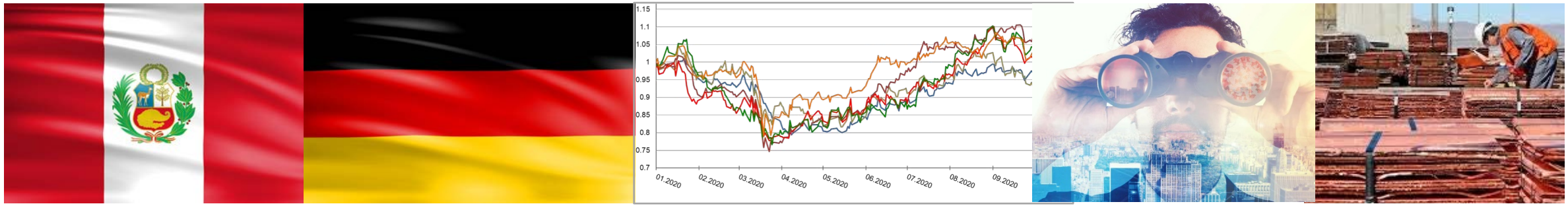


Neue Realität ◦ Neuer Bergbau ◦ Neue Kenntnisse | 6. Deutsch-Peruanisches Rohstoffforum |
24. & 26.08.2021 | Online

Mineralische Rohstoffe für Zukunftstechnologien, ihre Kritikalität sowie Chancen für die Zusammenarbeit zwischen Peru und Deutschland

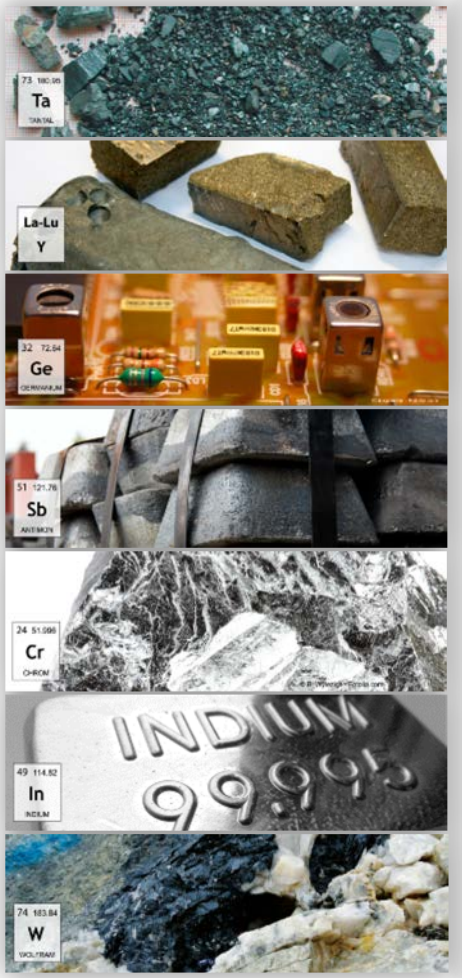
Raw materials for future technologies and their criticality - potential for cooperation between Peru and Germany

Dr.-Ing. Sven-Uwe Schulz
German Mineral Resources Agency (DERA) at the
Federal Institute for Geosciences and Natural Resources (BGR)

Federal Ministry
for Economic Affairs
and Energy

The Federal Institute for Geosciences and Natural Resources is the central geoscientific authority providing advice to the German Federal Government in all geo-relevant questions. It is subordinate to the Federal Ministry for Economic Affairs and Energy (BMWi).

German Mineral Resources Agency (DERA)



- national information and consultancy platform for mineral raw materials
- part of German Geological Survey, Federal Institute for Geosciences and Natural Resources, BGR
- Mission:
  contribute to a secure, affordable and sustainable mineral raw material supply for German industry via:
  - Market Analyses
  - Raw Materials Monitoring
  - Evaluation of Mineral Resources

New Reality – New Mining – New Knowledge

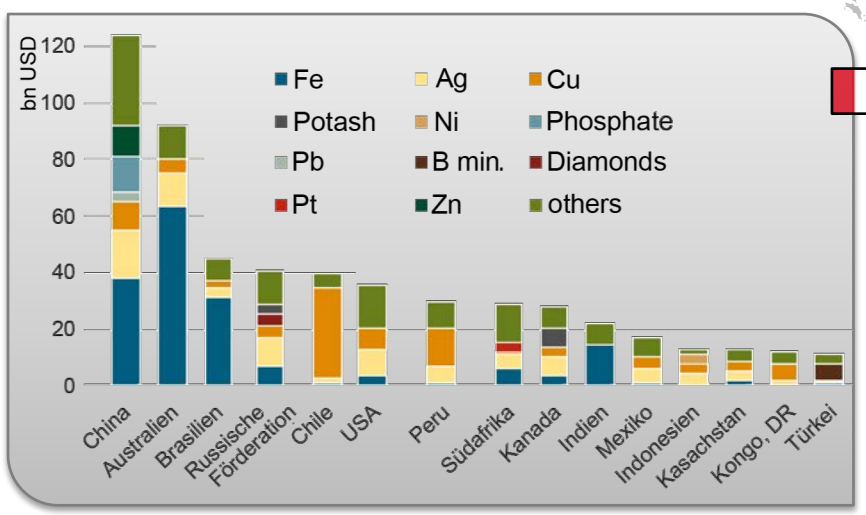
- New Reality and New Mining require New knowledge.

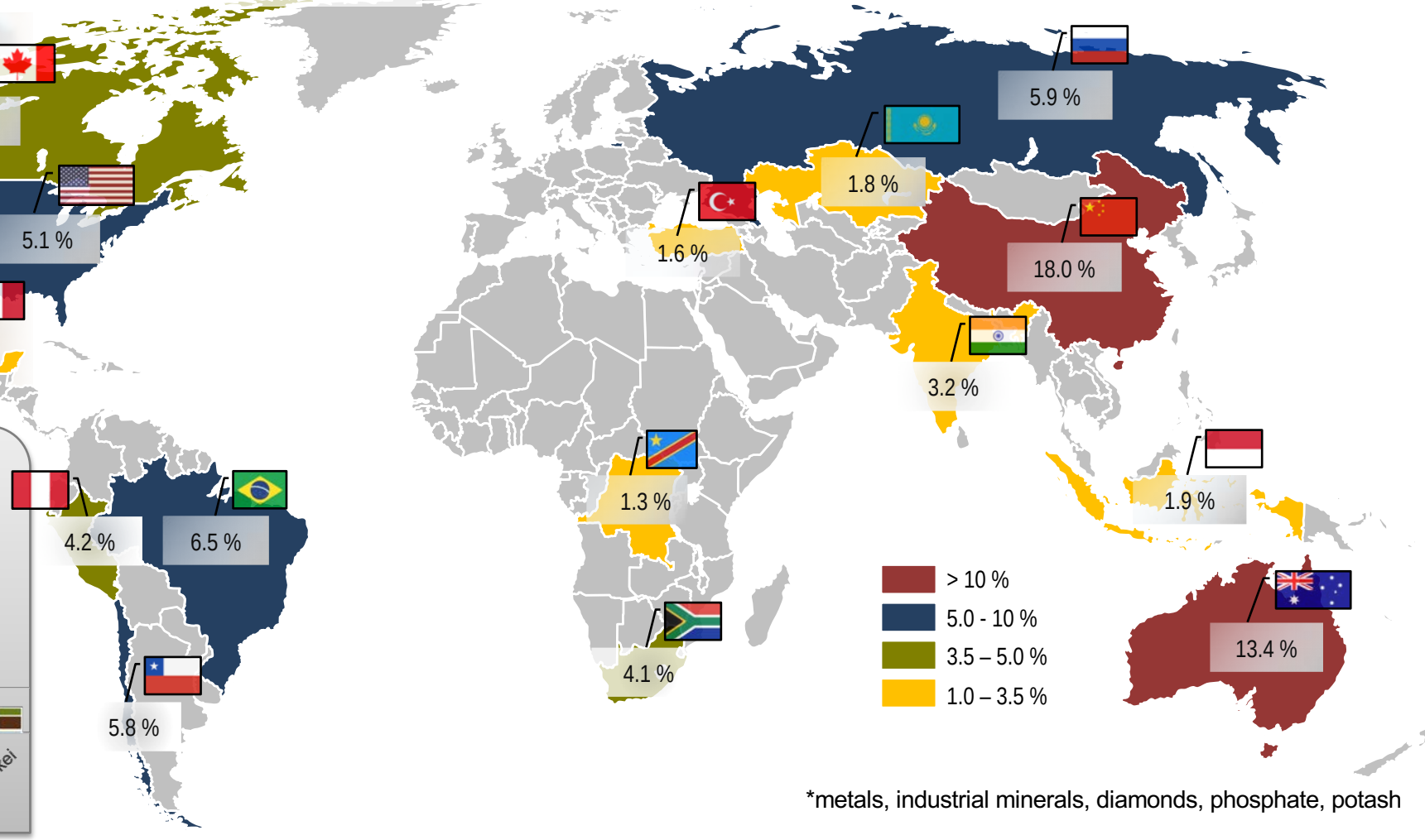
- Part of that is knowledge about supply and demand of mineral raw materials:

1. As basis for the national economies
   (Peru as mining country as well as Germany as buyer).
2. As basis for the potential of cooperation between producers and consumers
   (companies as well as state authorities and institutions).
3. To be prepared for the future by foreseeing trends and developments.

Status Quo: Peru still a global player - world mine production (2017)

Mining countries with shares > 1% of world production (by value)*



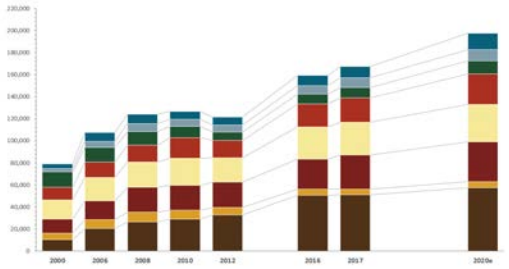


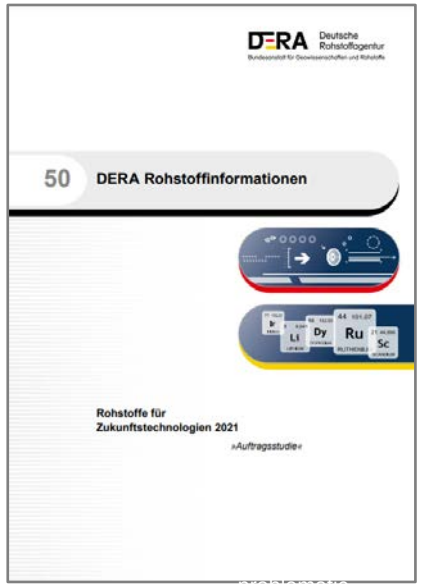
*metals, industrial minerals, diamonds, phosphate, potash

→ 15 countries representing ~80 % of world mine production (total value 2017: ca. 687 bn US$)

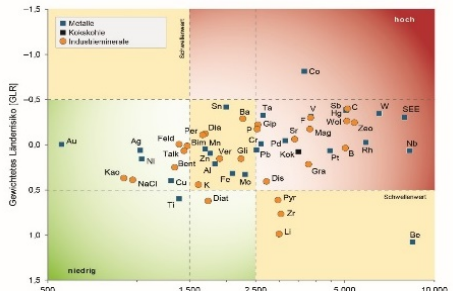
DERA Raw Materials Monitoring as data source for knowledge

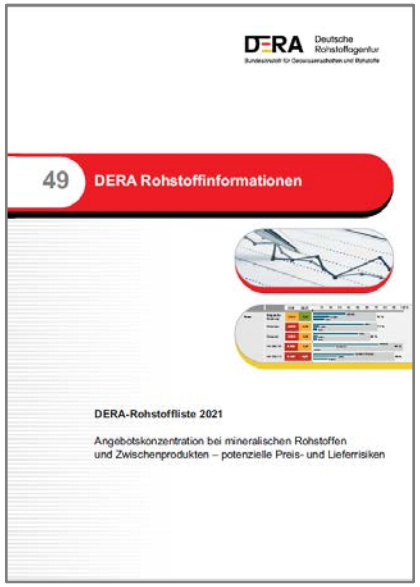
Demand





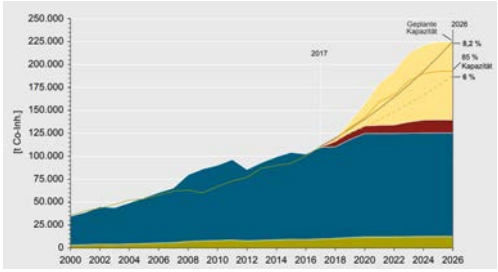
Supply



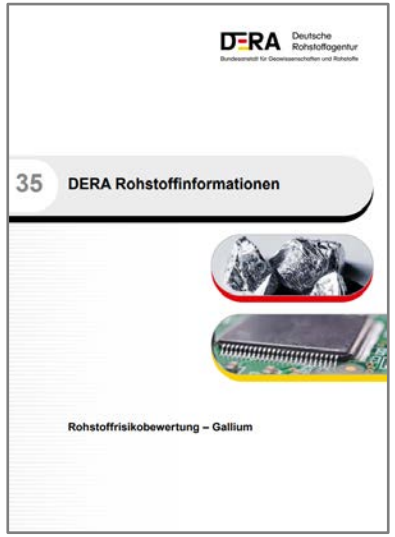


Price Monitoring

Commodity Risk Assessments

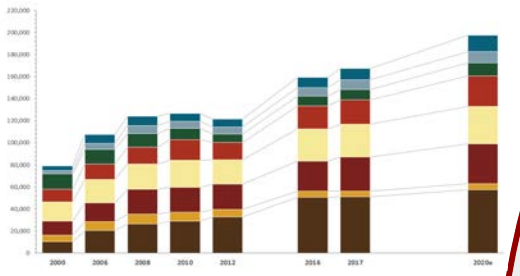


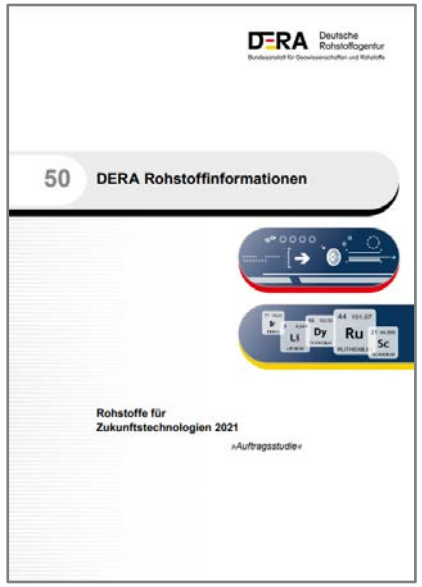
relaxed | moderate | problematic



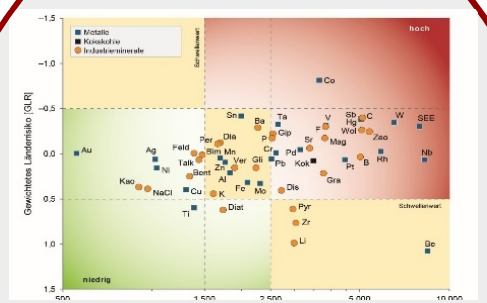
DERA Raw Materials Monitoring as data source for knowledge

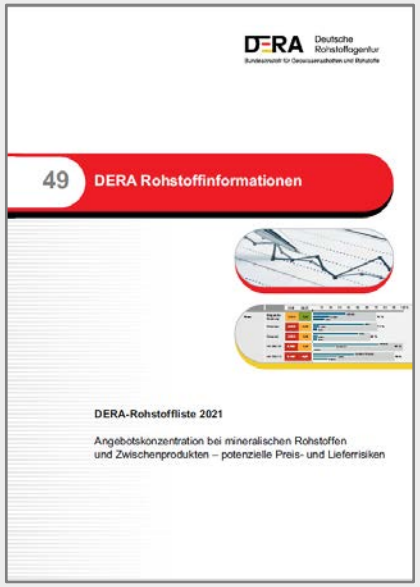
Demand





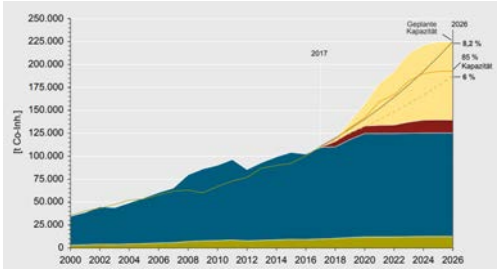
Supply



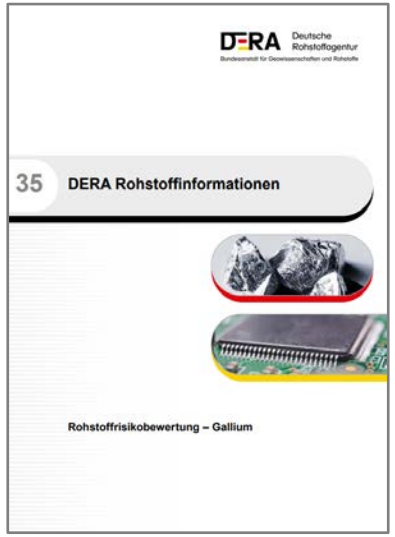


Price Monitoring

Commodity Risk Assessments



relaxed | moderate | problematic



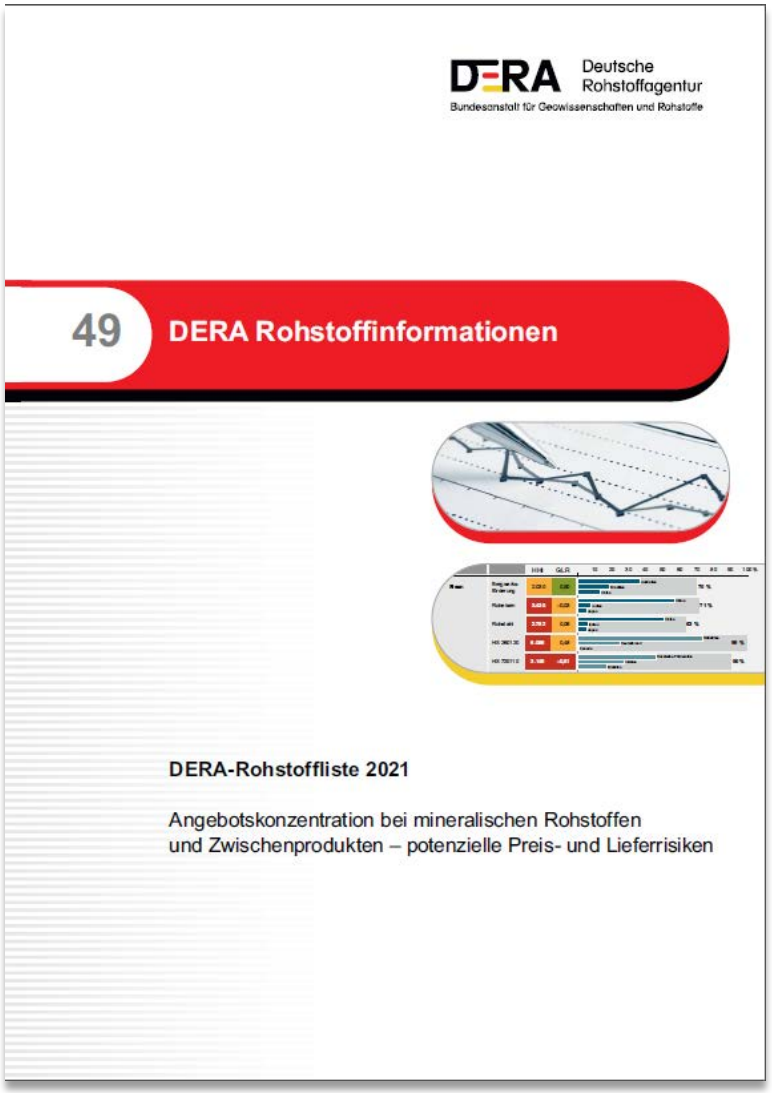
DERA-Raw Materials List: Screening of Supply since 2012

- 1st edition 2012
- 40 raw materials:
  26 metals, 14 industrial minerals
- 35 mining products, 14 refined products

- 2nd edition 2014: start of analysis of traded products

- **5th edition 2021**
- **62 raw materials:**
  34 metals, 27 industrial minerals, coking coal
- **53 mining products, 27 refined products, 217 traded products**

DERA-Raw Materials List 2021



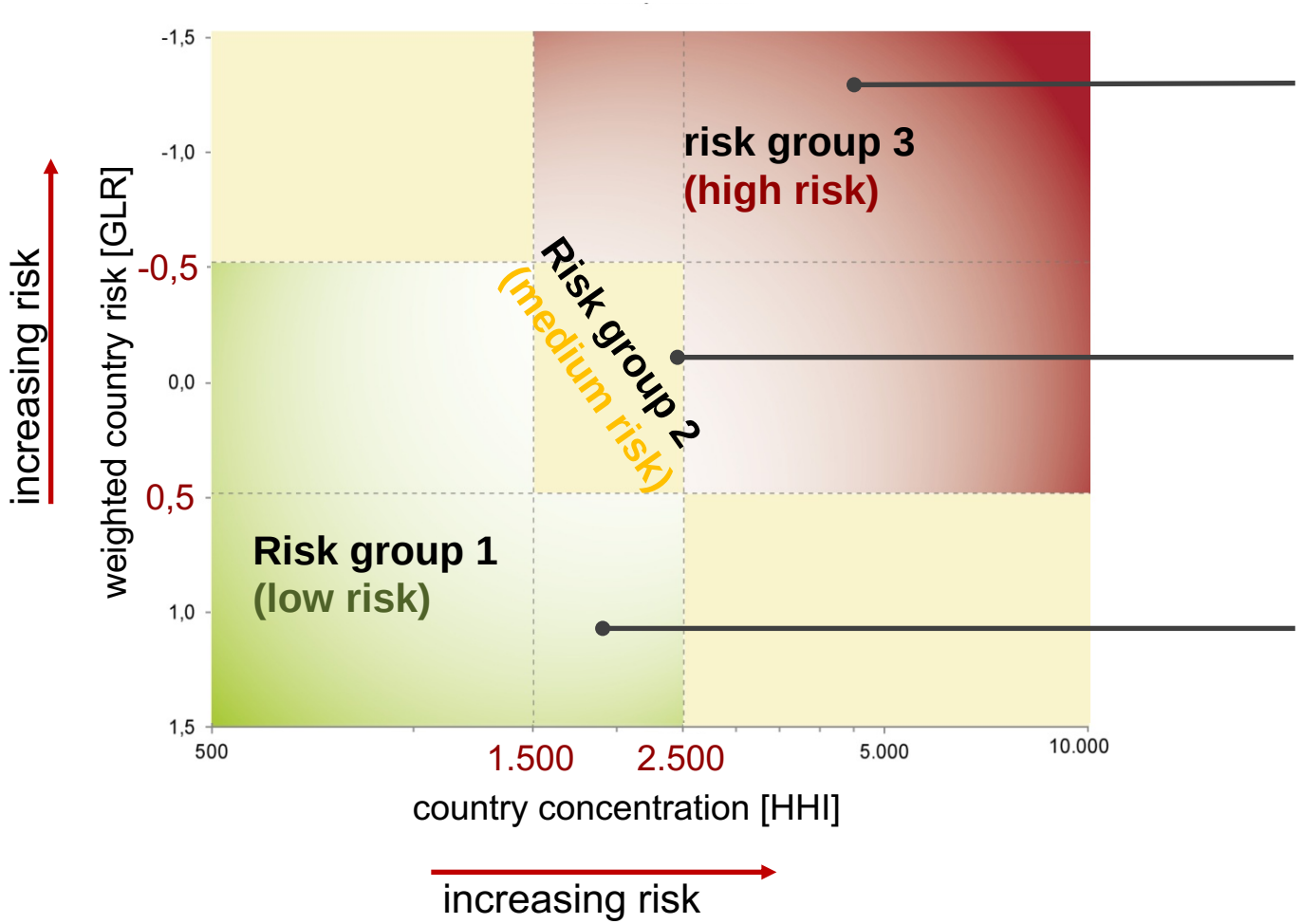
53 mining products **27 refined products** **217 traded products**

- **34** metals, **27** industrial minerals, coking coal
- Country concentration and country risks for 2018
- **Historical data** for the development of HHI and weighted country risk of mining production and refined production.

Data basis:

- BGR raw materials data bases
- Global Trade Atlas of IHS Markit Inc.

DERA-Raw Materials List 2021: **Methodology - risk groups**



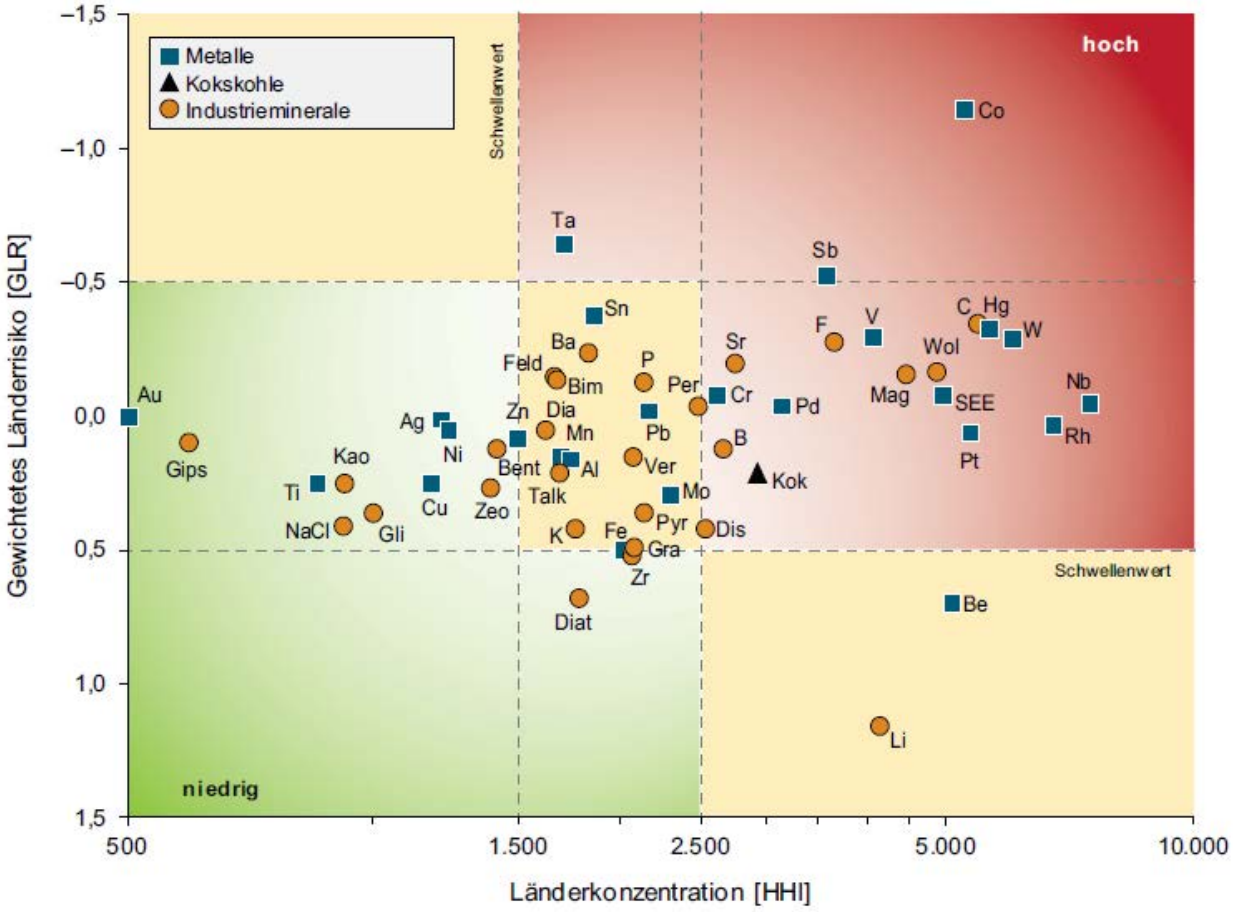
Raw materials showing high country concentration and medium to high weighted country risks.

Raw materials showing medium to high country concentration and medium to low weighted country risks.

Raw materials showing low to medium country concentration and low to medium weighted country risk.

DERA-Raw Materials List 2021: **Results - mine production**

mine production



- 21 of 53 mine products (40 %) ranging in risk group 3
- 11 of 21 mining products of risk group 3 with China as top producing country
- 22 of 53 mine products see China as top producer, 13 more show China among the Top 3

= Risikogruppe 1 = Risikogruppe 2 = Risikogruppe 3

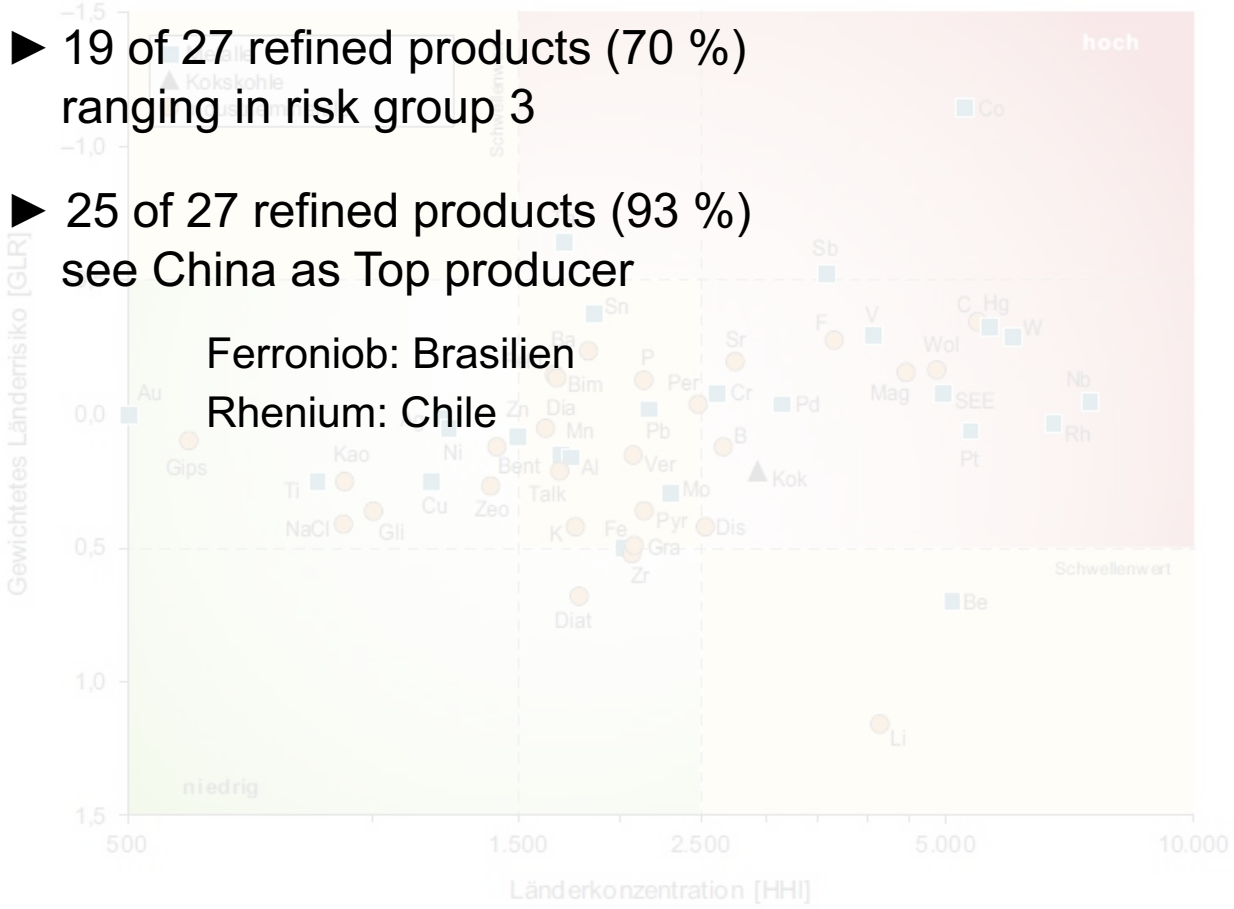
DERA-Raw Materials List 2021: **Results - refined production**

- ► 19 of 27 refined products (70 %) ranging in risk group 3
- ► 25 of 27 refined products (93 %) see China as Top producer

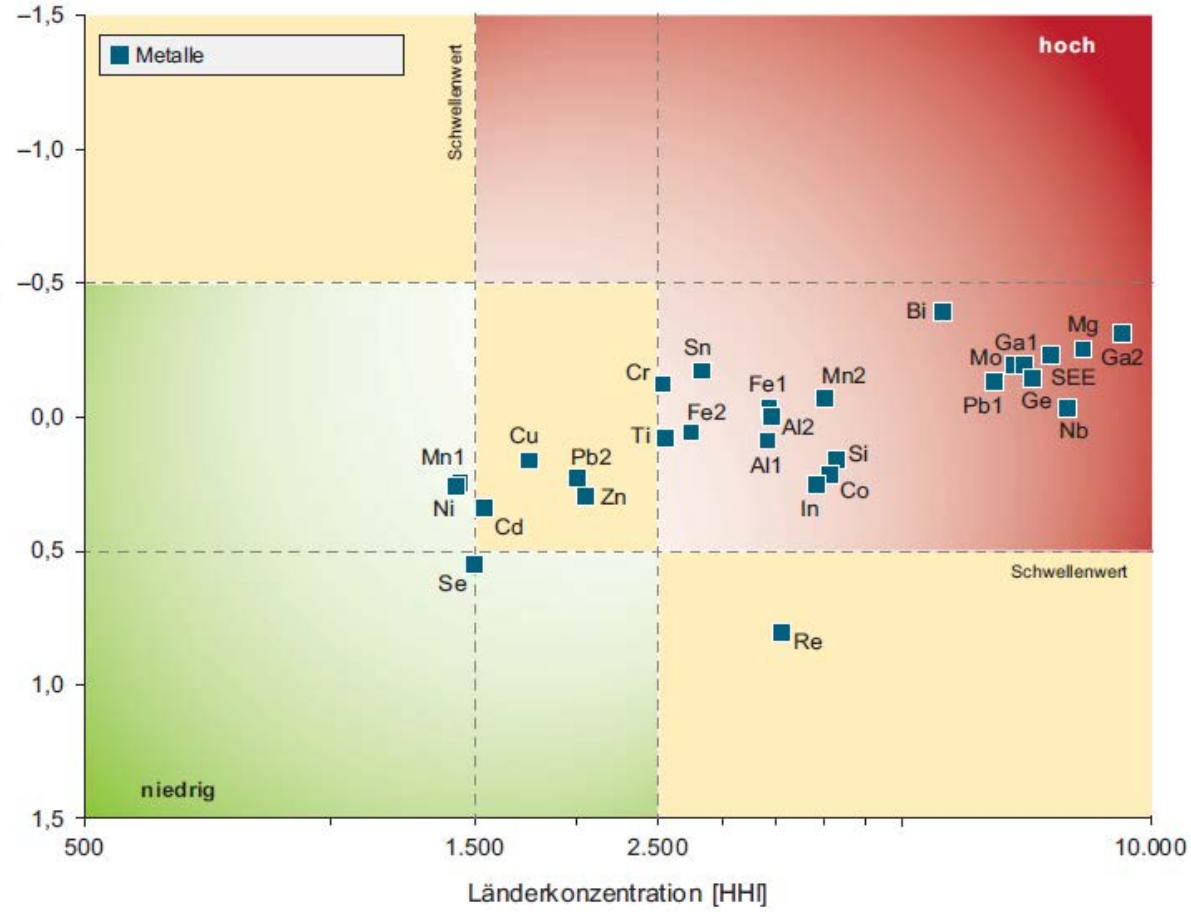
  Ferroniob: Brasilien

  Rhenium: Chile

Bergwerksförderung

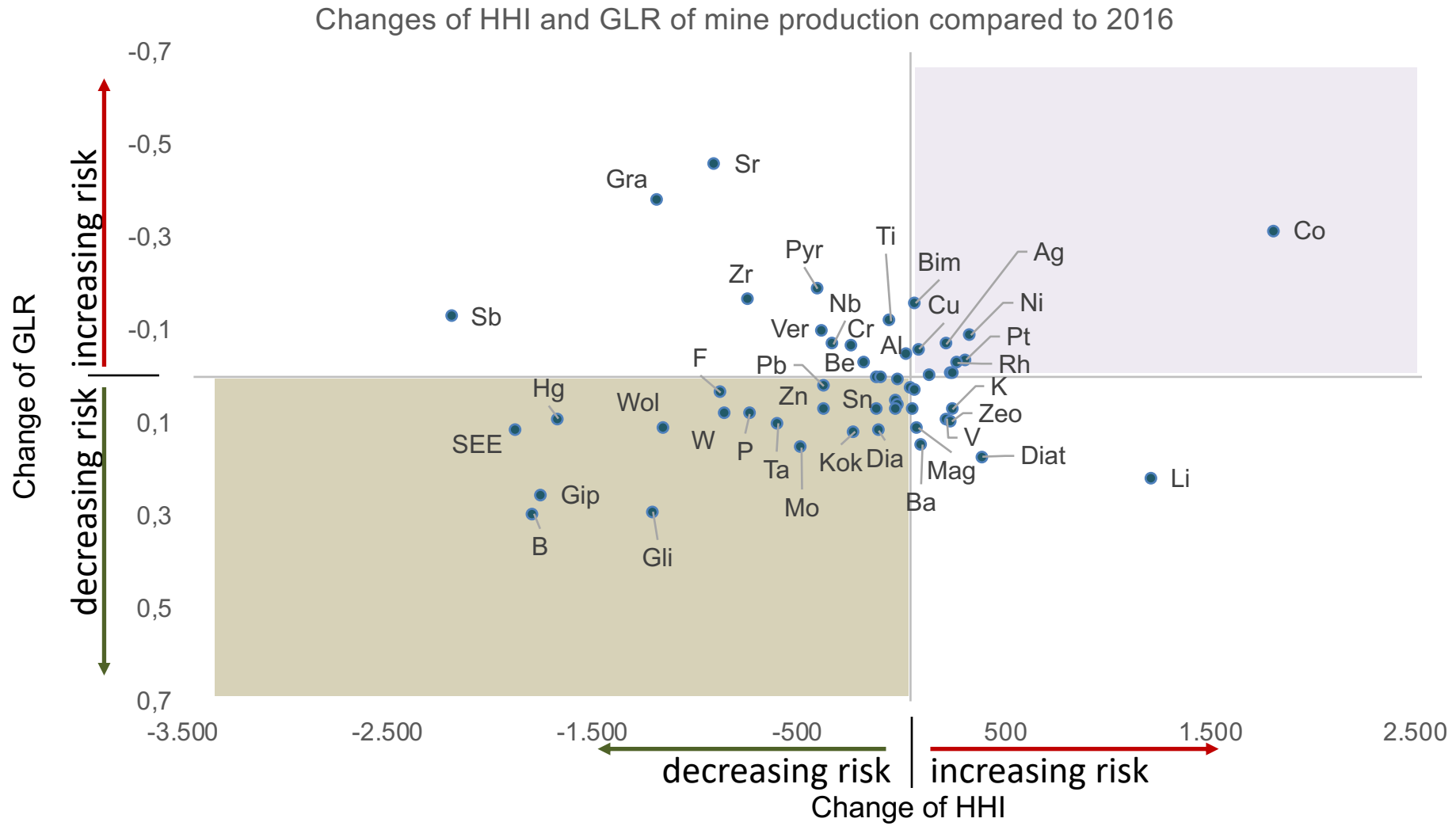


refined and by-products

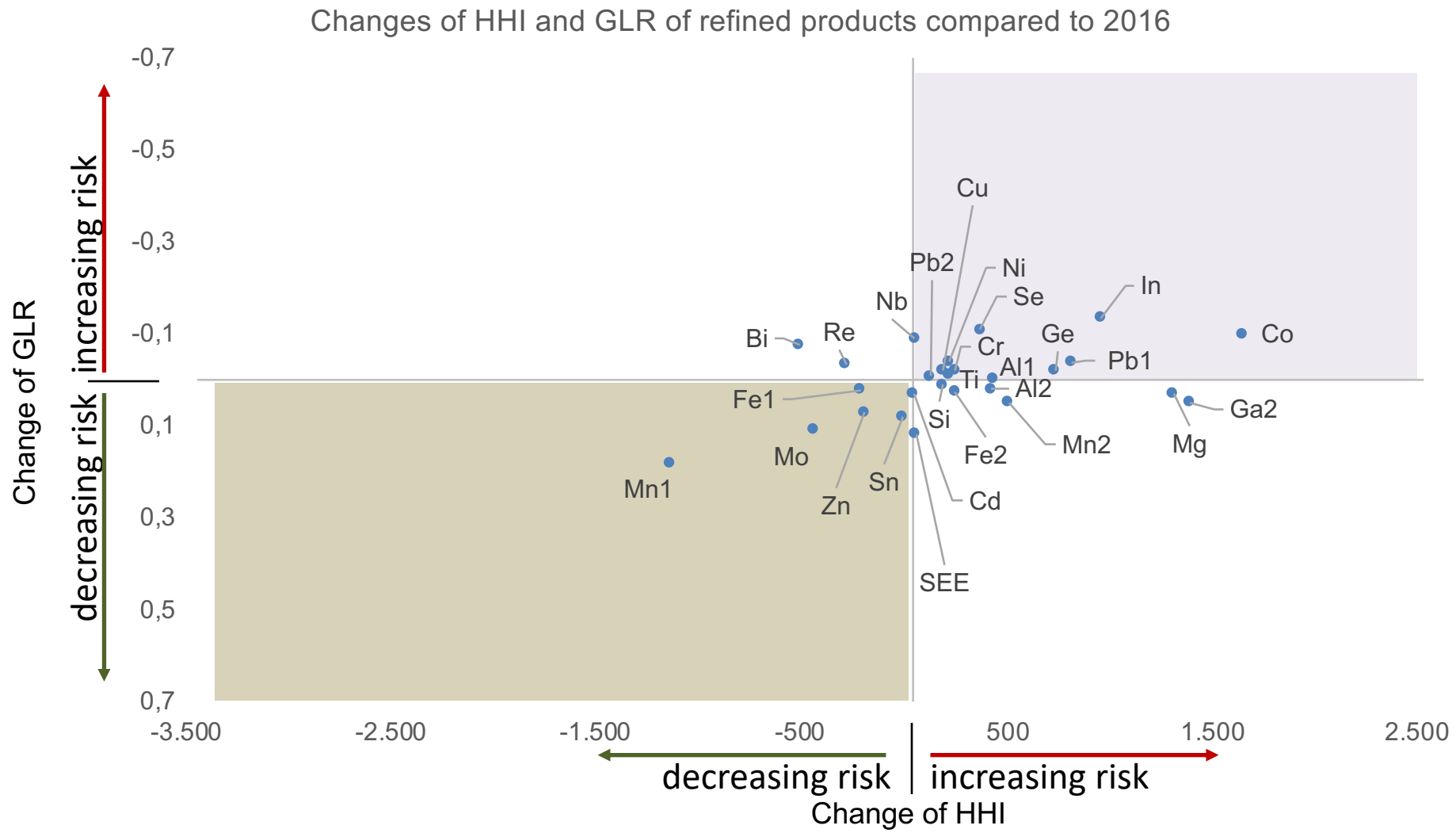


= Risikogruppe 1 = Risikogruppe 2 = Risikogruppe 3

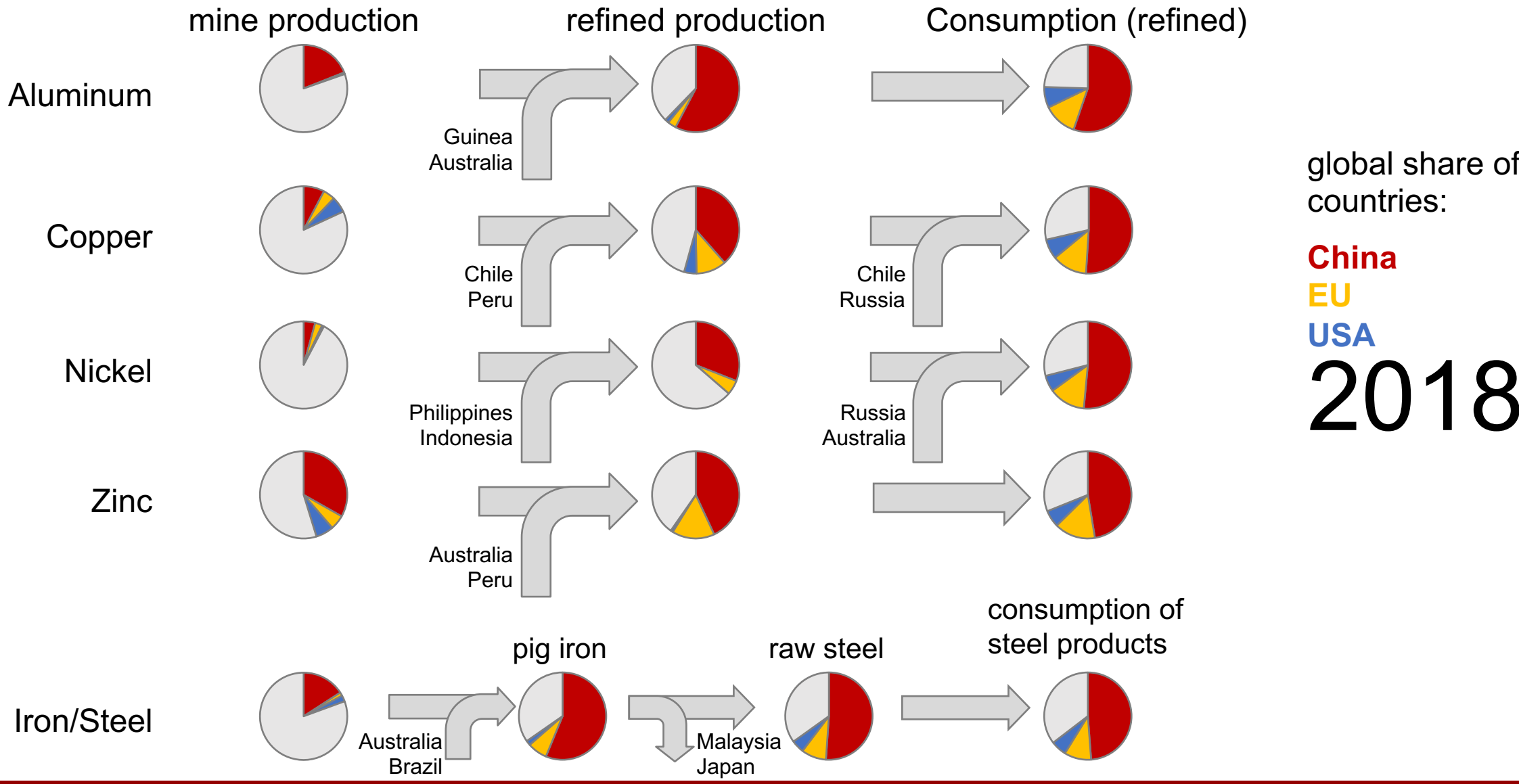
DERA-Raw Materials List 2021: **Results - changes since 2016**



DERA-Raw Materials List 2021: **Results - changes since 2016**



Chinas share at global production and consumption and important trade partners 2018



global share of countries:

China

EU

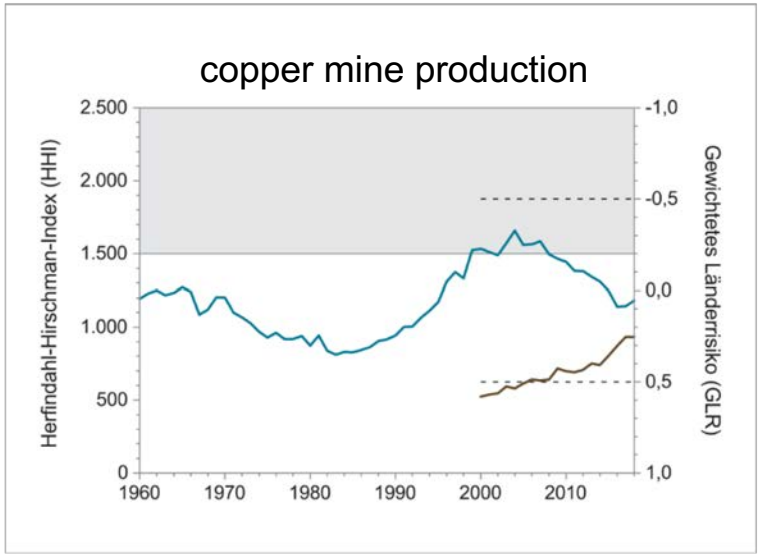
USA

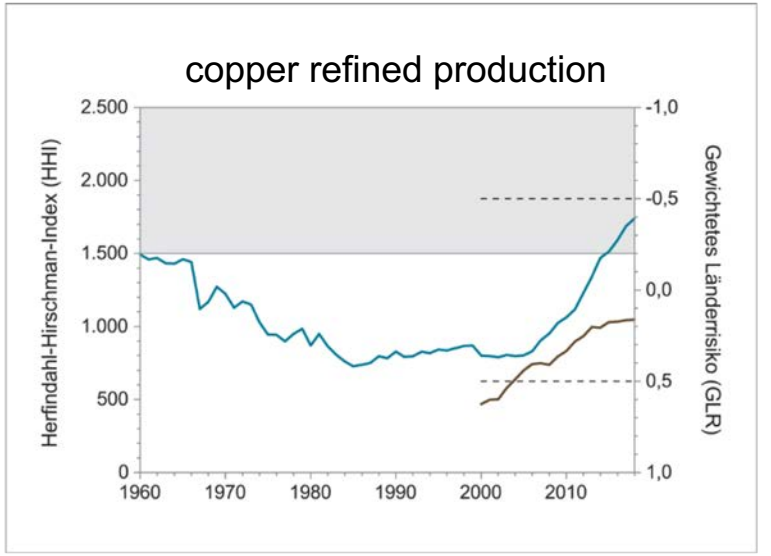
2018

DERA-Raw Materials List 2021: **Results: 2 Examples for Peru**

[1)] *ore and concentrate*

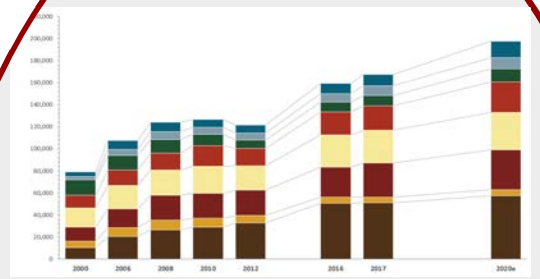
countries for mine and refined production *export countries*

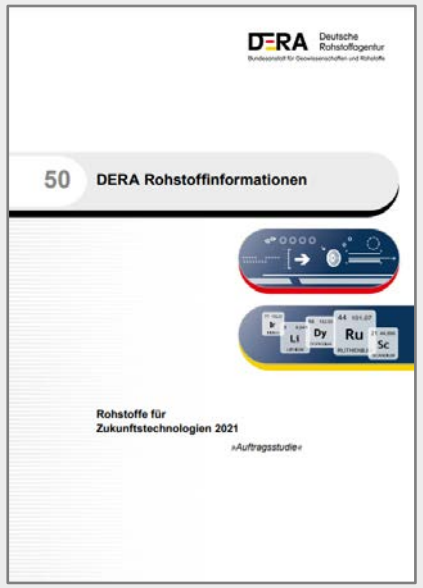




DERA Raw Materials Monitoring as data source for knowledge

Demand





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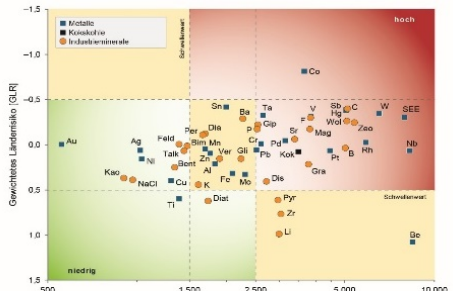

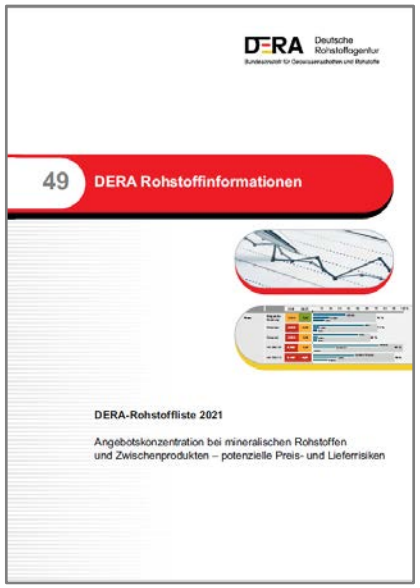

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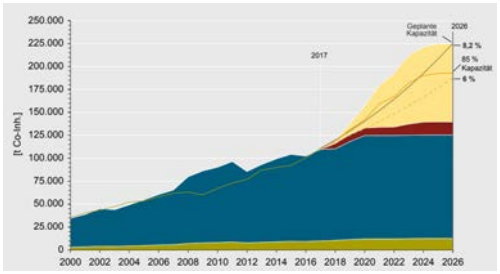
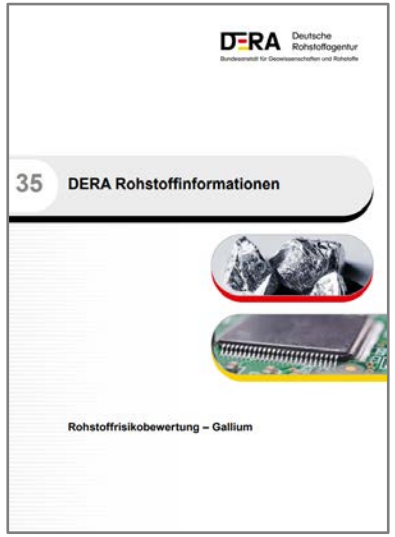
Price Monitoring

→

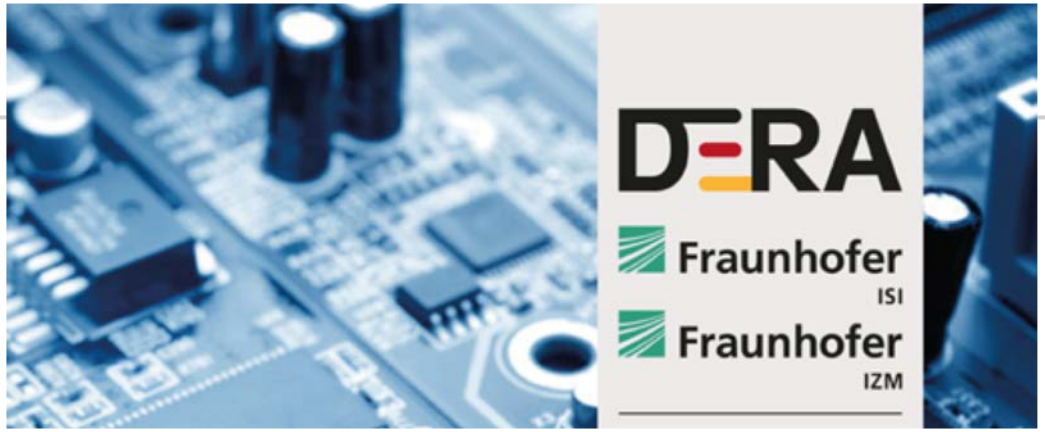
Commodity Risk Assessments



relaxed | moderate | problematic



Raw materials for emerging technologies



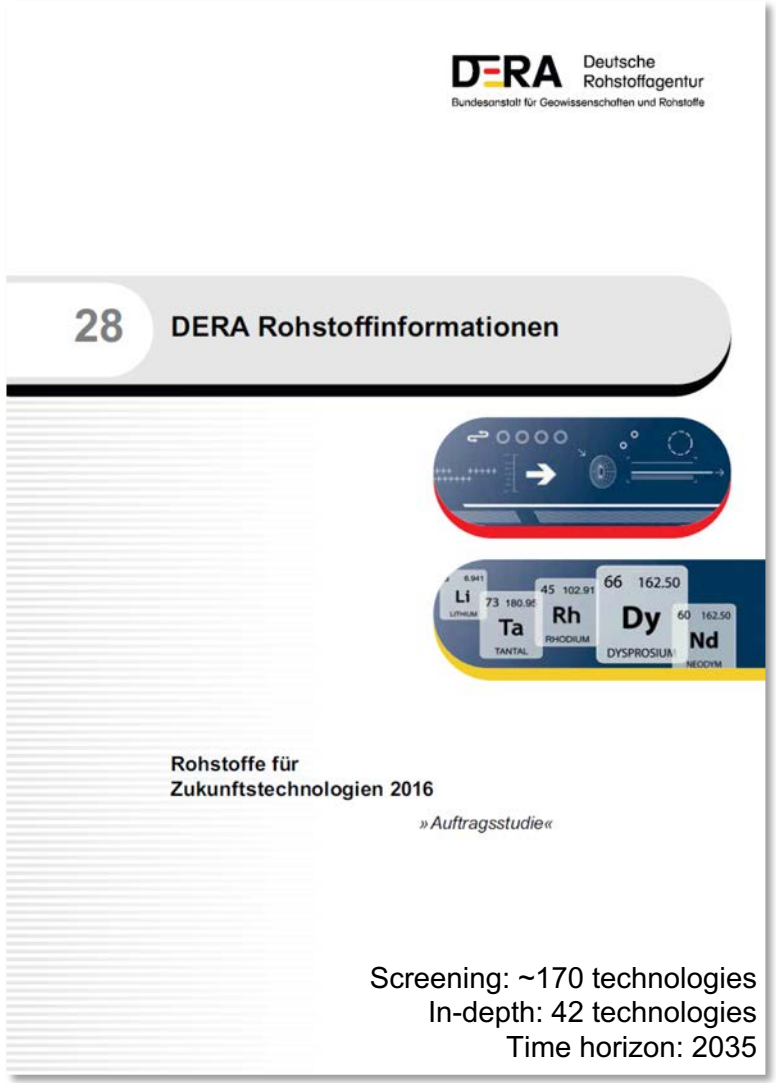
- new Report published in July 2021
- 33 Technologies analysed in detail
- estimation of raw materials demand until 2040
- 11 raw materials with demand higher than actual production

English version coming!

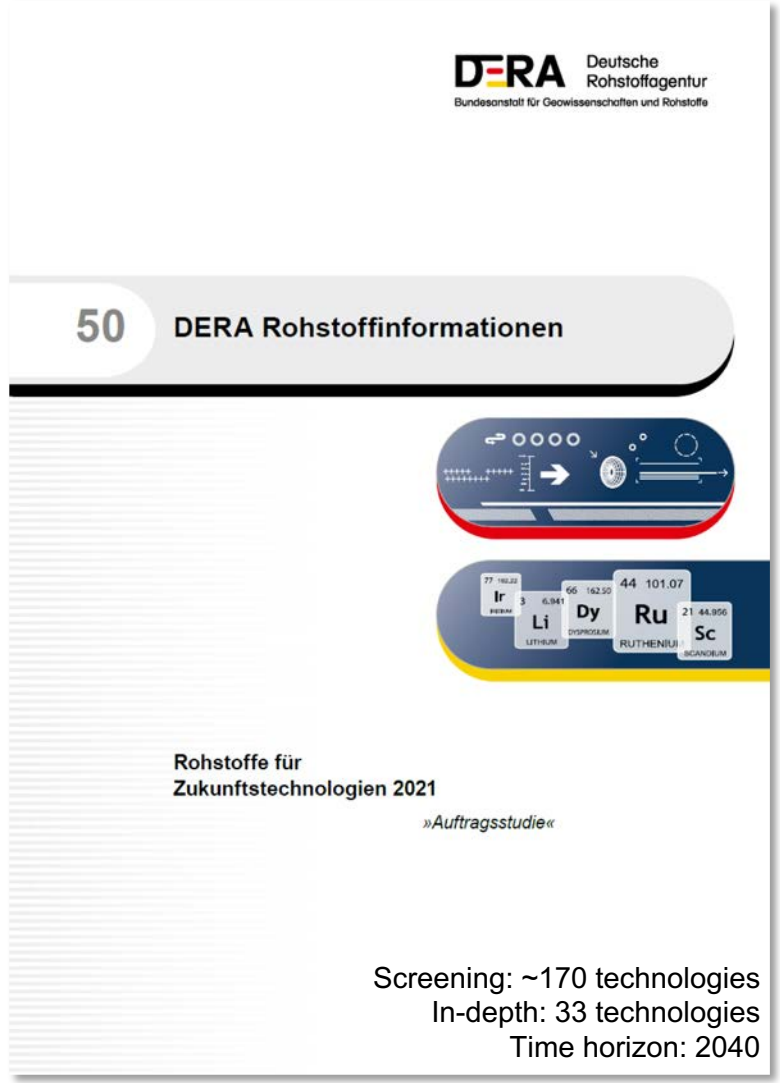
Marscheider-Weidemann et al. (2021): Rohstoffe für Zukunftstechnologien 2021. DERA Rohstoffinformationen 50, Berlin

Raw materials for emerging technologies: **Series**

Screening: ~100 technologies
In-depth: 32 technologies
Time horizon: 2030



Screening: ~170 technologies
In-depth: 42 technologies
Time horizon: 2035



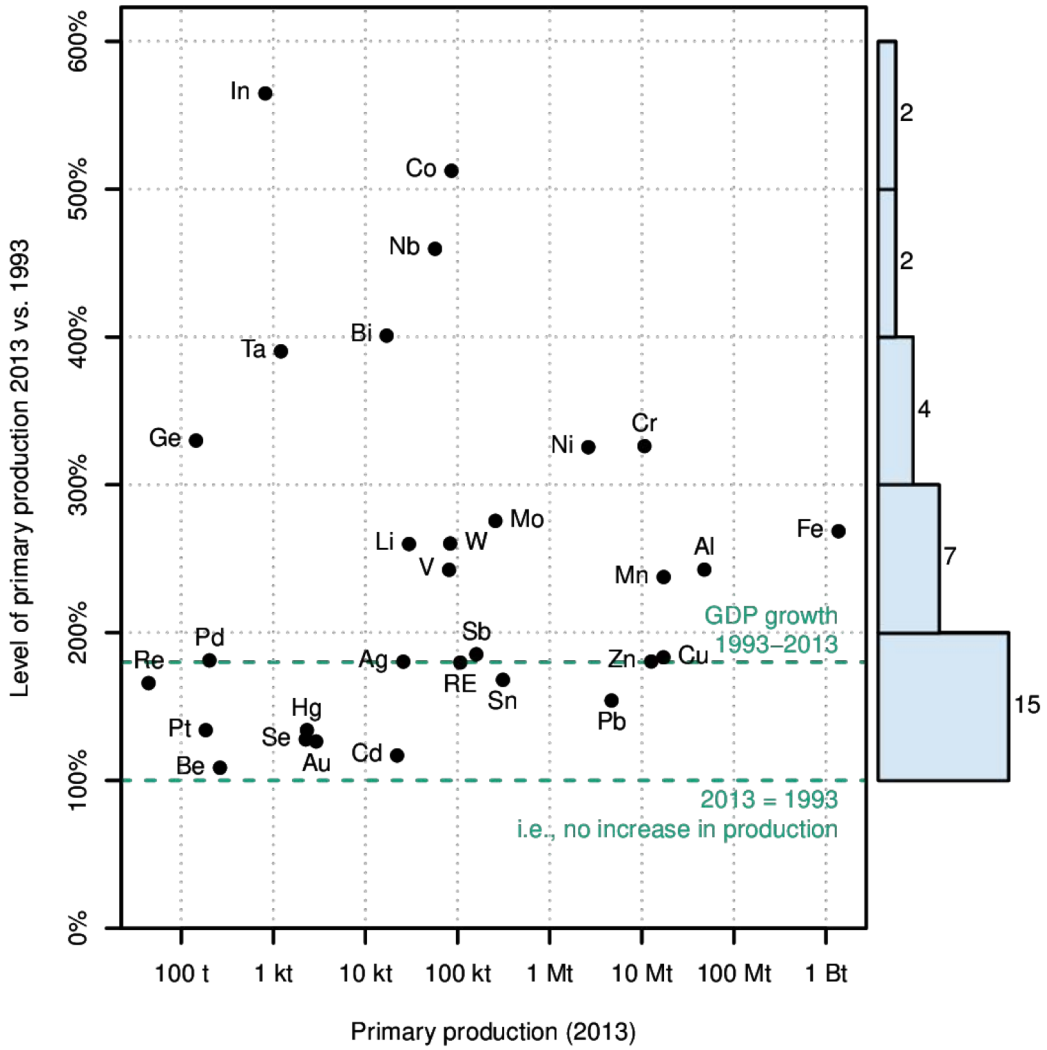
Screening: ~170 technologies
In-depth: 33 technologies
Time horizon: 2040

Raw materials for emerging technologies 2021: **Basics**

- Demand drives raw materials markets
- Technological change is an important demand determinant for many metals
- Germany is a technology provider and importer or metallic raw materials

➢ Early warning for radical change is important!

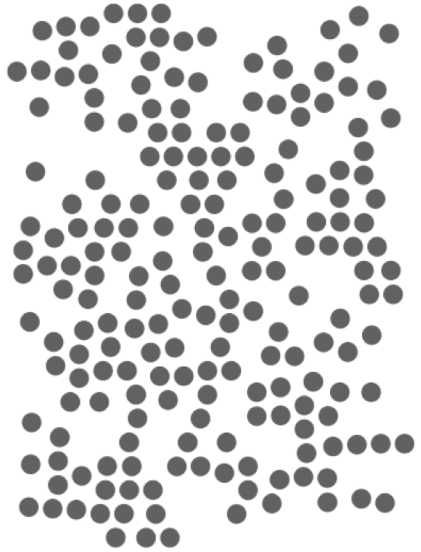
  – German Raw Materials Agency (DERA) tasked with observing trends



Langkau & Tercero Espinoza, *Sustainable Materials and Technologies*, 16 (2018) 54–59, https://doi.org/10.1016/j.susmat.2018.02.001

Raw materials for emerging technologies 2021: **Methodology**

Collection of candidate technologies
(app. 170)



Examine Technologies

Rapid assessment

Market Potential

Raw material requirements

if both „high“

Selected technologies
(n=33)

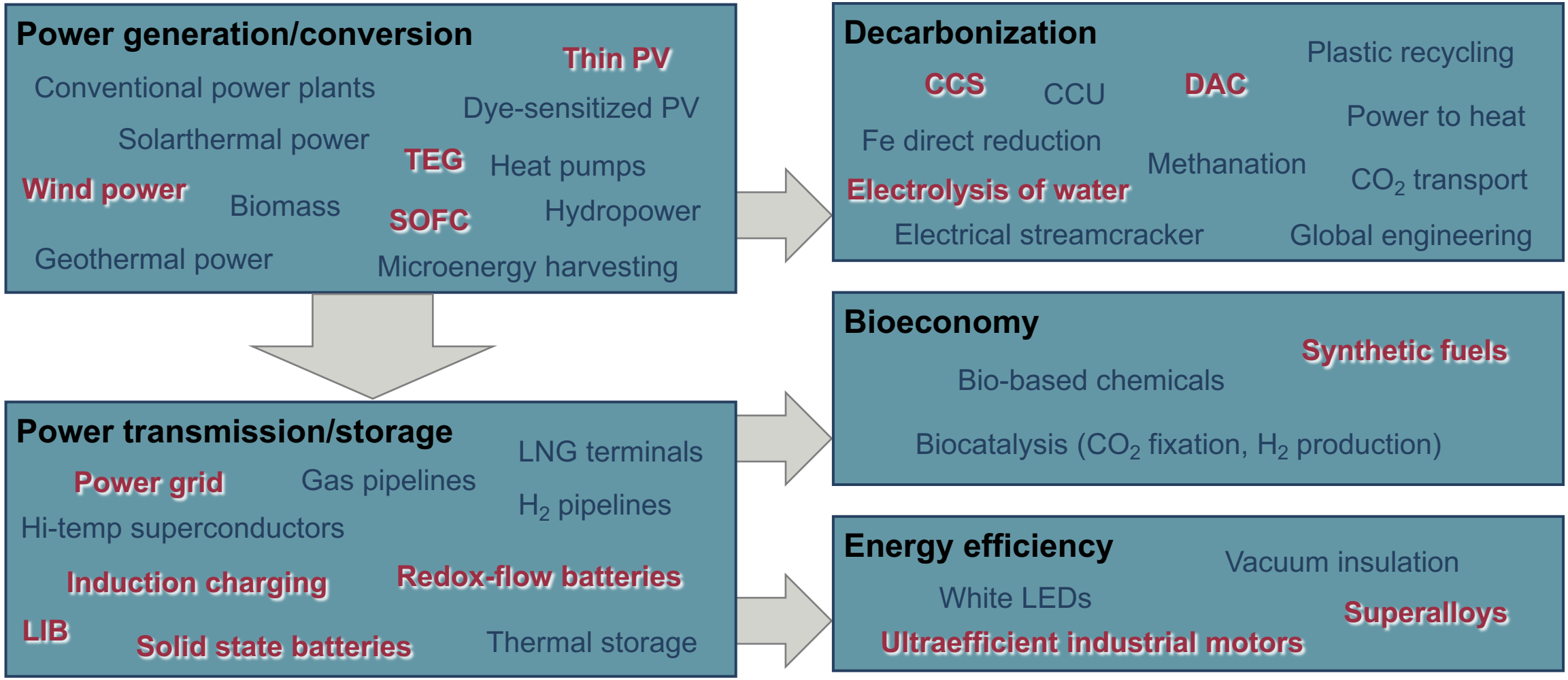
Technology Clusters

- 33 technologies organized into five clusters

- Clusters include not only „future technologies“ but also those essential to the functioning of one or more clusters, e.g. power grid

Raw materials for emerging technologies 2021: **Example of a cluster**

Energy technologies and decarbonization



Raw materials for emerging technologies 2021: **Scenario Settings**

Shared Socio-economic Pathways

- Following the 5th IPCC report definition since 2011
- For the report:
  - SSP1: Sustainability
  - SSP2: Middle Path
  - SSP5: Fossil Path

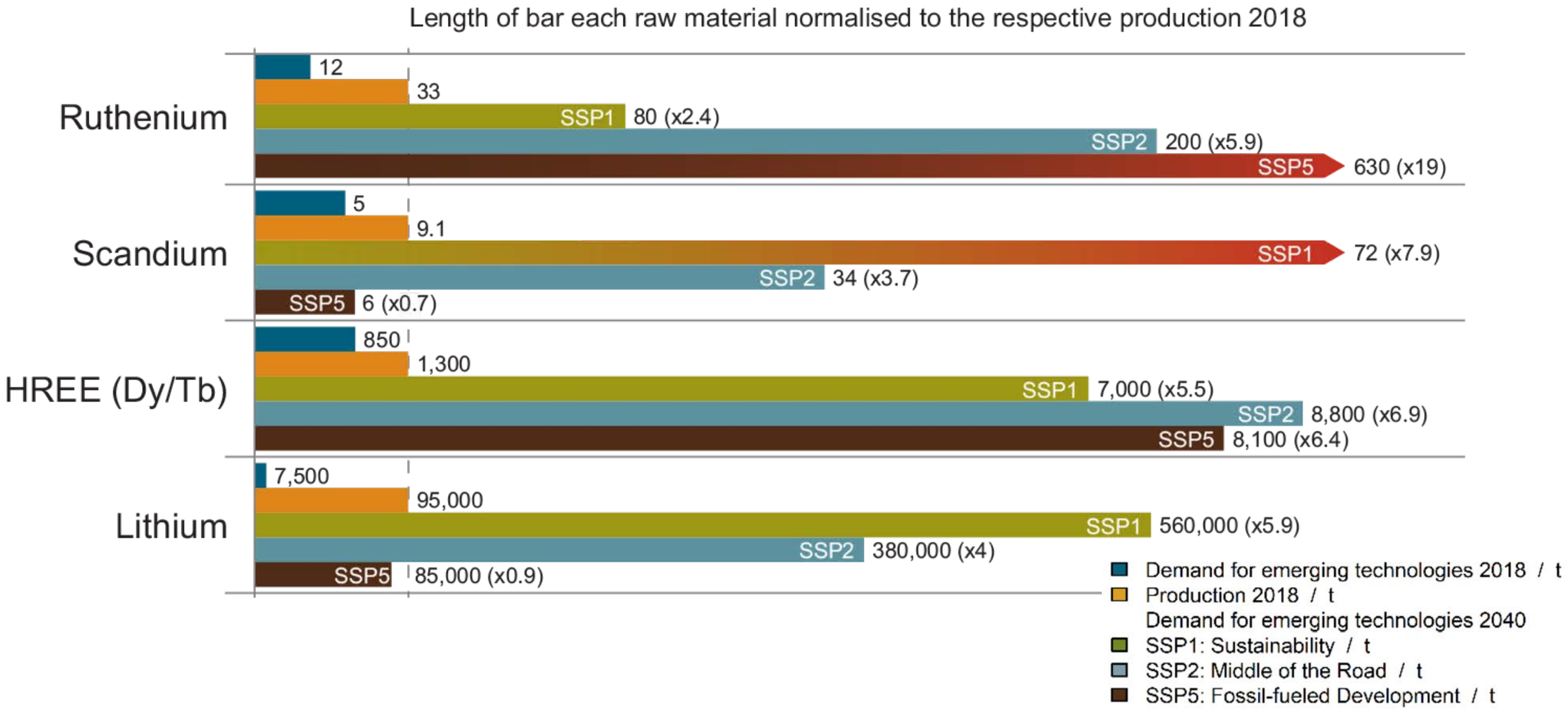
Raw materials for emerging technologies 2021: **Results across technologies**

Raw material		Ruthenium	Scandium	HRE	Lithium	Iridium	Platinum	Cobalt	LRE	Tantalum	Germanium	Lanthanum	Vanadium	Rhenium	Titanium	Yttrium	Graphite	Indium	Copper	Gallium
Demand / Production 2018		0.4	0.5	0.6	0.1	0	0	0.4	0.3	0.7	0.4	0	0	0.1	0.3	0	0	0.3	0.2	0.1
Demand 2040 / Production 2018	SSP1	2.4	7.9	5.5	5.9	5	0.3	3.9	2.2	1.4	1.7	1.1	0.7	0.6	0.6	0.6	0.9	0.5	0.2	0,2
	SSP2	5.9	3.7	6.9	4	2.9	1.2	2.9	2	1.4	1.7	0.3	0.8	0.5	0.6	0.3	0.8	0.4	0.3	0.2
	SSP5	19	0.7	6.4	0.9	0.3	4.3	1.2	2.2	2.1	1.9	0.03	0.7	0.7	0.7	0.2	0,2	0.4	0.4	0.2
Emerging technologies with high demand		Data centers, superalloys, synthetic fuels	SOFC – stationary fuel cell, H_2O- electrolysis	Electric traction motors for motor vehicles, wind turbines	Lithium-ion high-performance electricity storage, solid-state batteries, alloys for airframe lightweight construction	Water electrolysis	Data centers	Superalloys, lithium ion high-performance electricity storage, solid-state batteries	Electric traction motors for motor vehicles, wind turbines, high-performance permanent magnets, data centers	Superalloys, microelectronic capacitors, radio frequency microchips, data centers	Fiber optic cable	Solid-state batteries, water electrolysis, SOFC – stationary fuel cell	CCS – Carbon Capture and Storage, redox flow storage	Superalloys	Alloys for lightweight construction, super-alloys, solid-state batteries, 3D printers, H_2O-electrolysis, seawater desalination	Automatic piloting of road vehicles, H_2O-electrolysis, SOFC – stationary fuel cell	Lithium-ion high-performance electricity storage	Indium tin oxide (ITO) in display technology, optoelectronics/photonics, thin-film photovoltaics	Power grid expansion, electric traction motors for motor vehicles, wind turbines, solid-state batteries, H_2O-electrolysis	Radio frequency microchips, thin-film photovoltaics

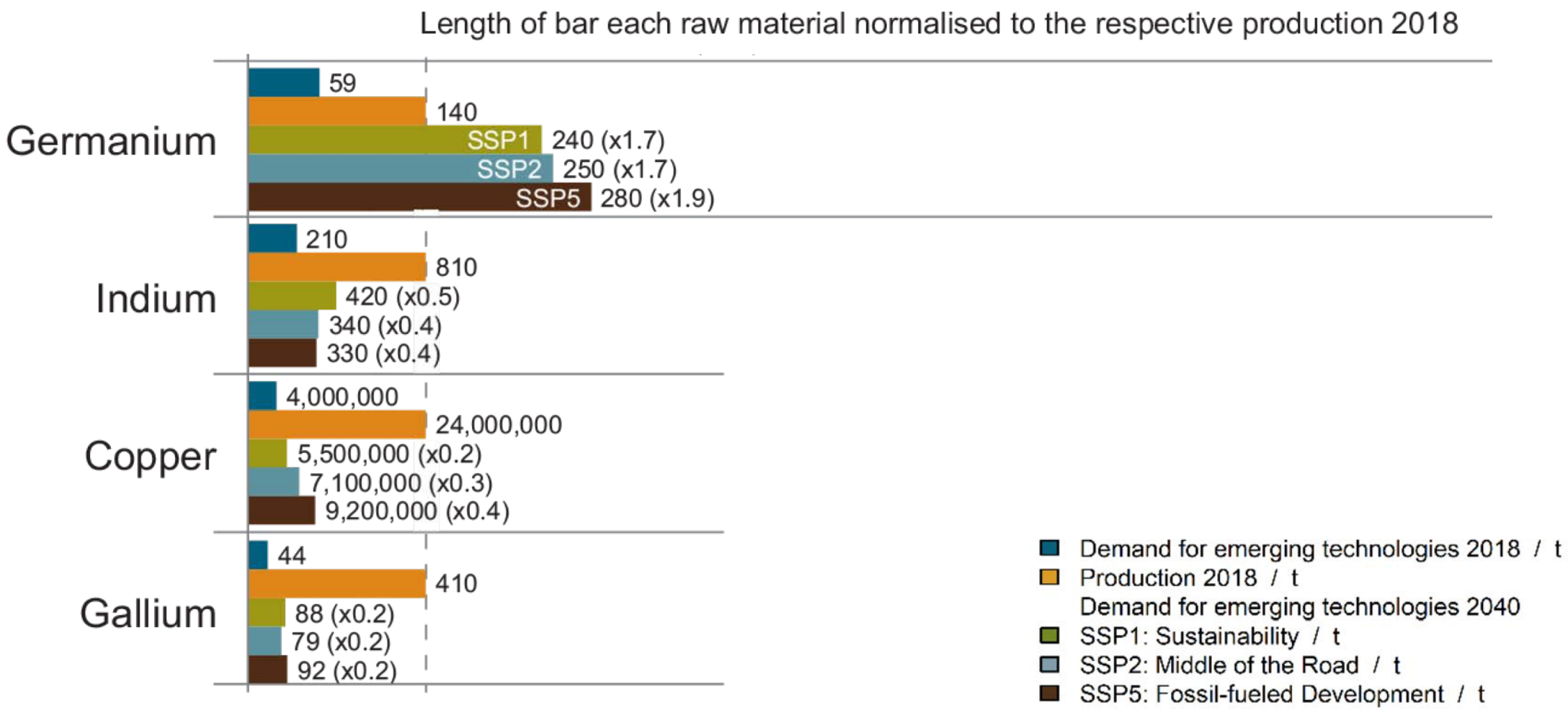
Raw materials for emerging technologies 2021: **Results across technologies**

Raw material		Ruthenium	Scandium	HRE	Lithium	Iridium	Platinum	Cobalt	LRE	Tantalum	Germanium	Lanthanum	Vanadium	Rhenium	Titanium	Yttrium	Graphite	Indium	Copper	Gallium
Demand / Production 2018		0.4	0.5	0.6	0.1	0	0	0.4	0.3	0.7	0.4	0	0	0.1	0.3	0	0	0.3	0.2	0.1
Demand 2040 / Production 2018	SSP1	2.4	7.9	5.5	5.9	5	0.3	3.9	2.2	1.4	1.7	1.1	0.7	0.6	0.6	0.6	0.9	0.5	0.2	0,2
	SSP2	5.9	3.7	6.9	4	2.9	1.2	2.9	2	1.4	1.7	0.3	0.8	0.5	0.6	0.3	0.8	0.4	0.3	0.2
	SSP5	19	0.7	6.4	0.9	0.3	4.3	1.2	2.2	2.1	1.9	0.03	0.7	0.7	0.7	0.2	0,2	0.4	0.4	0.2
Emerging technologies with high demand		Data centers, superalloys, synthetic fuels	SOFC – stationary fuel cell, H_2O- electrolysis	Electric traction motors for motor vehicles, wind turbines	Lithium-ion high-performance electricity storage, solid-state batteries, alloys for airframe lightweight construction	Water electrolysis	Data centers	Superalloys, lithium ion high-performance electricity storage, solid-state batteries	Electric traction motors for motor vehicles, wind turbines, high-performance permanent magnets, data centers	Superalloys, microelectronic capacitors, radio frequency microchips, data centers	Fiber optic cable	Solid-state batteries, water electrolysis, SOFC – stationary fuel cell	CCS – Carbon Capture and Storage, redox flow storage	Superalloys	Alloys for lightweight construction, super-alloys, solid-state batteries, 3D printers, H_2O-electrolysis, seawater desalination	Automatic piloting of road vehicles, H_2O-electrolysis, SOFC – stationary fuel cell	Lithium-ion high-performance electricity storage	Indium tin oxide (ITO) in display technology, optoelectronics/photonics, thin-film photovoltaics	Power grid expansion, electric traction motors for motor vehicles, wind turbines, solid-state batteries, H_2O-electrolysis	Radio frequency microchips, thin-film photovoltaics

Raw materials for emerging technologies 2021: **TOP4-Results across technologies**



Raw materials for emerging technologies 2021: **Results across technologies important for Peru**



Raw materials for emerging technologies 2021: **Takeaways**

- Emerging technologies can lead to strongly increasing demand for certain raw materials
  - Working definition of emerging technology: new and/or strongly growing (and possibly changing), or essential to one or more technology clusters
- Scenarios should provide consistent pictures of a possible future
  - Shared Socio-Economic Pathways provide consistent set of assumptions for most technologies
  - Additional assumptions still necessary, especially on e-mobility and digitization
- Electric mobility, energy transition and digitization lead to important increases in the use of raw materials, e.g.:
  - E-mobility: Li, Co, Ni, natural graphite, light and heavy REE for batteries and electric drives
  - Energy transition: Light REE, V for power generation and storage
  - Digitization: Light REE for HDD in data centers and magnets in consumer electronics

- Evaluate Peruvian raw materials potentials beyond Cu, Zn, Ag …
- Enhance cooperation and partnership between the countries

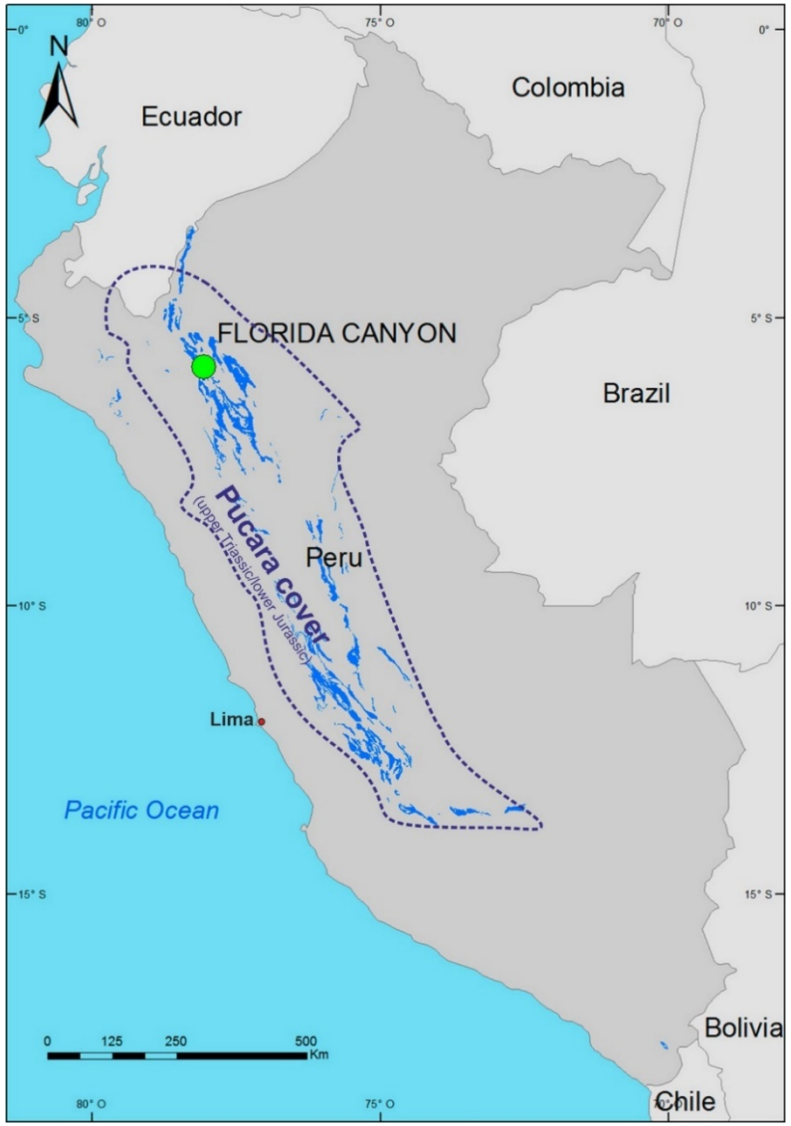
Strategic Partnership

strəˈtiː.dʒɪk ˈpɑːrt.nə.ʃɪp

an arrangement between two companies or organizations to help each other or work together, to make it easier for each of them to achieve the things they want to achieve

https://dictionary.cambridge.org/de/worterbuch/englisch/strategic-partnership

Cooperation INGEMMET - BGR/DERA: Pb-Zn deposits and by-products in northern Peru



Investigation of Pb-Zn „MVT“ deposits within the Pucara Group (carbonate formations) in the northern Cordillera Oriental with regard to their high-tech by-products

Cooperation INGEMMET - BGR/DERA: Pb-Zn deposits in the Pucara unit

- First field work (sampling) in Sept. 2019 in the Florida Canyon exploration project (Nexa Resources)
- Futher sampling of further deposits (also other types as SedEx) is planned for 2022 (?)

- Focus on by-products as Germanium, Gallium, Indium
- Development and optimizing of processing methods
- The aim of these processing tests is to determine economic and environmental friendly methods for the recovery of these rare high-tech metals with German technologies.

Muchas Gracias | Thank you very much | Vielen Dank

„Bergbau ist nicht eines Mannes Sache allein.“

„Mining is not a matter for one person alone.“

„La minería no es asunto de un solo person.”

Schwazer Bergbuch (1556)

Dr.-Ing. Sven-Uwe Schulz
German Mineral Resources Agency (DERA) at the
Federal Institute for Geosciences and Natural Resources (BGR)

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