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Regulation and criticality: the case of gallium and beryllium

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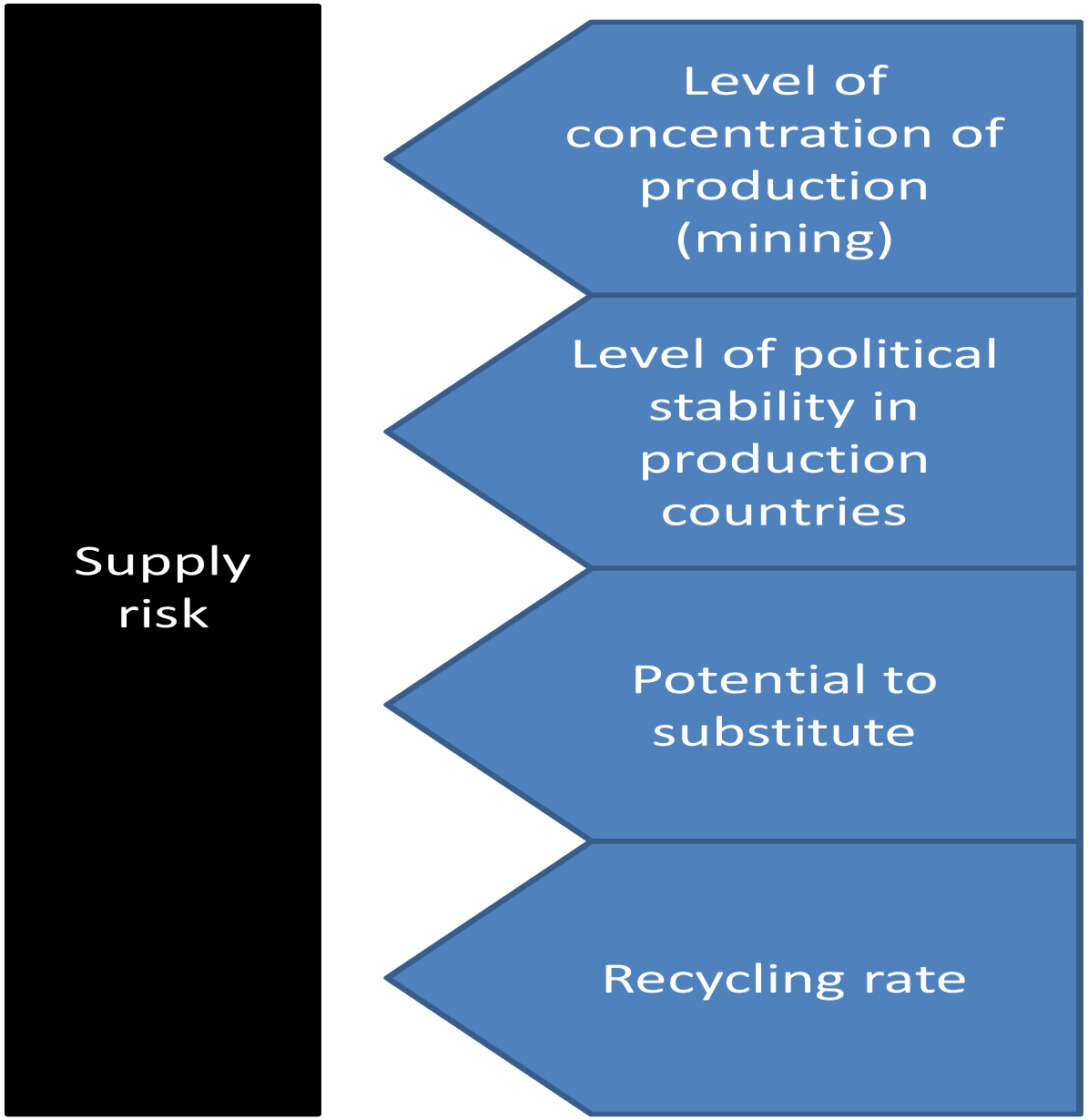
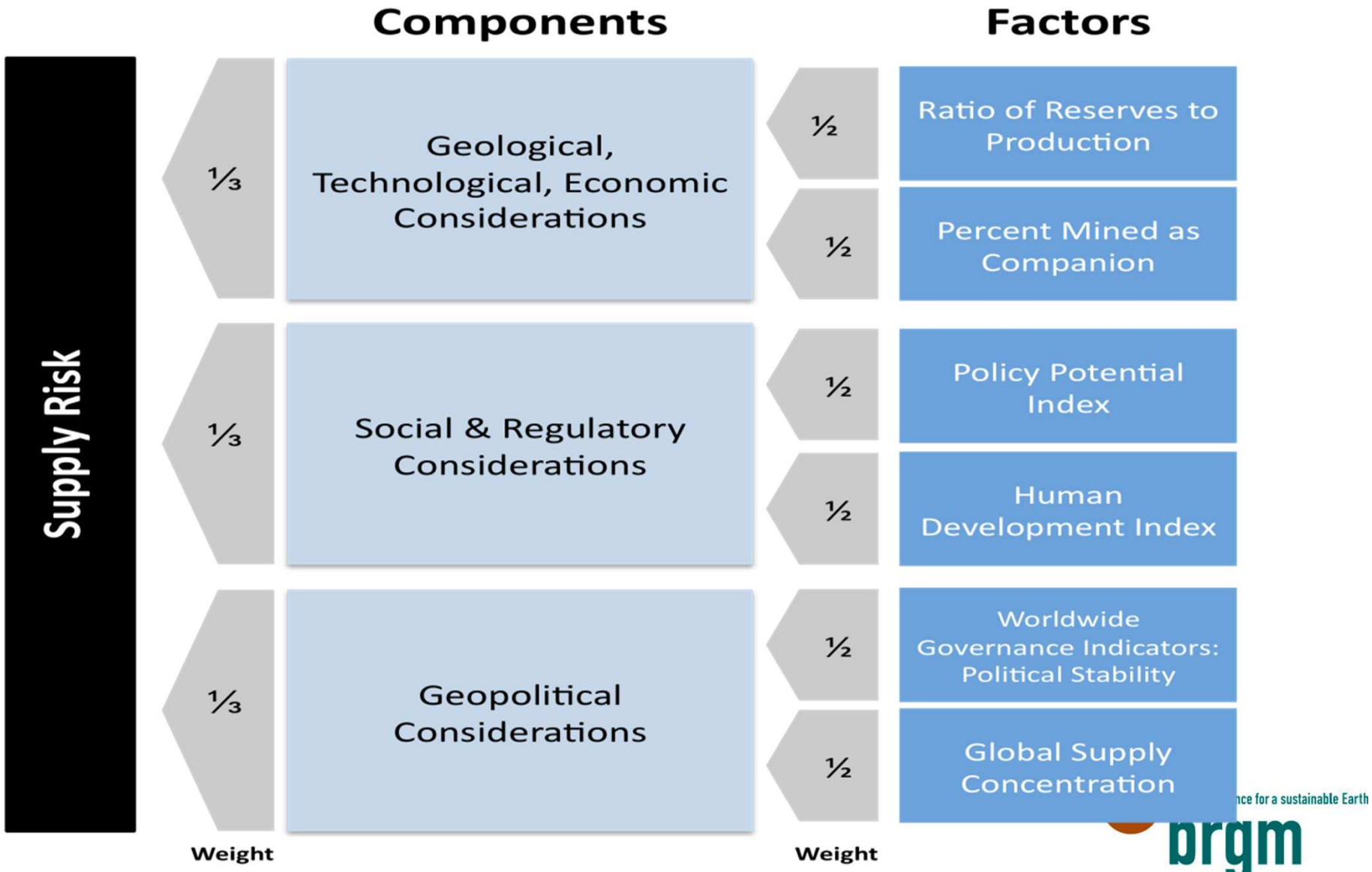
Mineral criticality assessments, a tool to inform policy makers, industry, academia, research and society

- Since 2007 there have been numerous criticality assessments looking at supply risk and their potential impacts on given economies or corporations
- Most lack a forward looking dimension
- Several factors, such as mining project pipeline analysis, location and concentration of metallurgy, supply and demand trends, human capacities, R&I effort patent applications along the supply chain, and more are not taken into consideration. Some are very difficult to assess.

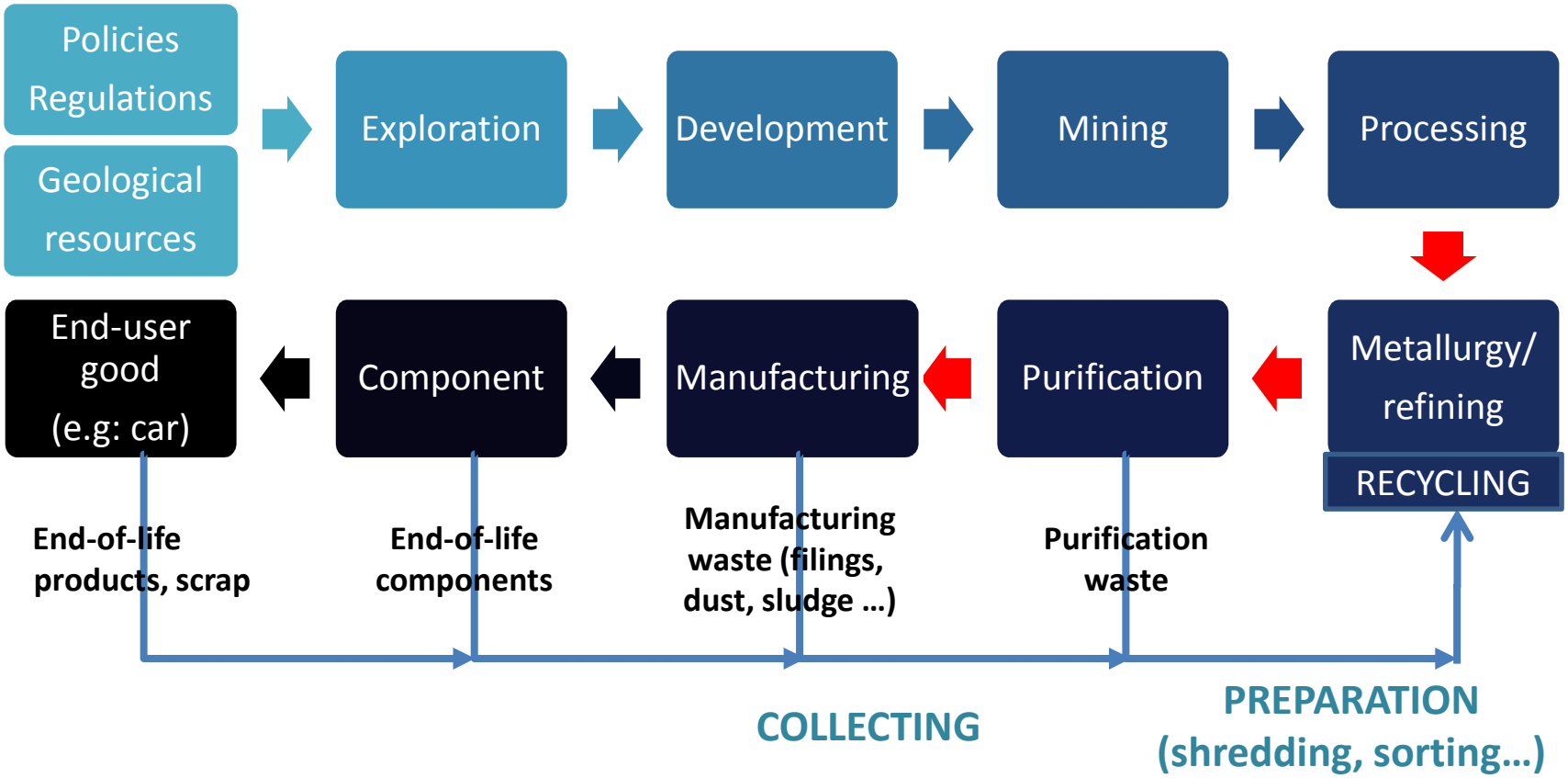
European approach: « Critical minerals to the EU economy » (2010)



University of Yale approach: Criticality of the Geological Copper family » - Nassar et al. – 2012 – J. of Environmental Science & Technology



A different approach to criticality assessment: the supply chain analysis: where are the criticality factors, seen from a long term perspective (20 years and more) perspective at each stage?



This presentation focuses on regulatory issues as a criticality factor that can hit important supply chains

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An evaluation of criticality factors related to beryllium and gallium

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Be

Beryllium

Mined Production 2011: 235 metric tons (USGS)

Total world production / consumption 2011: 400 metric tons (BeST)

CAGR 3 years (2008-2011): 10%

Resource: Relatively abundant

(USA proven reserves of nearly 60 years world consumption)

1st producer: USA (80+%) – 1 company

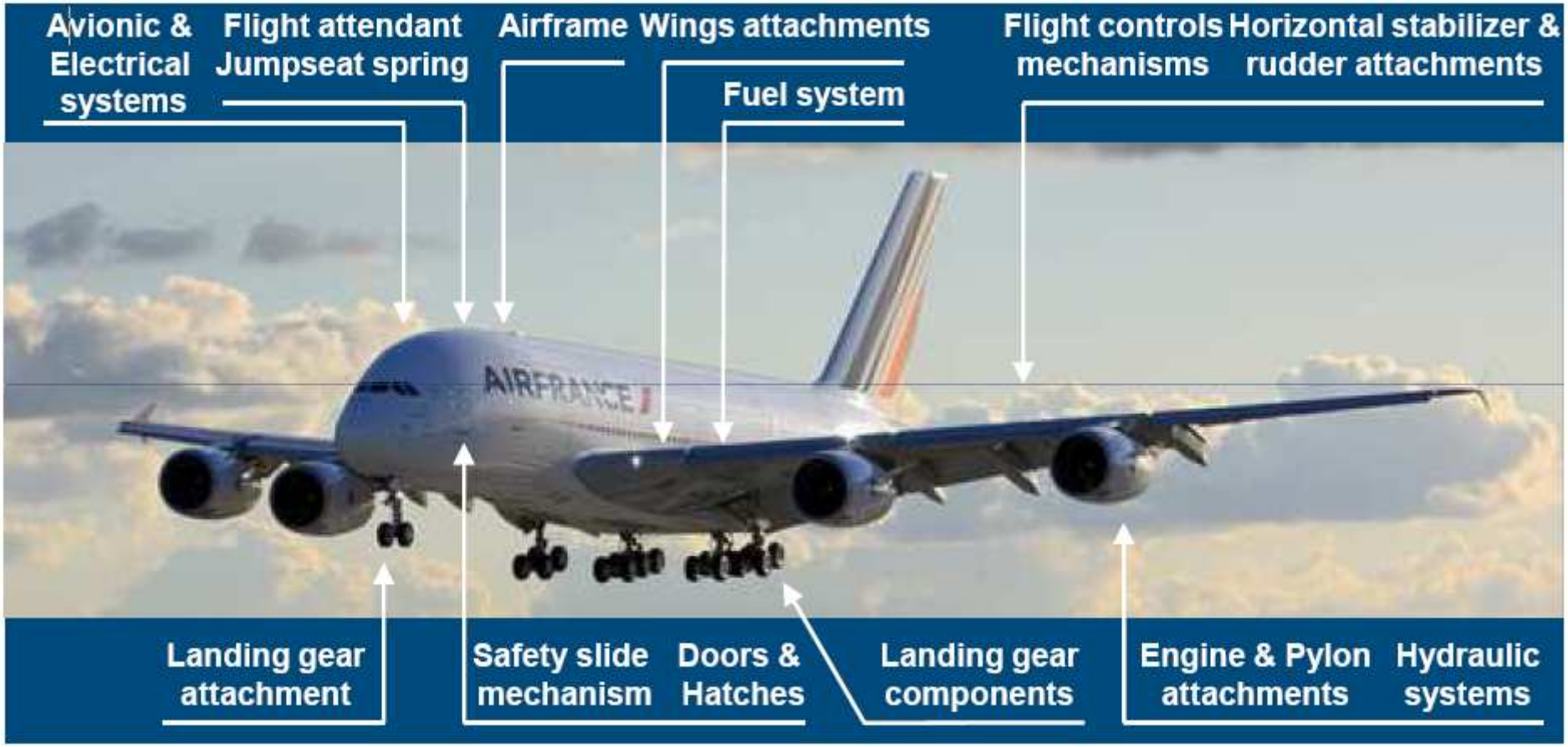
Spot Price 2011 (USGS): 448 000 $/t 2011 (Niche high-tech market)

Unique physical, chemical, atomic and nuclear properties

Beryllium uses – what is at stake in the EU

- **15% as Pure beryllium metal:** X-Ray / CT Scanner windows, Satellite components, ISS, space telescopes Hubble & James Webb, nuclear reactors especially ITER, defence, hi-fi loudspeakers…);
- … or **80% in Cu-Be alloys** containing 0.2 – 2% Be: connectors (aircraft, cars), plastics industry, ICT (computer keyboards, connectors), non magnetic components / safety tools for the oil and gas industry …;
- Conservation of strategic know-how and of downstream industries

Beryllium uses (aircraft)



In addition, an Airbus A380 uses 530 km of wiring; 40,300 connectors; 2.9 million terminals. Virtually all sockets are made of Cu-Be alloy

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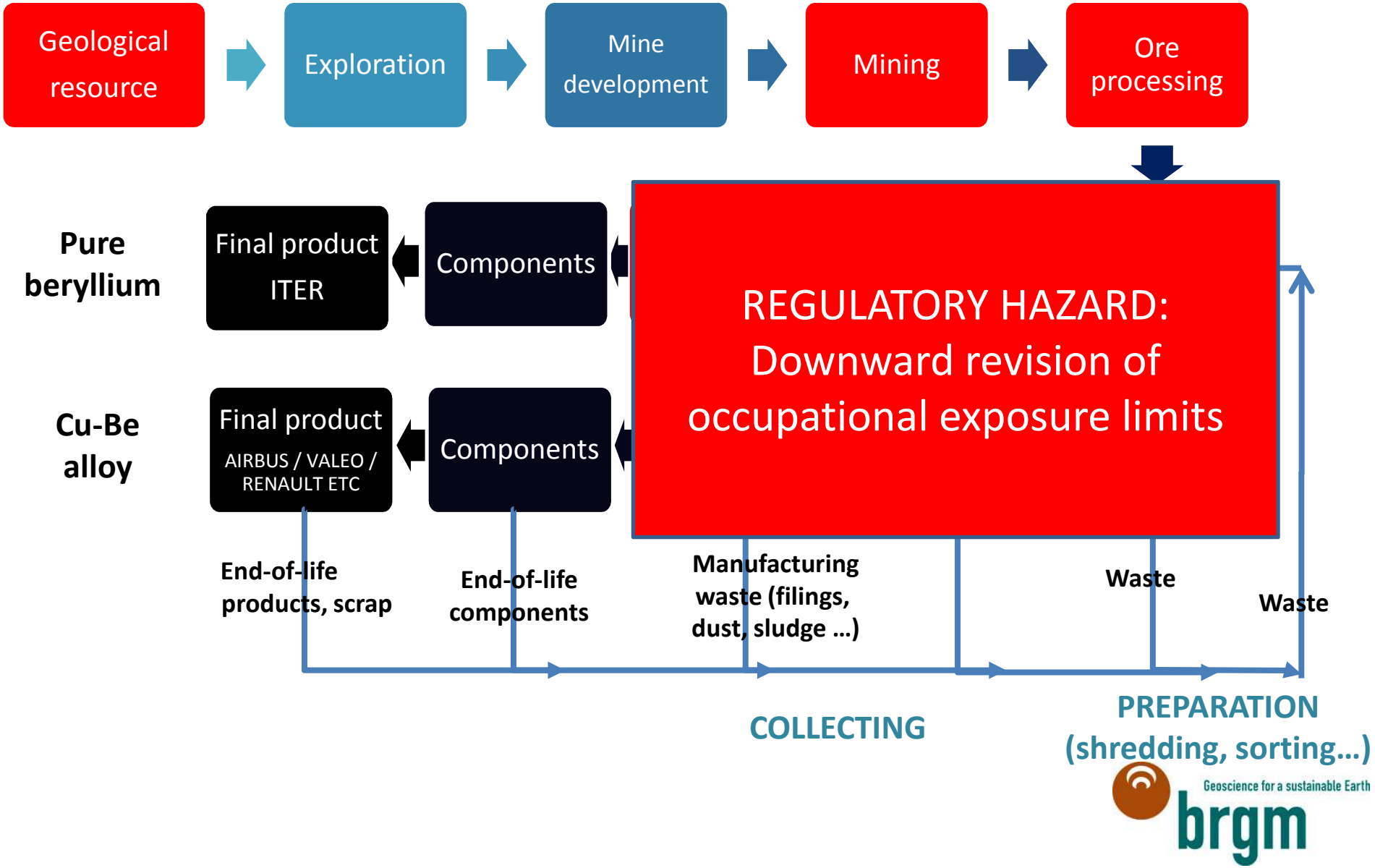
Beryllium uses

- **Substitutability** very low or nil in applications :
  - Where atomic/ nuclear properties are used
  - Where reliability and high performance is essential
  - Where no other metal system gives same combination of properties

- **Be** and **Cu-Be** are recyclable

SIMPLIFIED VIEW OF THE BERYLLIUM AND COPPER-BERYLLIUM SUPPLY CHAINS FOR SELECTED INDUSTRIES



The EU beryllium industry

- Be metal supplier: Materion Brush (USA) – quasi monopoly
- Be metal downstream chain:
  - Fabrication: Atmostat +5(France), ExoTec Precision +5 (UK)
  - Wide range of downstream applications including

- Cu-Be downstream chain:
  - Fabricator / Distributors : France (4), Germany (4), Sweden (1), UK (2)
  - Stampers/ connector makers: France (75+), Germany (100+), Italy (50+), Sweden (1), UK (20+), Spain (15+), Switzerland (25+)
  - Plastic mould makers EU (75+)
  - Landing gear makers France (2), UK (1), Germany (1), Poland (1)
  - Oil & Gas Equipment Makers: UK (50+), France (10+), Germany (5+)
  - …

Ga

Gallium

Production 2011: 292 tonnes (USGS), 85 tonnes (World mining data)

CAGR 3 years (2008-2011): 37% (USGS)

Resource: very abundant (30 to 80 g/t in bauxite, the aluminium ore, 2011 prod. : 259 Mt)

1st producer: Production capacity 2011: 404 t. (1st capacity: China, 208 t., 69% of global vapacity, EU: 10%)

Spot Price 2011 (USGS): 499 000 $/t for 4N Ga (Niche high-tech market)

Unique atomic properties

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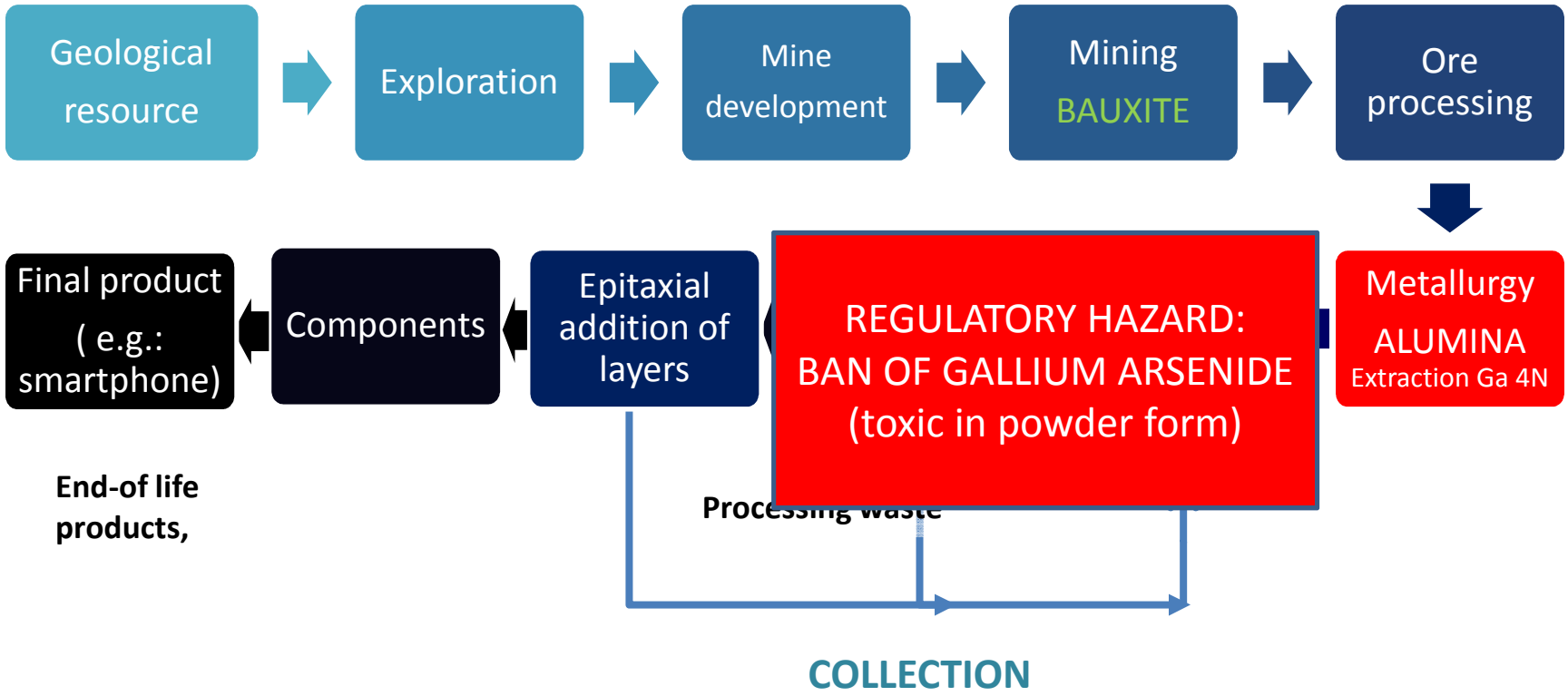
Gallium uses – what is at stake in the EU

- **Gallium arsenide (5x faster than silicium):** high-frequency integrated electronic components (WiFi, Bluetooth, frequency convertors used in telecoms, computers, smartphones, aircraft, defence, space, remote sensors), microwave ICs, laser diodes, solar cells (space applications, conversion factors of 30% and more)
- **Gallium nitride**: LED lighting
- Conservation of strategic know-how and of downstream industries

Gallium uses

- **Substitution is impossible without loss of functionality, as the unique atomic structure of Ga is used in all its key applications**
- **Ga As primary recycling (manufacturing scrap) is well developped**
- **Ga As end-of-life recycling theoretically possible but likely to be way too costly compared to the use of new material**



Simplified view of the gallium supply chain for the smartphone industry

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The EU gallium industry

- 4N Ga extraction at two alumina plants: at Stade (Germany, 40 tpy estimated capacity) and Ajka (Hungary, 8 tpy). This means that the EU has an estimated 12% of the primary global Ga production capacity (404 tpy, USGS figure for end 2011, 69% located in China
- Purification to 7N grade: UK (1 plant, from primary and secondary sources), Germany (1 plant from secondary Ga), Hungary (1 plant), Slovakia (1 plant)
- Substrate manufacturing (AsGa): DE(1), FR (1)
- Epitaxial grown wafers: DE(2), FR (3)
- Technological processes: FR (2)

Conclusions

Conclusions

- Changes in regulations/ regulatory incertainty/ unclarity in policy objectives are one important criticality factor in the supply chains linking minerals and metals to downstream industry
- Regulatory changes can kill downstream EU industries and lead to environmental and social burden shifting to third countries, being detrimental to global long-term sustainable development goals
- It can aggravate EU economic loss of competitiveness but also lead to innovation (can be a long, uncertain and costly process)

Conclusions

- Decisions should be based on thorough:
  - risk assessments taking into consideration EU competitiveness and **global** sustainable development into consideration;
  - environmental footprints all along the supply chain
  - cost/ benefit analysis, including in terms of social well-being

Risk = hazard x probability x (value x vulnerability of impacted asset)

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