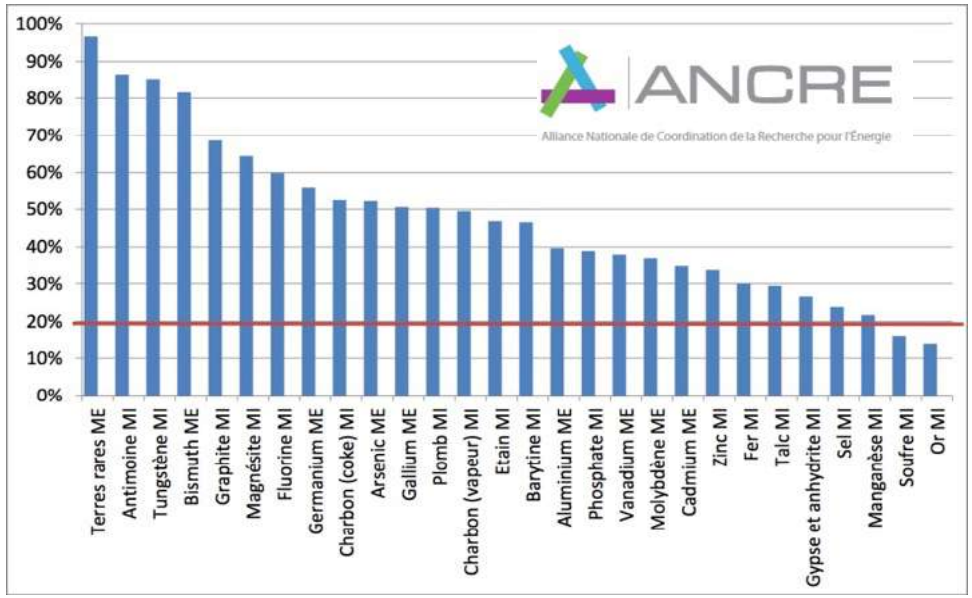
# Production is not equally spread around the world

- World cobalt mining production is concentrated in the DRC for geological and economic reasons: 2/3 of the known resources are associated with the Copperbelt intra-sedimentary copper deposits in the DRC and Zambia with grades 10 times higher than other world deposits.

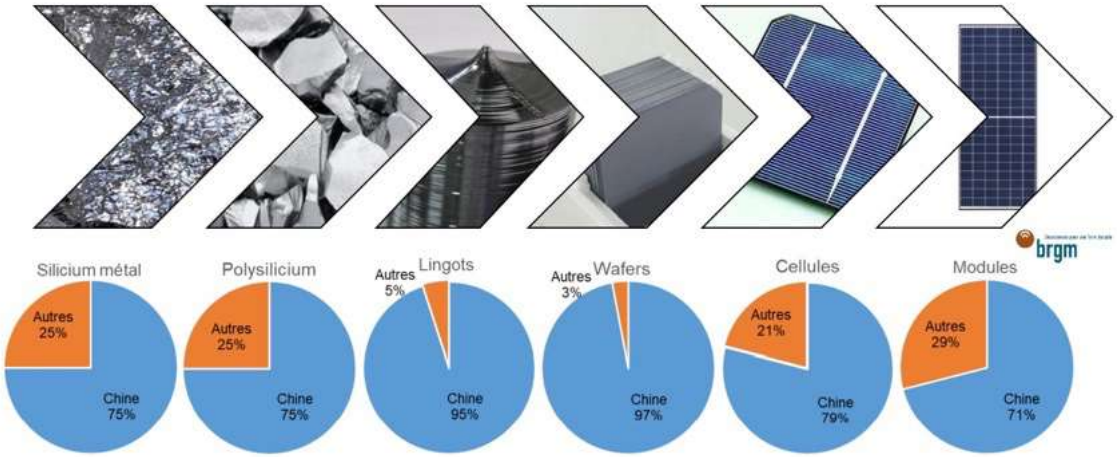



*China's mining (MI) or metallurgical (ME) production (source rapport ANCRE 2015, ressources minérales et énergie)*

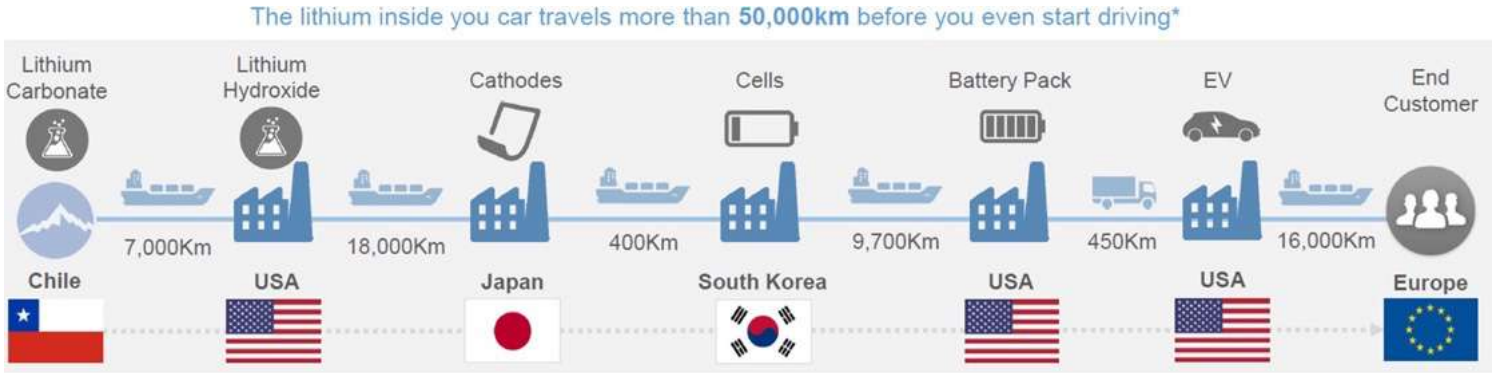
- China is the world's leading mining and/or metallurgical producer of more than thirty mineral raw materials

# Complex processing sequences



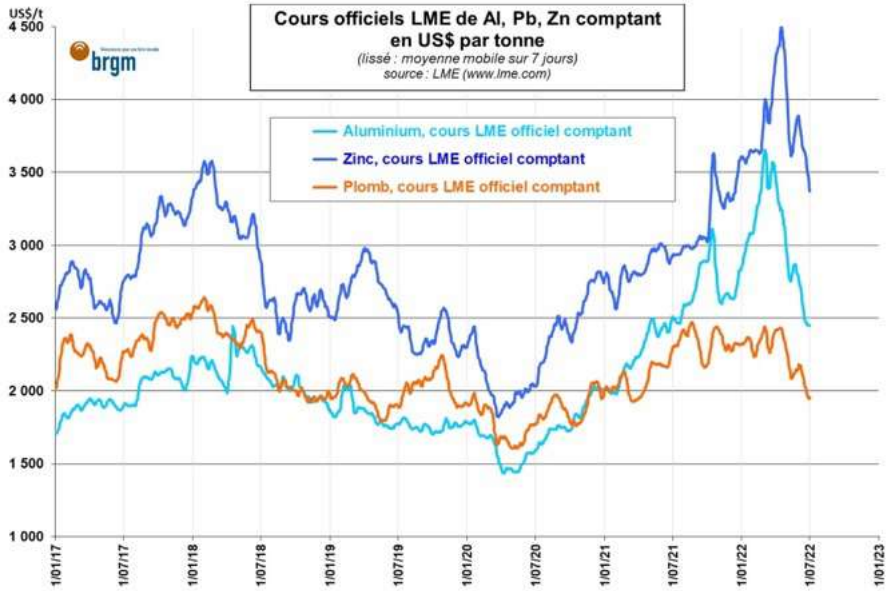

*Silicon value chain for solar panel manufacturing (source BRGM, inspiré de Bernreuter)*

- Supply chains = succession of processing steps
- These operations are often spread over different countries → control of the value chain can be done at any level
- China is specialised in intermediate processing industries



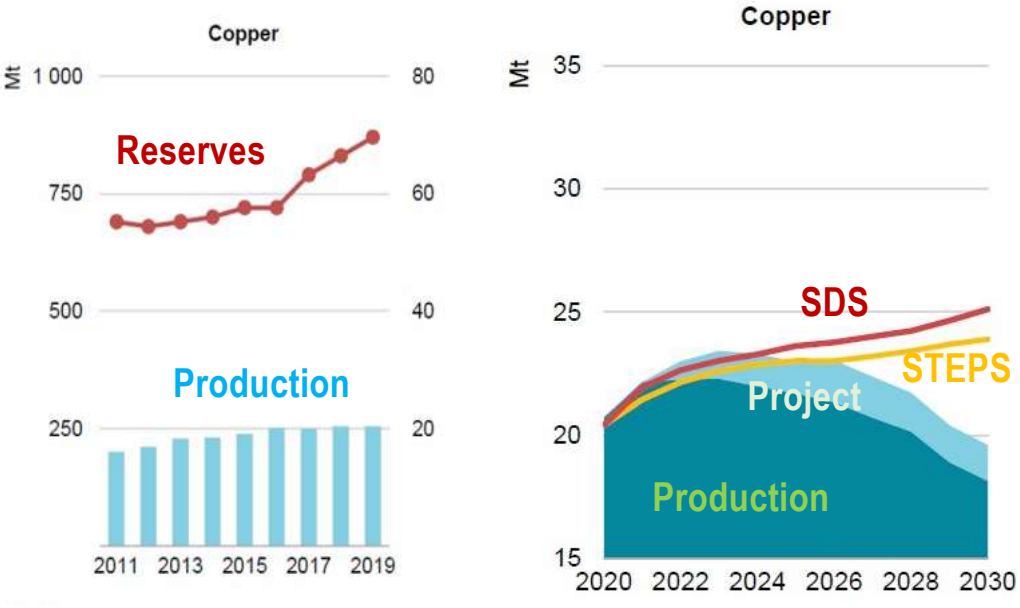
# Difficulty in satisfying demand and high price volatility

## High price volatility




- Strong increase in prices → slowing down the deployment of the energy transition.
- Volatility is not good for industrial consumers

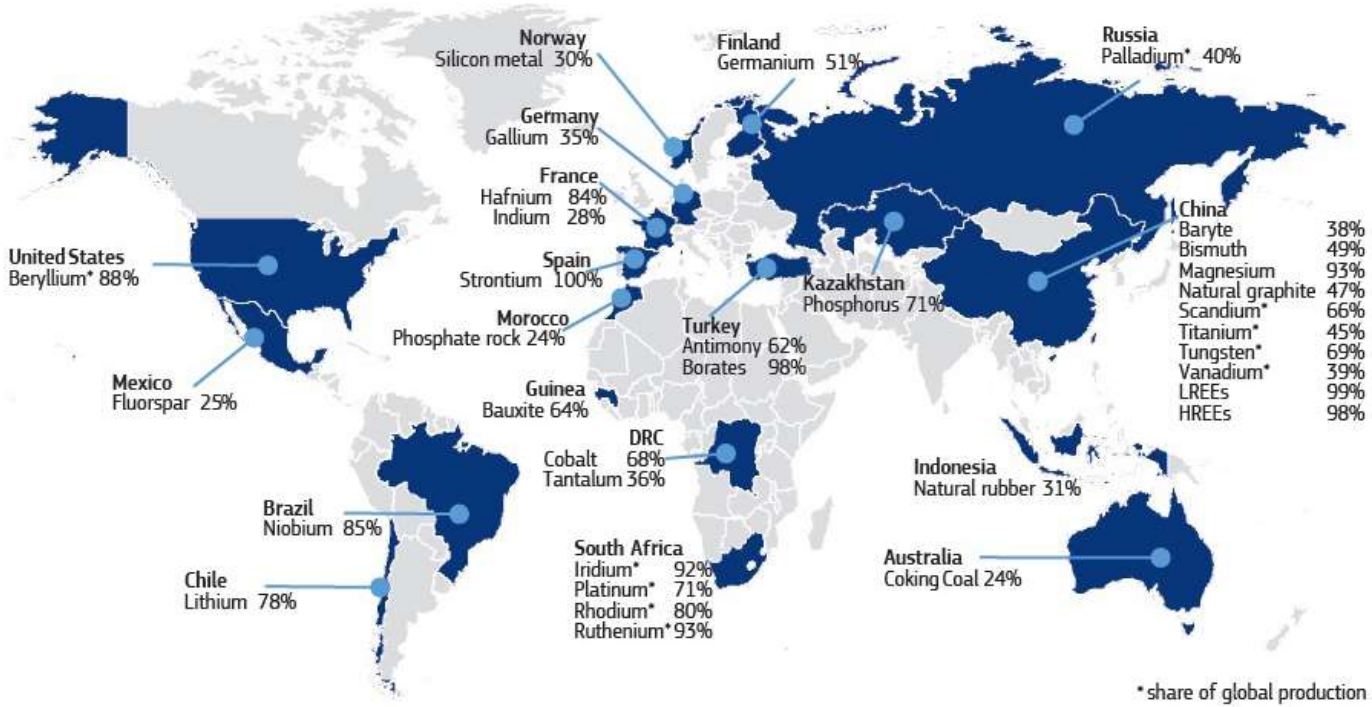
## Difficulties in matching supply to demand




*Copper reserves and production compared to demand in the SDS and STEPS scenarios (source IAE)*

- Growing tension and difficulties in meeting demand

# European dependence on raw materials supply




*Origin of critical raw materials used in Europe (RM scoreboard 2021)*

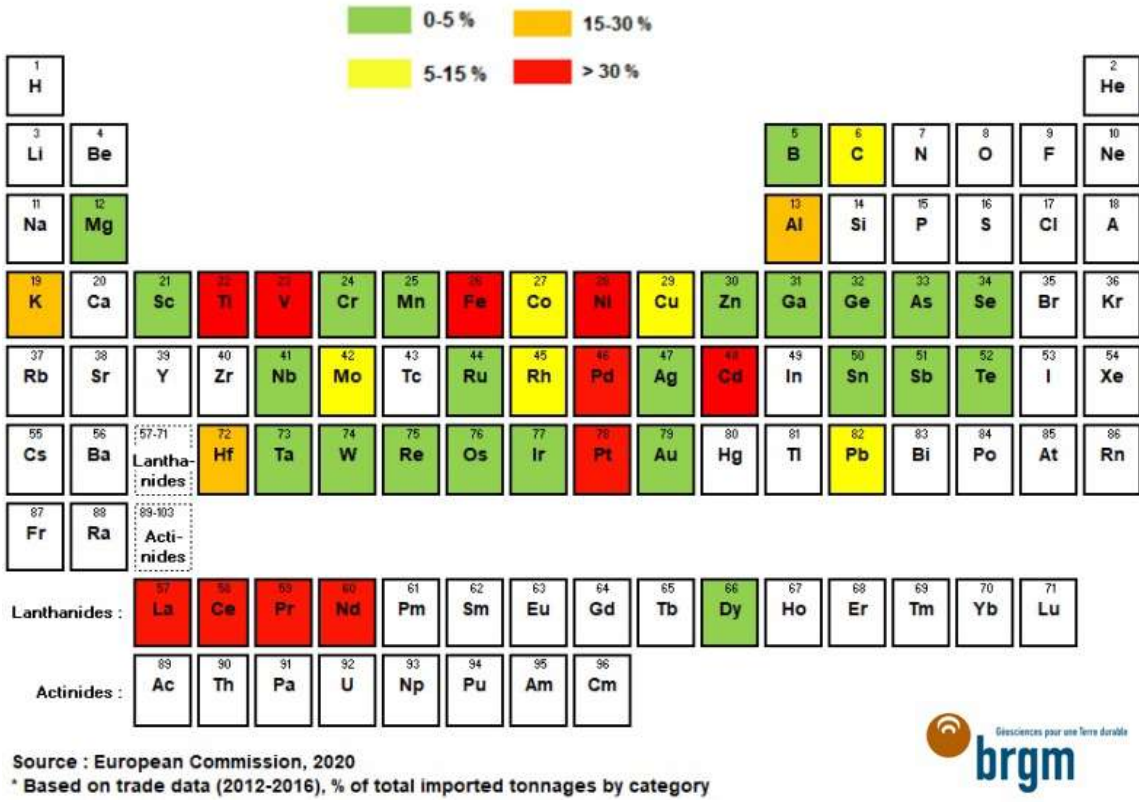
- Extractive and processing activities have been progressively relocated to countries with low labour costs and less concern for environmental impact.
- The EU is more than 50% import-dependent for around 20 substances.
- 78% of European Lithium comes from Chile, over 70% of Platinoids from South Africa, over 70% of Cobalt from DRC and 99% of Rare Earths from China.

# Recent events show the importance of securing supplies

Example of the invasion of Ukraine by Russia
Many European manufacturers depend on Russia for their metal supplies: titanium sponges for aeronautics, nickel crisis on the LME in March 2022...

But before that: covid19 crisis (2019 - 2021), Suez Canal blocked (2021), rare earth crisis (2010 - 2011)...

And tomorrow...
What could a crisis between the US and China over Taiwan look like?




*Share of imports of some strategic materials from Russia to the EU, 2012 - 2016 data (source Commission Européenne, BRGM)*

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# Raw materials criticality assessment

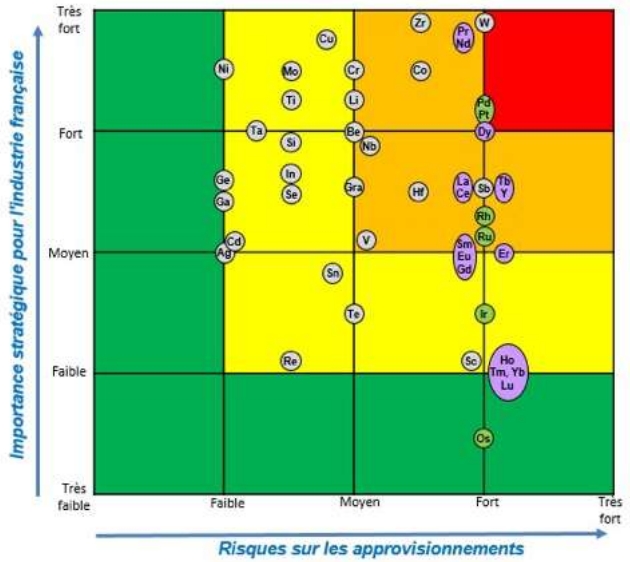
- Various methodology to evaluate the criticality of supply but always based on **the supply risk** in relation to **the strategic importance** of the substance

BRGM methodology based on various criteria:

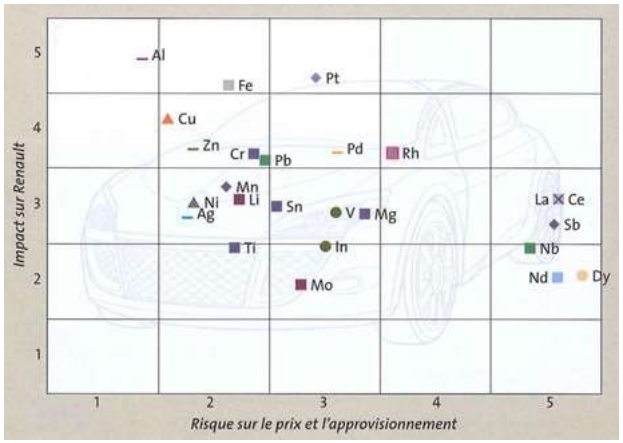
- Main hazards (causing a gap between supply and demand):
  - Logistical disruption
  - Price increase
  - Geopolitical event
- Main vulnerabilities
  - Loss of incomes / business
  - Loss of first necessity product
  - Strategic vulnerability
- Capacity to react to a supply disruption

→ Each consumer (region, country, industrial) has is own critical raw materials depending on its needs

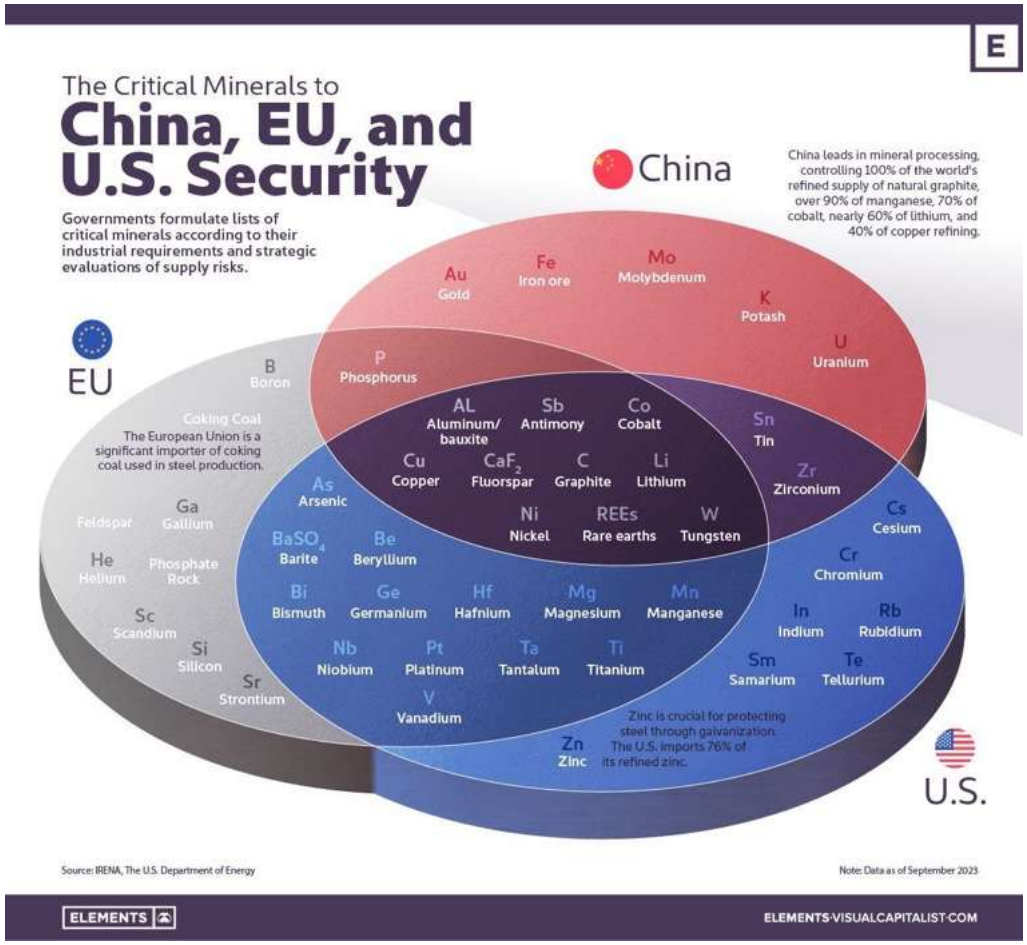
- Approche **BRGM:**



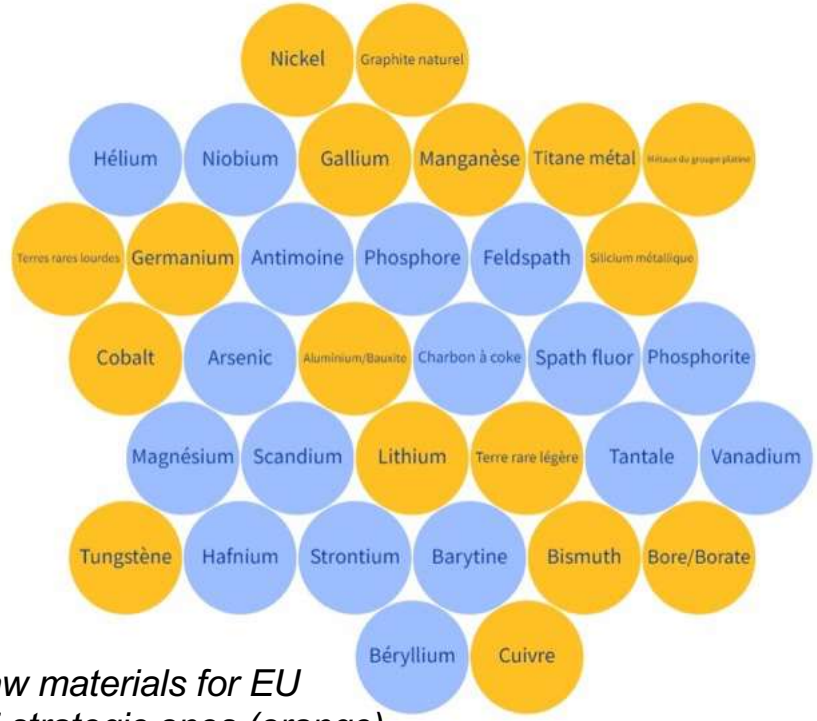

- Approche **Renault:**



# Raw materials criticality assessment




- EU critical raw materials list updated every 3 years
- **Critical substances:** raw materials that are important to the European economy and present a high risk of supply disruption.
- European Funds to CRM project development

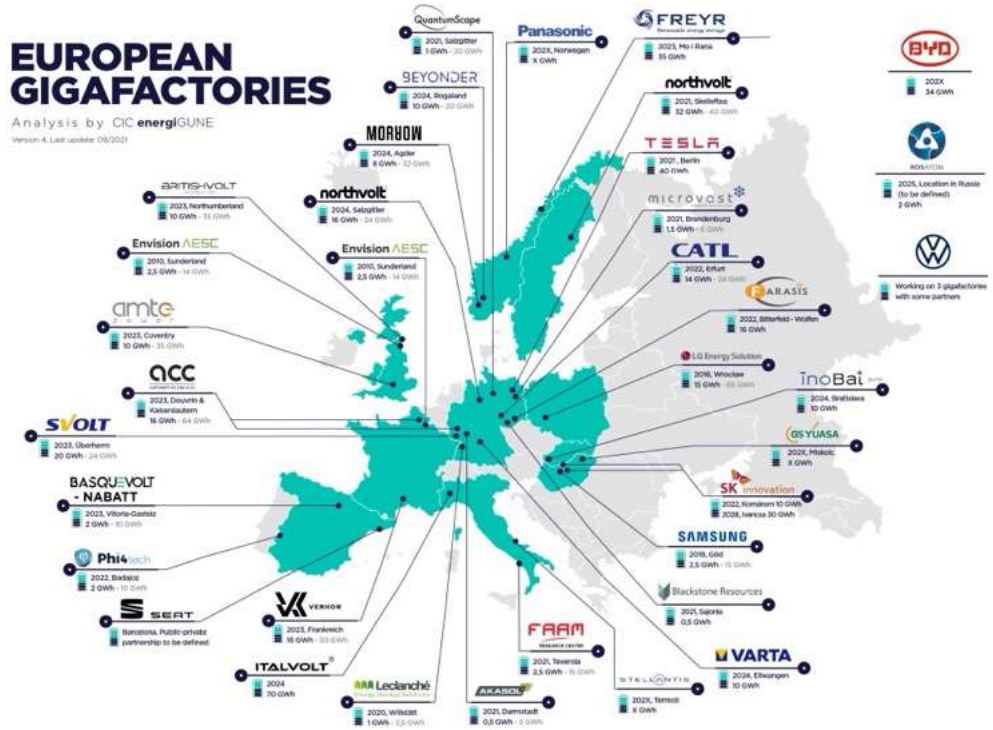



*34 critical raw materials for EU including 17 strategic ones (orange)*

# Critical Raw Materials Act (European CRM Act)


Comprehensive set of actions to ensure the EU's access to a secure, diversified, affordable and sustainable supply of critical raw materials:

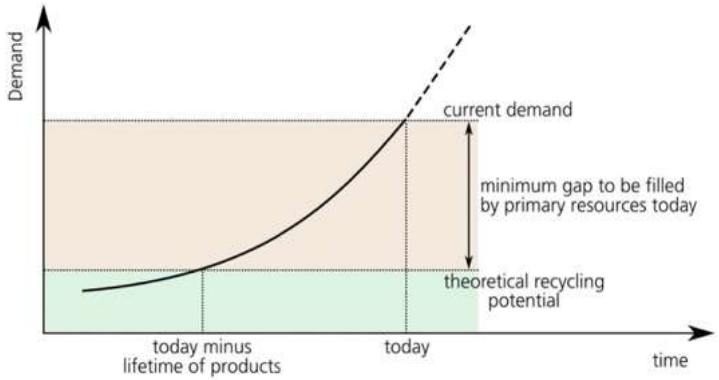
- Simplification of administrative procedures
- Financial support for R&D and new projects
- National exploration programmes
- Coordination of EU strategic stocks
- Audit of company supply chain resilience



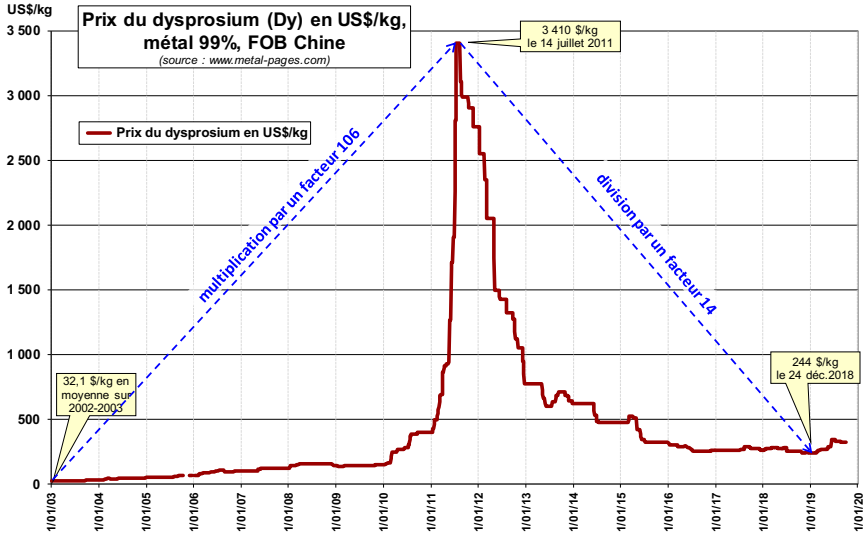

- The European Union is working to recover its independence → 6 billion euros of public funds have been released to support the construction of giant battery production plants.

# Solutions to manage your supply

- Recycling is an opportunity to be taken in terms of relocation, industrial control, resource saving and sovereignty
- But implementation is difficult:
  - Collection of end-of-life products
  - Efficient recycling processes
  - Processing industry




- **Recycling**
- **Sobriety**
- **Substitution**
- **International diplomacy**
- **Industrials partnership**
- **Responsible design of products**




**Example of Rare Earths:**

- Strong Chinese pressure in 2010-2011
- Dramatic rise in prices
- Vulnerability of Western players, particularly for permanent magnets

**Technological substitution:**

Response from several European manufacturers

- Car engines (Renault, BMW): copper coil or induction motors
- Wind turbine rotors (Enercon): induction magnets

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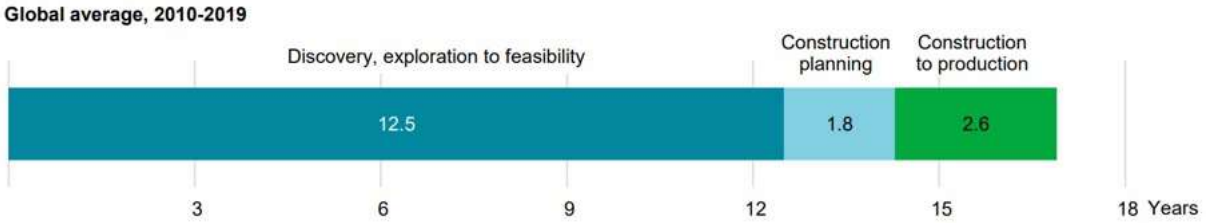
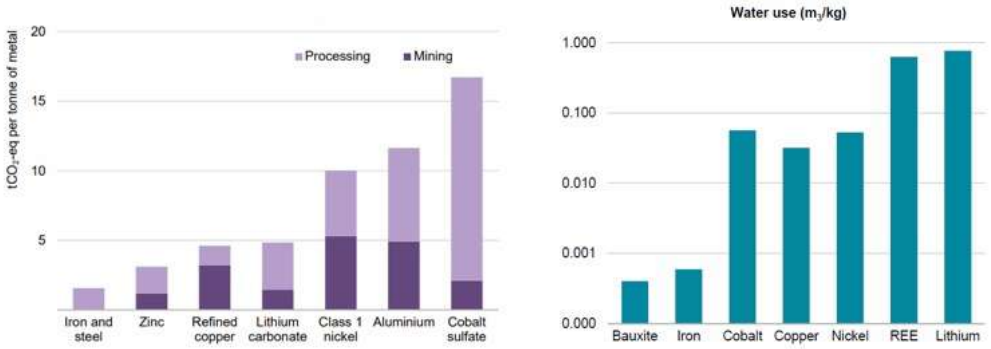
# Opening new mines is an extremely difficult challenge

- Numerous barriers: long and costly exploration phases, high CAPEX, administrative difficulties, opposition from local populations, etc.
- Need to integrate the environmental impact which depends on each ore and site: CO2 emissions, water consumption, pollution and waste, land use, etc.
- Need to take into account the concerns of local populations → Sustainable development objective




*Average time necessary between discovery of a deposit and its production (source IEA)*




*GHG emissions and water use in the production of some raw materials (source IEA)*

# Responsible mining and responsible supply

**Several international initiatives: IRMA, ICMM, IAI, EITI, Kimberley Process, etc.**

**Consideration of environmental impacts:**

- Water consumption
- Greenhouse gas emissions
- Waste management
- Biodiversity
- Various impacts: noise, dust, visual
- Site restoration

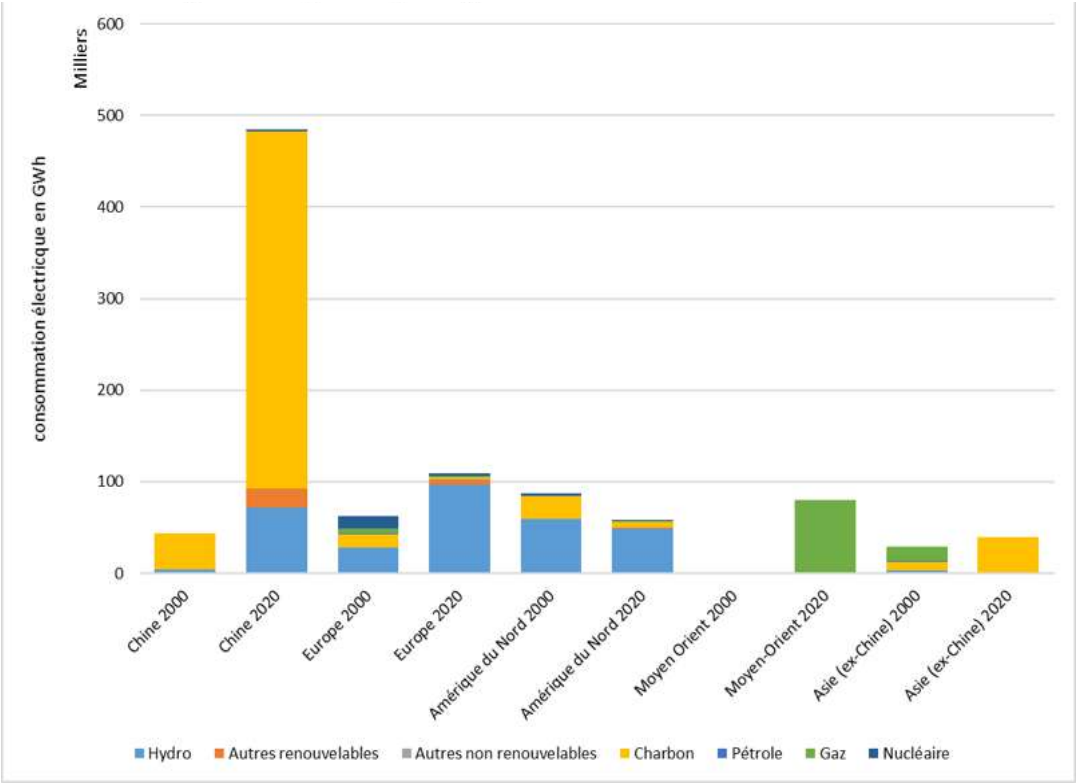
**Consideration of social impacts:**

- Populations concerned
- OHS
- Employment and training
- Site closure management
- Diversity, inclusion, equality

**Consideration of societal impacts:**

- Local taxation
- Governance
- Regional economic development
- Land use
- Areas of conflict

# Energy consumption and greenhouse gas emissions

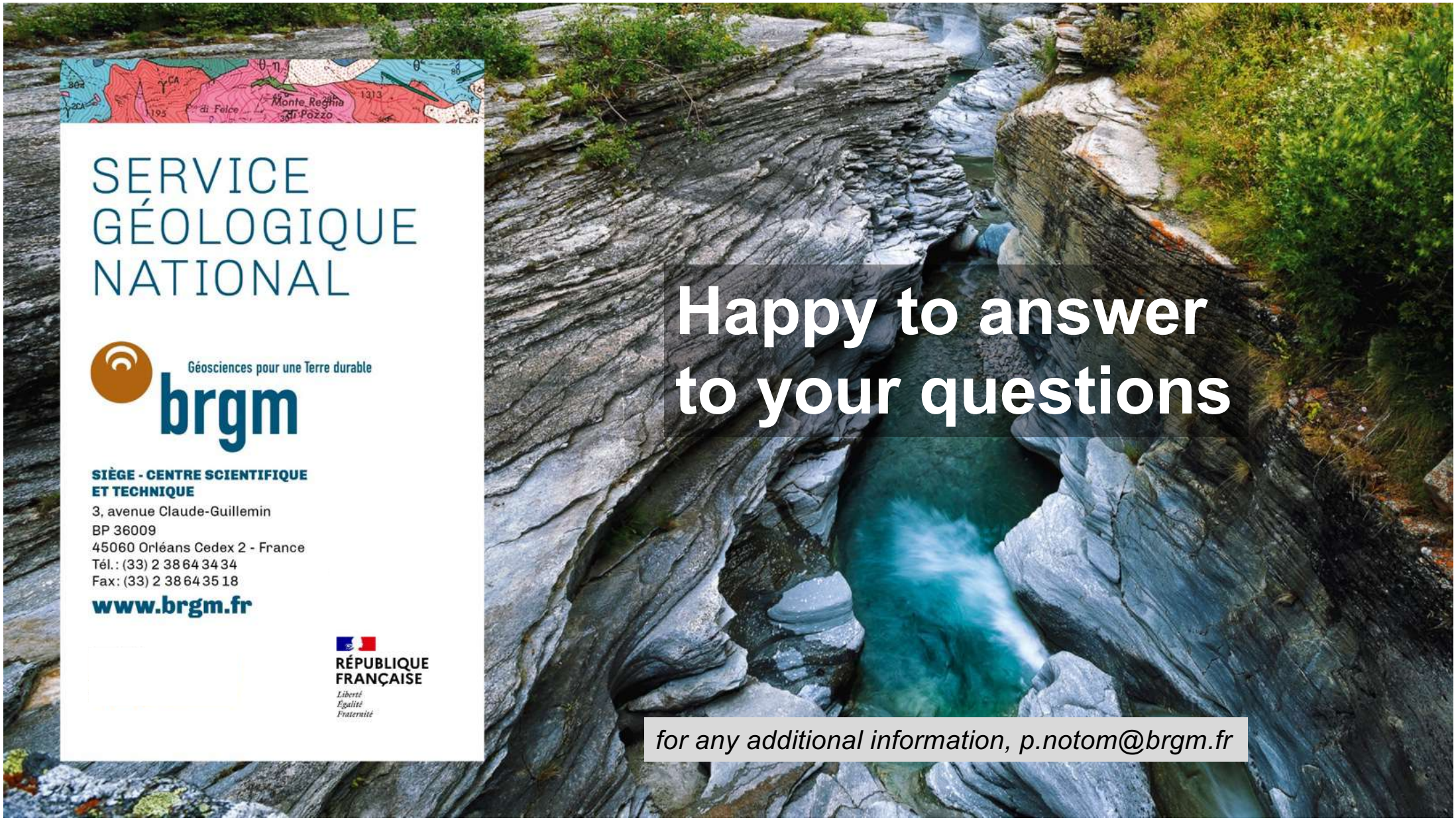



*Electrical origin of aluminium smelters in some regions of the World (source IEA)*

- Carbon footprint: between 5 and 25 tons of CO2eq per ton of aluminum produced

**The various initiatives to reduce emissions:**

- **Responsible sourcing at the LME**: LME passport and green brand
- **Carbon taxes:** Around twenty countries around the world have already introduced carbon tax systems of varying degrees of constraint (Canada, Norway, EU).
- **National initiatives:** the United Arab Emirates has a national strategic plan to use 70% low-carbon electricity by 2050 for its aluminium industries.
- **Company initiatives:** objective of market differentiation, cost reduction, R&D, etc.




# SERVICE GÉOLOGIQUE NATIONAL

Géosciences pour une Terre durable

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## Happy to answer to your questions

*for any additional information, p.notom@brgm.fr*