

The Role of Minerals & Mining in the Sustainability Transformation

...sustainable?





What's the connection?

Electronics

79 Au Gold	29 Cu Copper	47 Ag Silver	73 Ta Tantalum	74 W Tungsten
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Battery

13 Al Aluminium	3 Li Lithium	27 Co Cobalt
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Mining makes holding the world in your hand possible

More than 40 mined metals and rare earths are used to produce a single smartphone.

Sound

60 Nd Neodymium	5 B Boron	28 Ni Nickel	59 Pr Praseodymium
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04 Smartphones

Earbuds*
Phone Cases*

6 C Carbon	1 H Hydrogen
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Touch screen

14 Si Silicon	50 Sn Tin	19 K Potassium
49 In Indium	13 Al Aluminium	31 Ga Gallium

Mining is essential for Innovative tech

Canada's mining industry is providing the responsibly-sourced minerals and metals that power the technologies of today and of the future. In turn, we're helping businesses and their customers be confident in how they're made.

*Oil for these products can also be from non-mined sources.

What's the value of these materials?



1
iPhone



CONTAINS

31 grams
of aluminum



istock; Jenny Cheng/Business Insider

Minerals – Backbone of the economy

Major developments in global mining production based on World Mining Data 2025

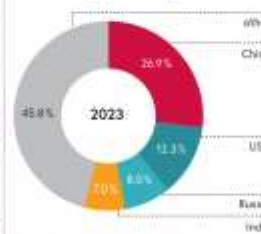


China is world's largest producer of 28 different commodities:

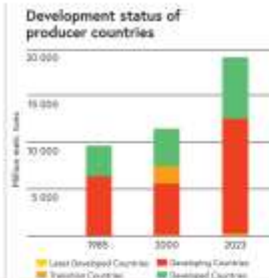
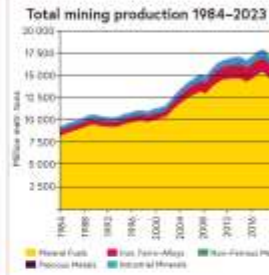
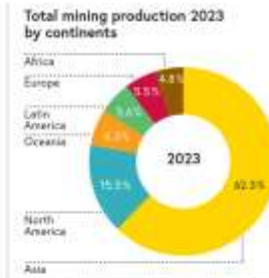
- 4 Iron and Ferro-Alloy Metals: Mo, Ti, W, V
- 14 Non-Ferrous Metals: Al, Sb, Bi, Cd, Ga, Ge, In, Pb, Hg, REE, Se, Te, Sn, Zn
- 1 Precious Metal: Au
- 7 Industrial Minerals: Fluorspar, Graphite, Gypsum, Magnesite, Phosphate Rock, Salt, Sulfur
- 2 Mineral Fuels: Steam Coal, Coking Coal



China, USA, Russia and India are the 4 biggest mining nations



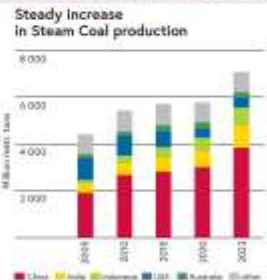
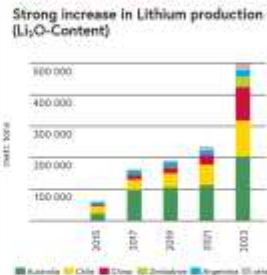
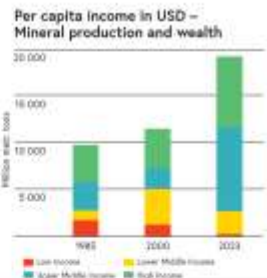
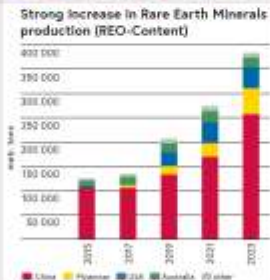
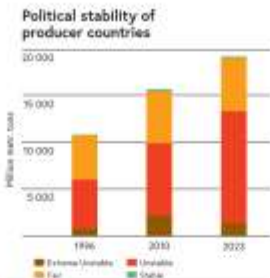
Δ 2000/2023 – Declining production rates only in Europe since 2000



Big changes in production

	Δ 2000/2023	Δ 2019/2023
Lithium	1 735.1%	160.2%
Gallium	1 271.2%	90.6%
Rare Earths	372.5%	89.2%
Mercury	-25.7%	-54.3%
Diamond (ind)	-30.2%	-31.7%
Asbestos	-39.8%	8.9%

Fertilizer Minerals: Mine production 2023 by major producer countries



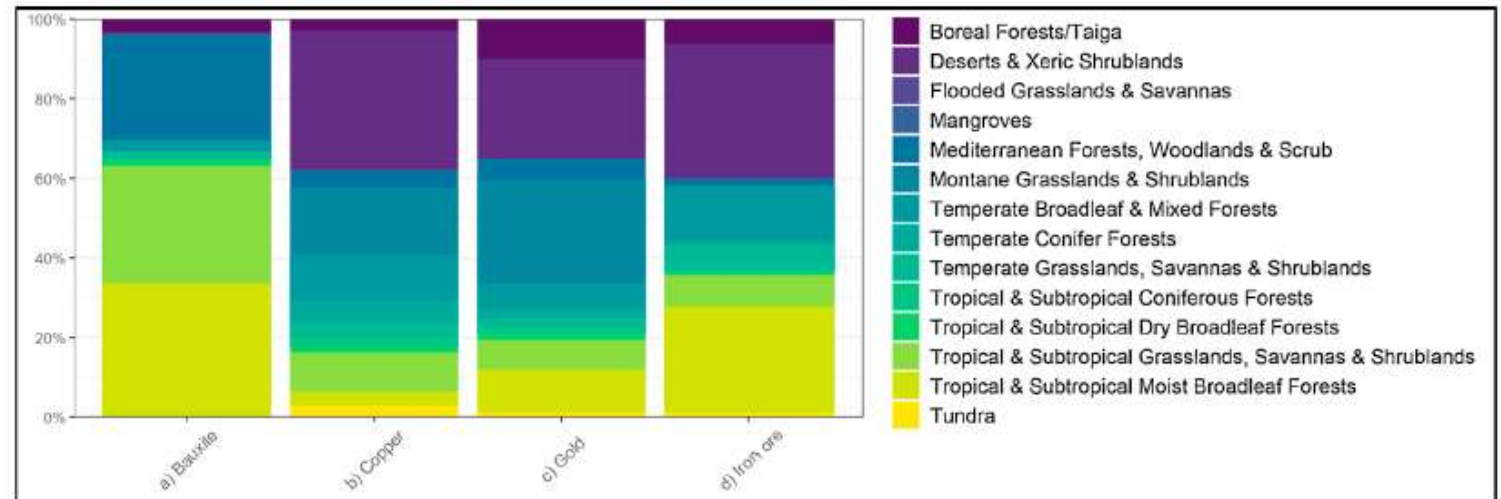
Why does this matter?

CO2 emissions, water use, land use / biodiversity

CO2 emissions 2016	Mt	%
Fossil fuel and industry	36000	
Fossil fuels	32000	100
of which industry	11520	36
Steel and Aluminium	4100	12,8
Mining 4 metals	190	0,6

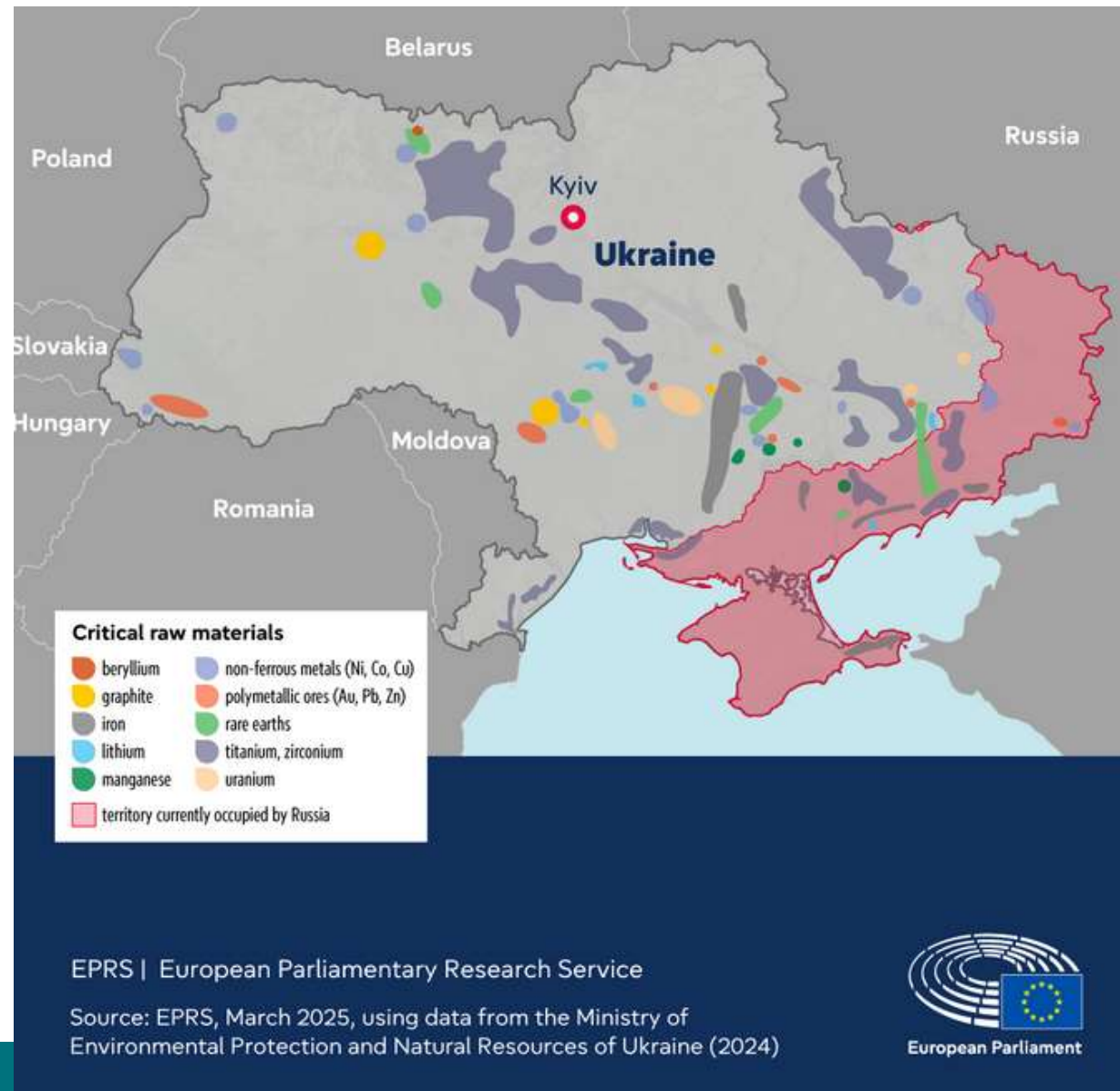
Land use 2016	ha
Al	106771
Cu	470839
Au	535507
Fe	315394
Total	1428511

Water withdrawals 2016	Gm3	%
Global	4180	
industry	794,2	100 (19% of total)
Steel and Aluminium	47,1	5,9
4 metals	4,9	0,6



Tost et al. 2018, 2020

Why does this matter?



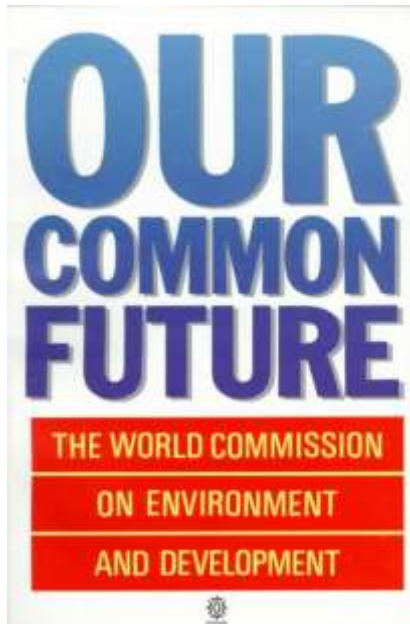
Sustainability – what's that?



Sustainability – from needs to inclusive well-being

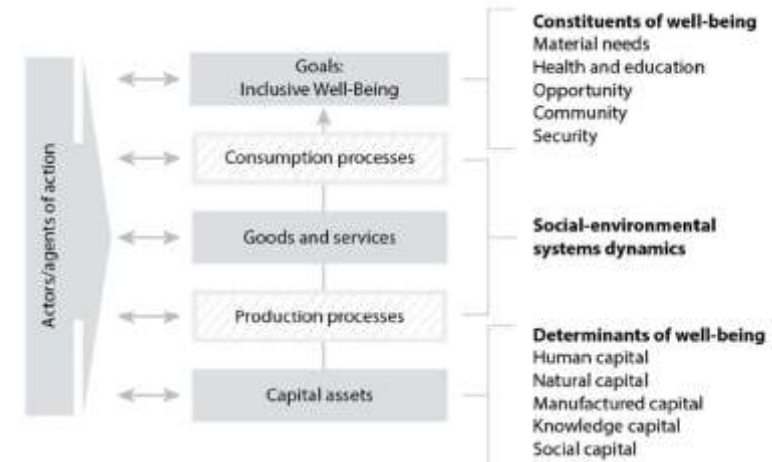


Meeting the needs of the present without compromising the ability of future generations to meet their own needs.



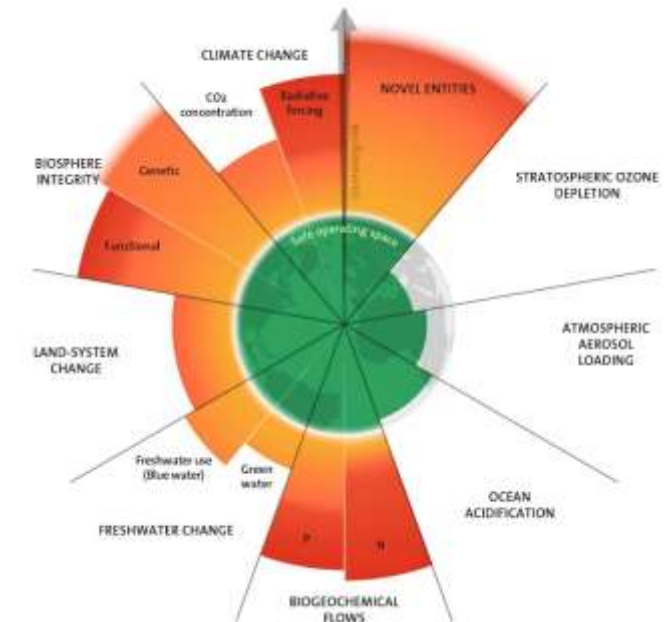
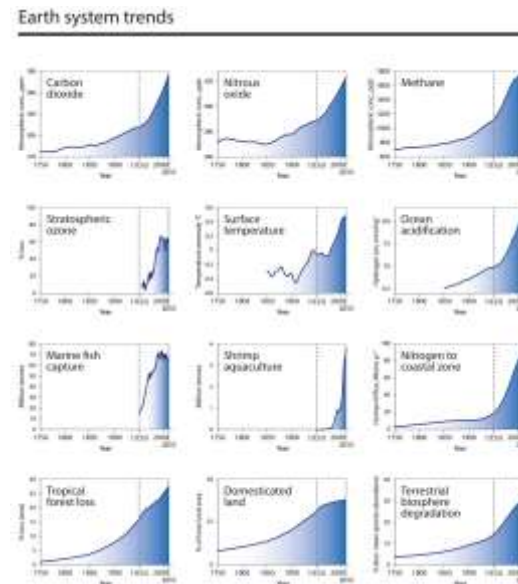
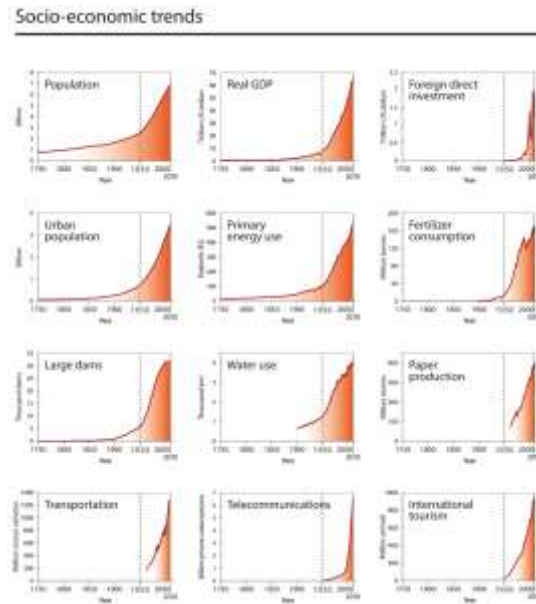
WCED 1987

A realization that our ability to prosper now and in the future requires increased attention not just to economic and social progress, but also conserving Earth's life support systems: the fundamental environmental processes and natural resources on which our hopes for prosperity depend.



Matson, Clark and Andersson 2016

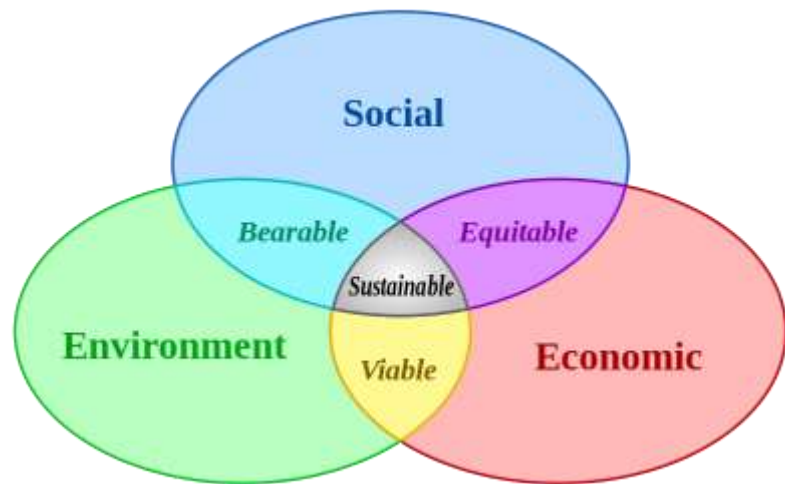
Sustainability – human development within environmental limits



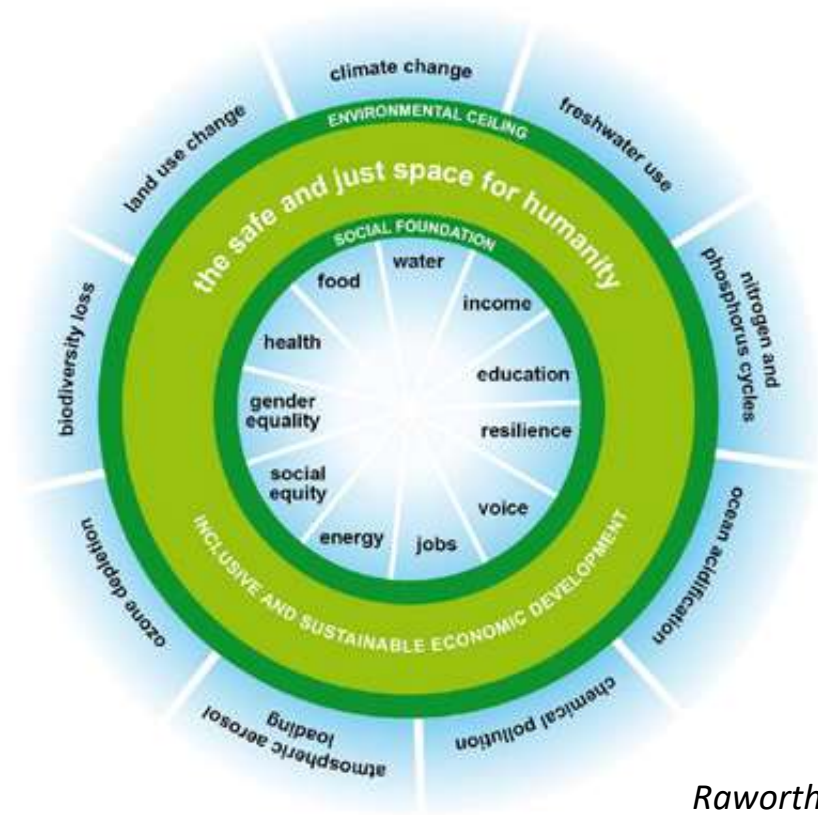
Steffen et al. 2015

Richardson et al 2023

Sustainability – from pillars to integrated views



Source: <https://en.wikipedia.org/wiki/Sustainability>



Raworth 2017

Sustainability transitions

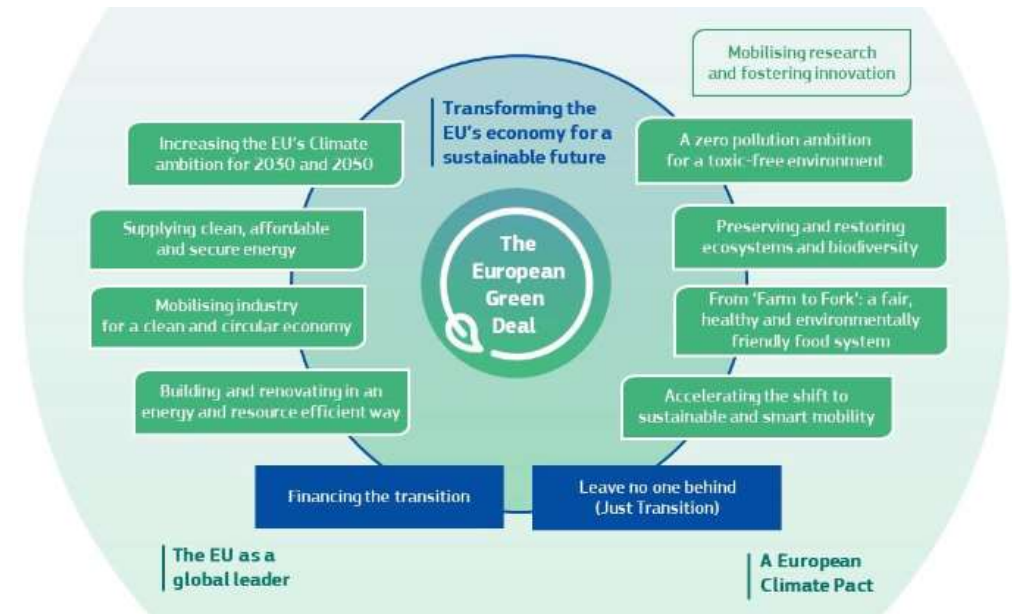
Sustainable Development Goals (SDGs)

- Paris Agreement
- Convention on Biological Diversity



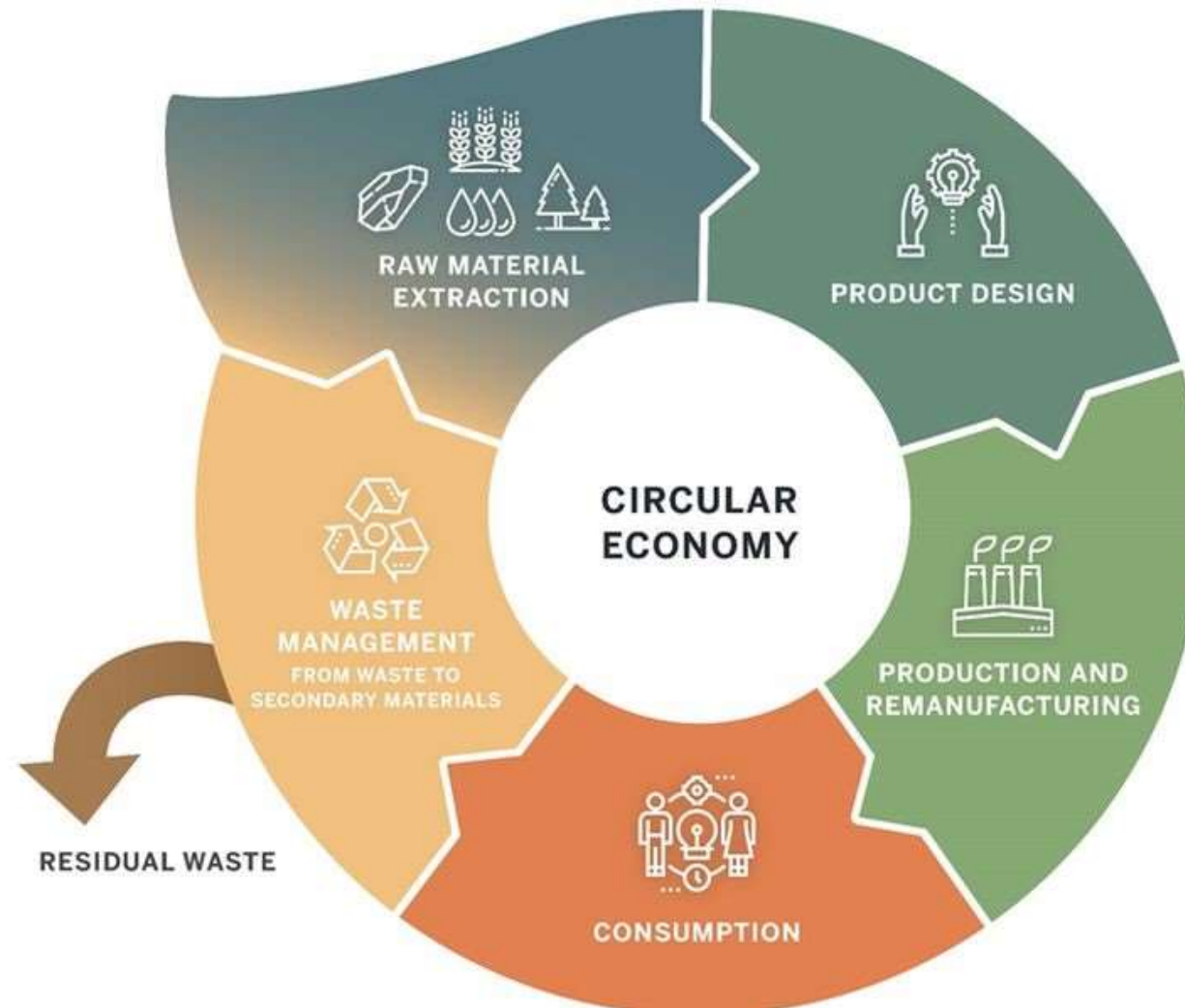
UN 2015

European Green Deal



EC 2019

Circular economy



EC 2019

What does this mean for mineral
raw materials and mining?

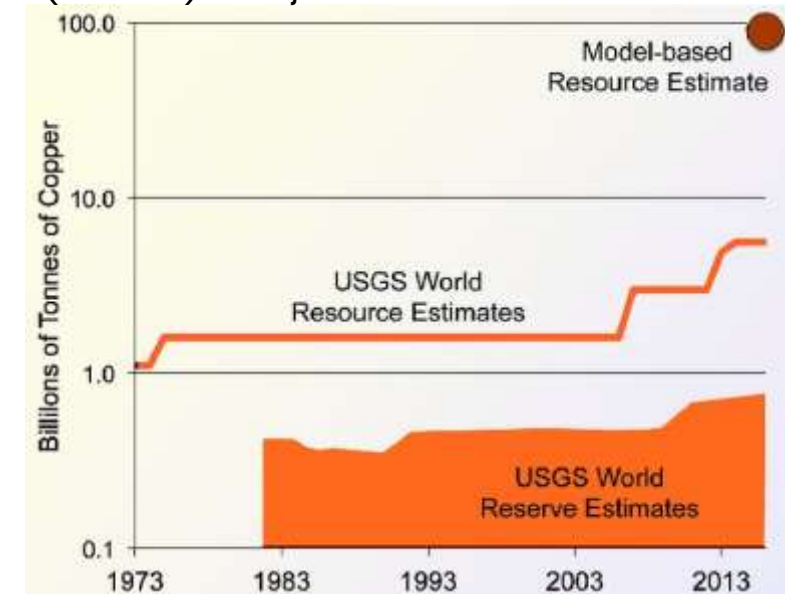
The non-renewability of minerals

2023 Lithium production
(USGS): 240.000 t

Li Resource (millions of tonnes)	Reference
13.8	USGS (2009)
19.2	Tahil (2008)
23.6	Mohr <i>et al.</i> (2012)
29.9	Evans (2008)
31.1	Kesler <i>et al.</i> (2012)
34.5	Evans (2010)
39.0	Gruber <i>et al.</i> (2011)
39.5	USGS (2016)
64.0	Yaksic and Tilton (2009)

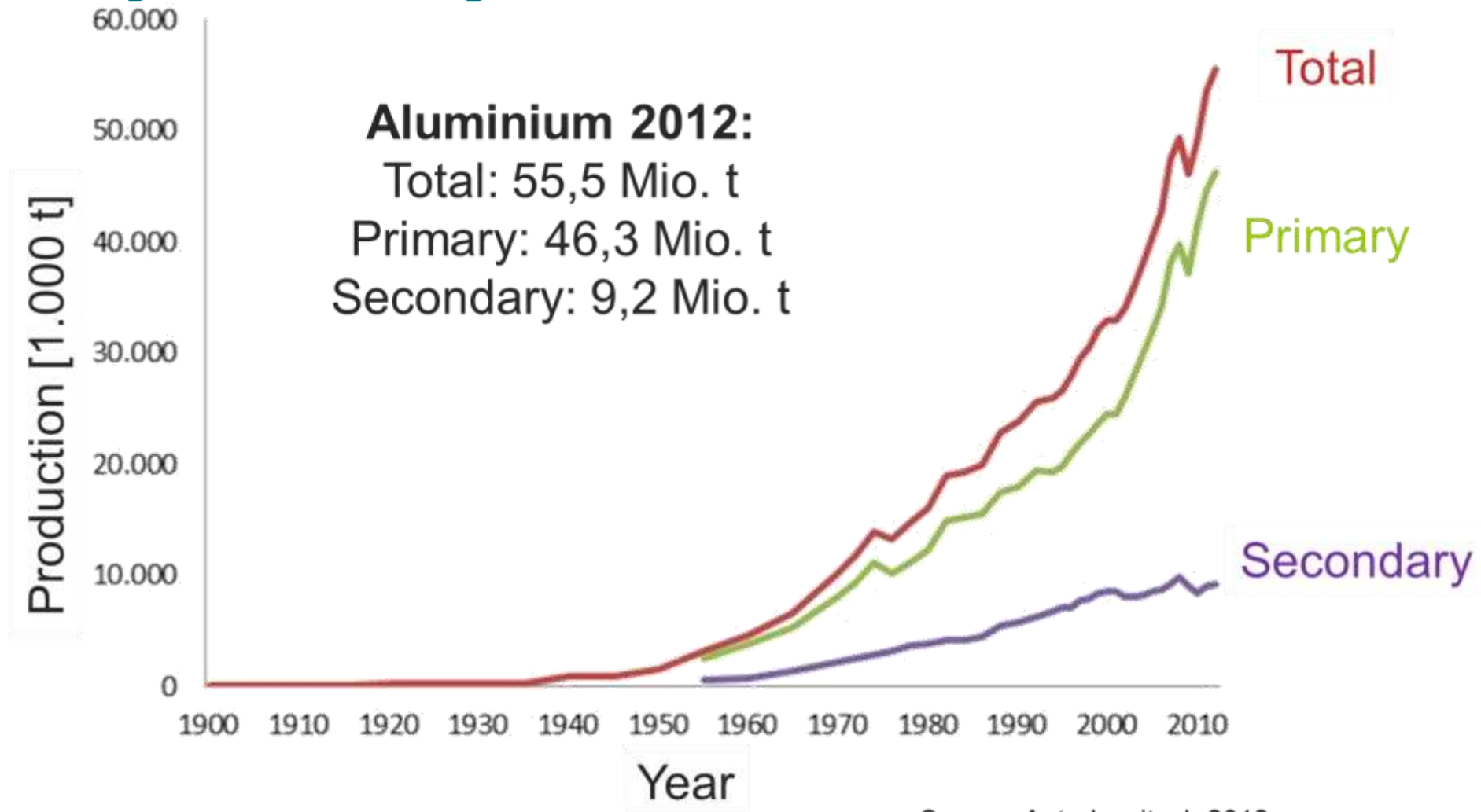
Arnt et al. 2017

2023 Copper production
(USGS): 22,6 M t



Chat GPT: „Tellurium is the tightest, with only about 32 years of currently identified reserves at present global production rates.”

Let's just recycle



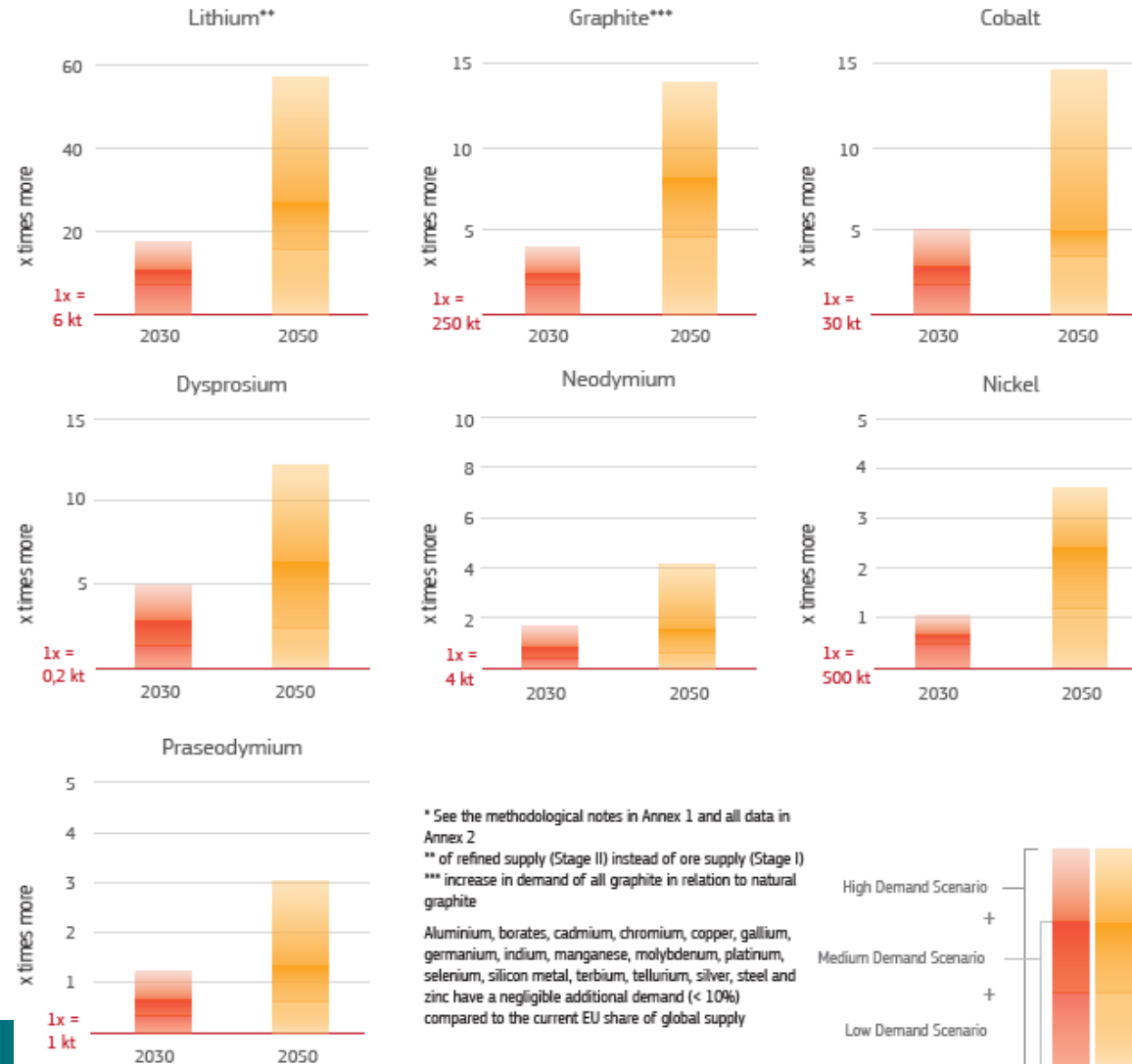
Source: Antrekowitsch 2012

We will still need mining, BUT...



...we need to differentiate what we mine

Additional material consumption batteries, fuel cells, wind turbines and photovoltaics in **renewables and e-mobility only** in 2030/2050 compared to current EU consumption* of the material in **all applications**



EC 2020

Less demand for coal?



Can we still afford to mine for luxury goods?



...mining itself needs to change

Mining company vs. materials company



BOLIDEN Operations ▾ Career Sustainability ▾ Investor Relations Media Contact BOLIDEN SEK 450,7 ▲ -32,5 (-6,7%)

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Read more about our operations

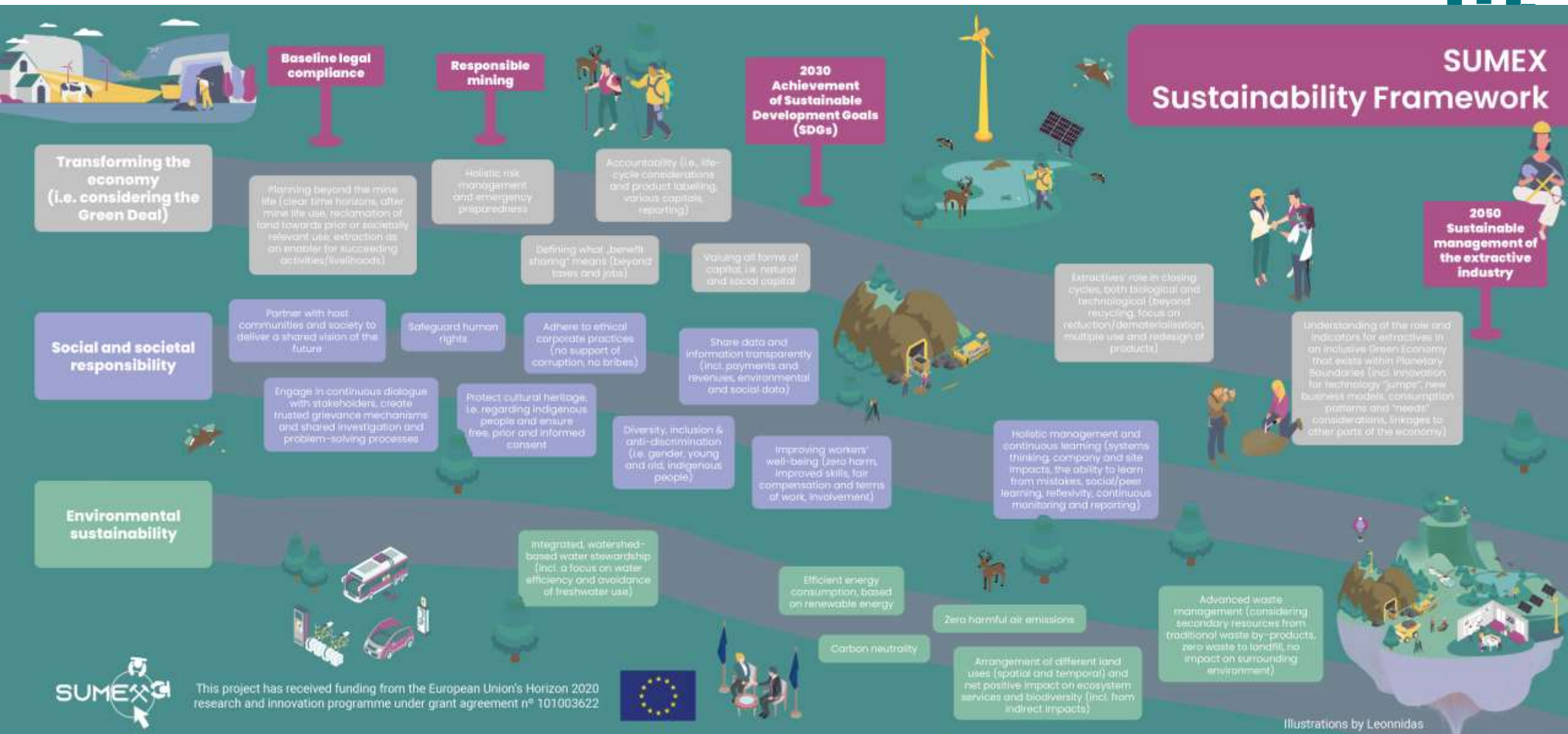
  **Exploration**

  **Mines**

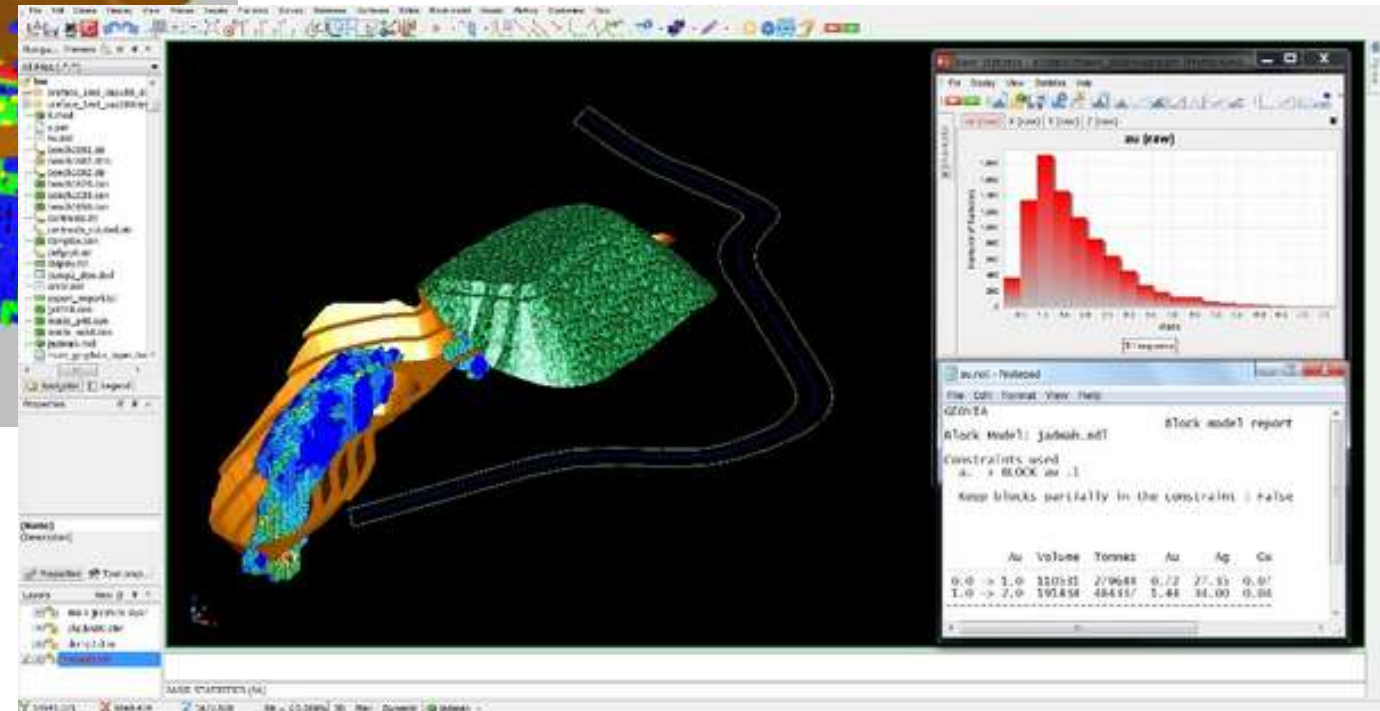
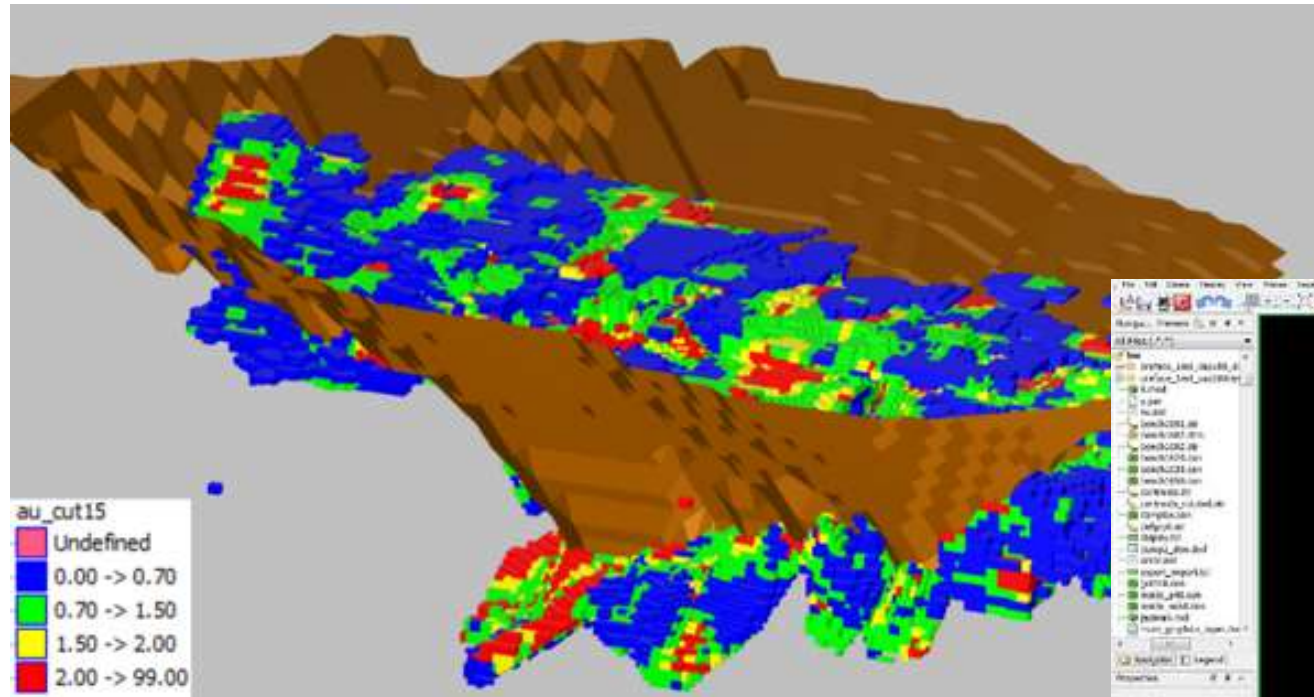
  **Smelters**

  **Products**

Source: <http://www.boliden.com>



Mine planning and AI



Geovia, 2021

Elektrifizierung - Förderung



VA Erzberg

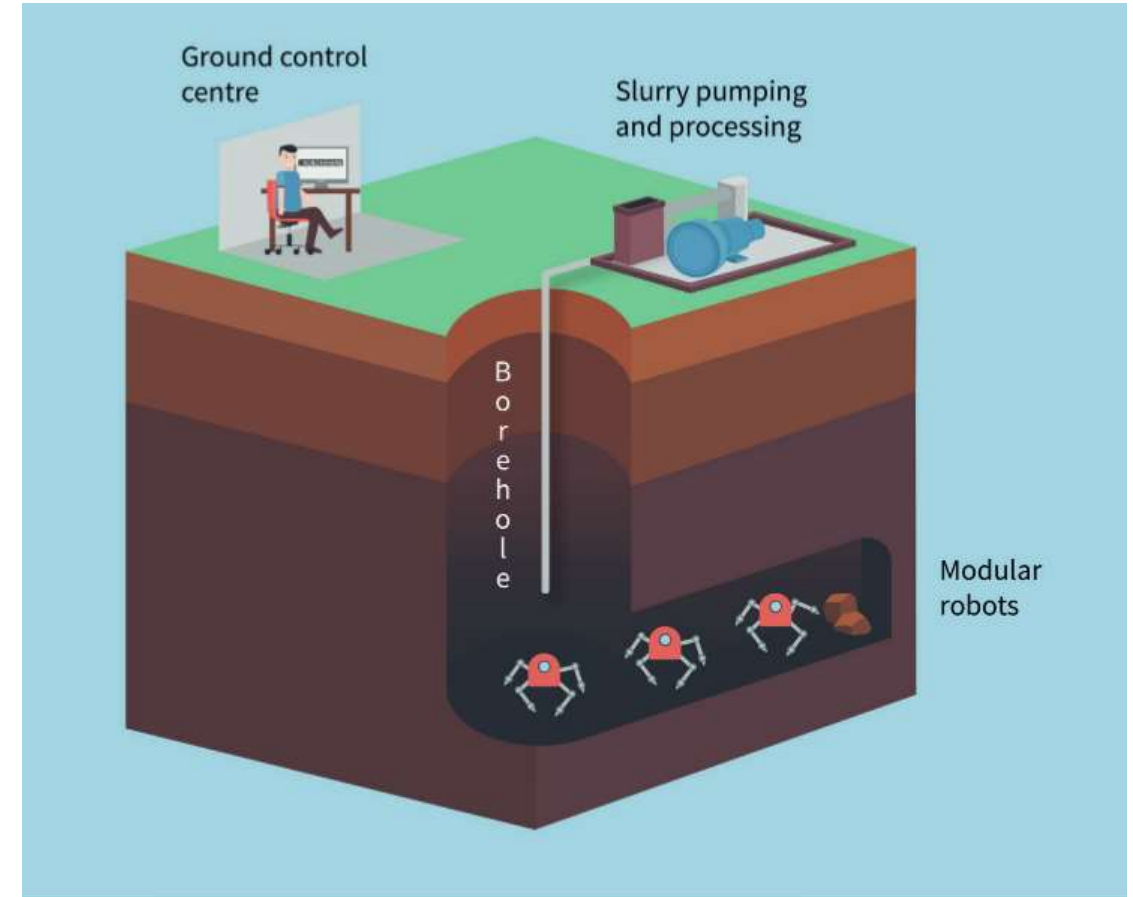


Siemens

Robominers



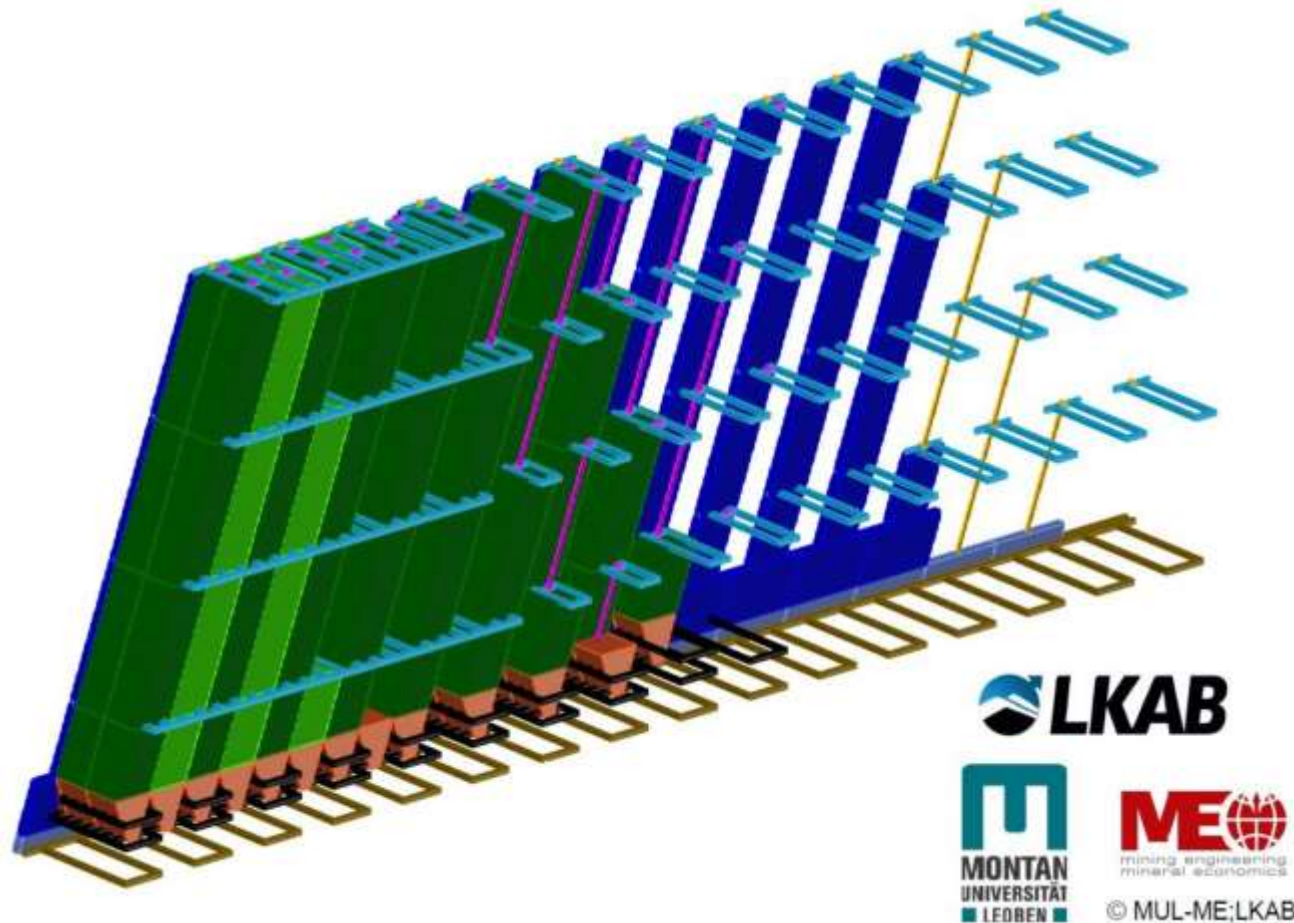
Komatsu



Robominers, 2020

Underground mining

Raise caving

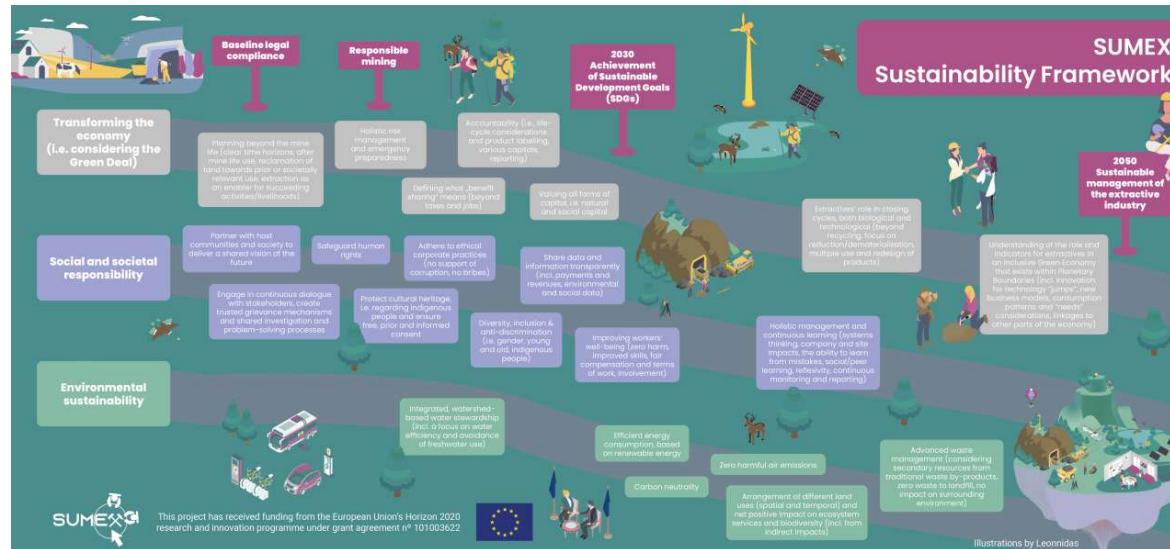


Post-mining



Max Siegmayer (Wikipedia)

So, can mineral raw materials be sustainable?



Michael Tost

Thanks for your attention!