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Module 2: Critical Raw Materials and LCA

'Business Relevance'

- Supply Chain Risks and CRM
- Depletion in classical LCA
- Supply chain Risk in modern LCA
- Exercise (example)
- Discussion on circular business models

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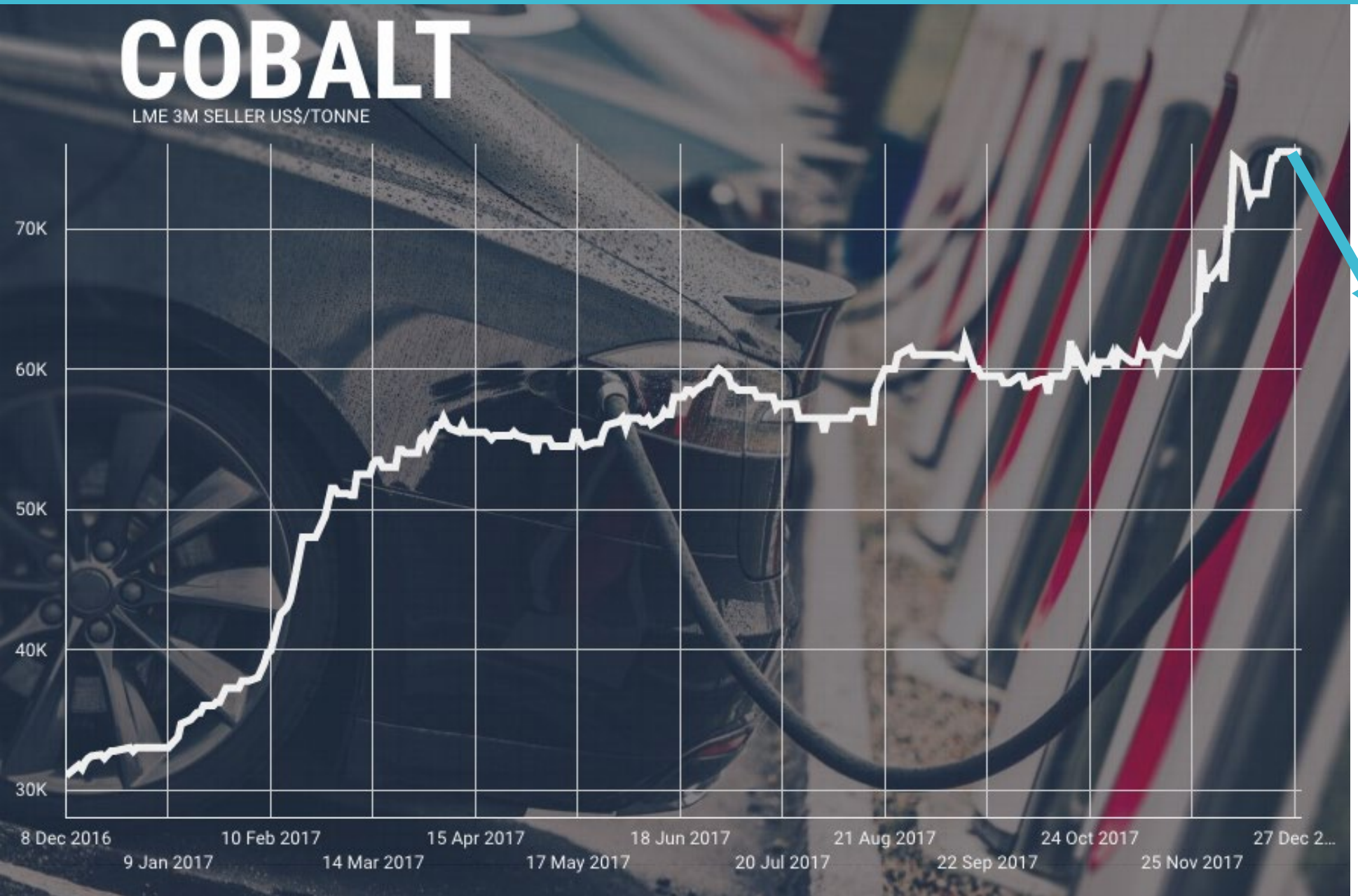


A hype in price

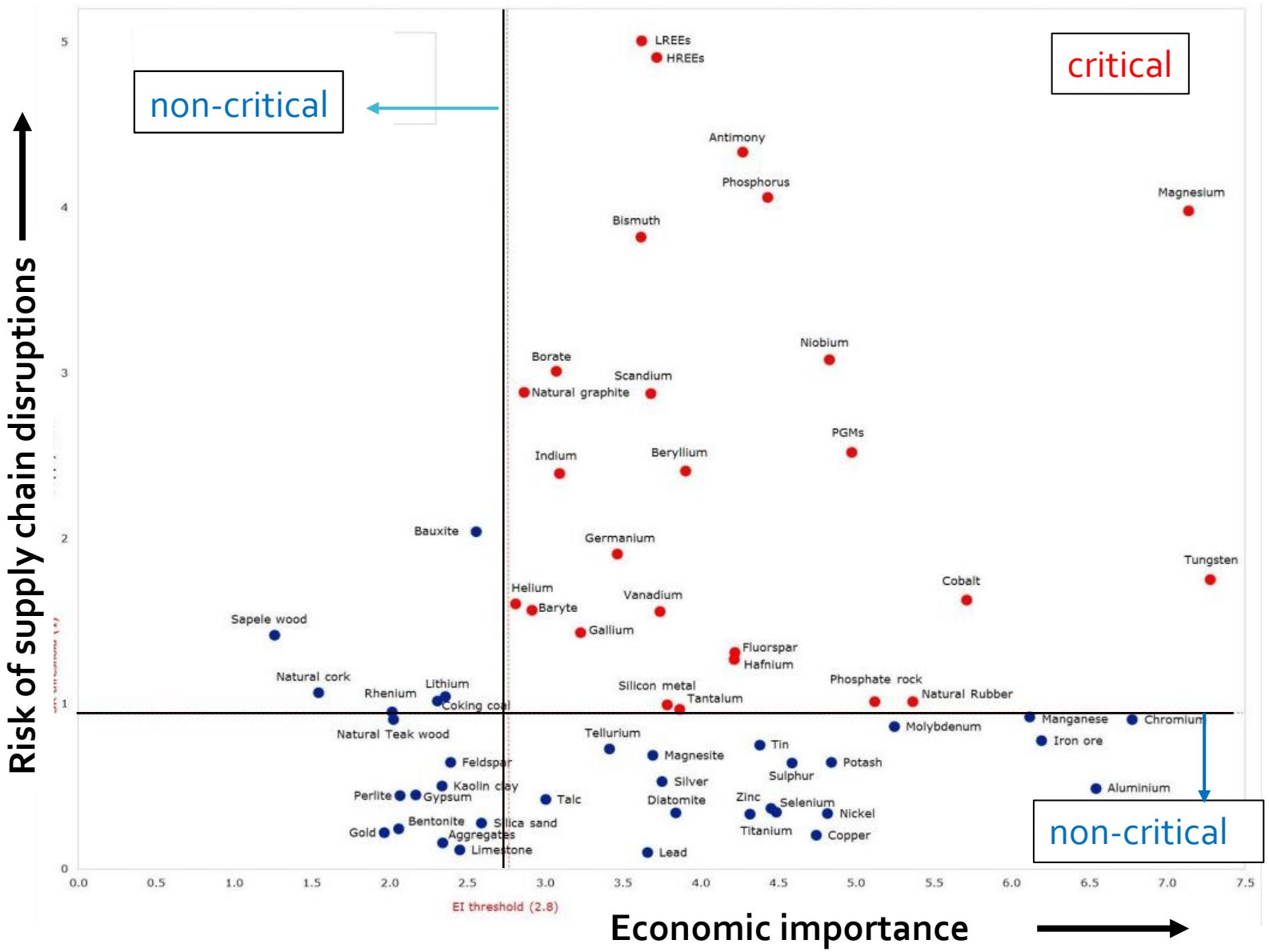
- High future demand because of $LiCoO_2$ batteries in cars
- Supply Risks of mines in Congo

Prices after 2017

- end 2018: 55k per tonne
- end 2019: 30k per tonne
- 2020: ??k per tonne (oversupply)

Conclusion:
such a **price peak** may **hit your business**

Critical Raw Materials (CRM) in the EU



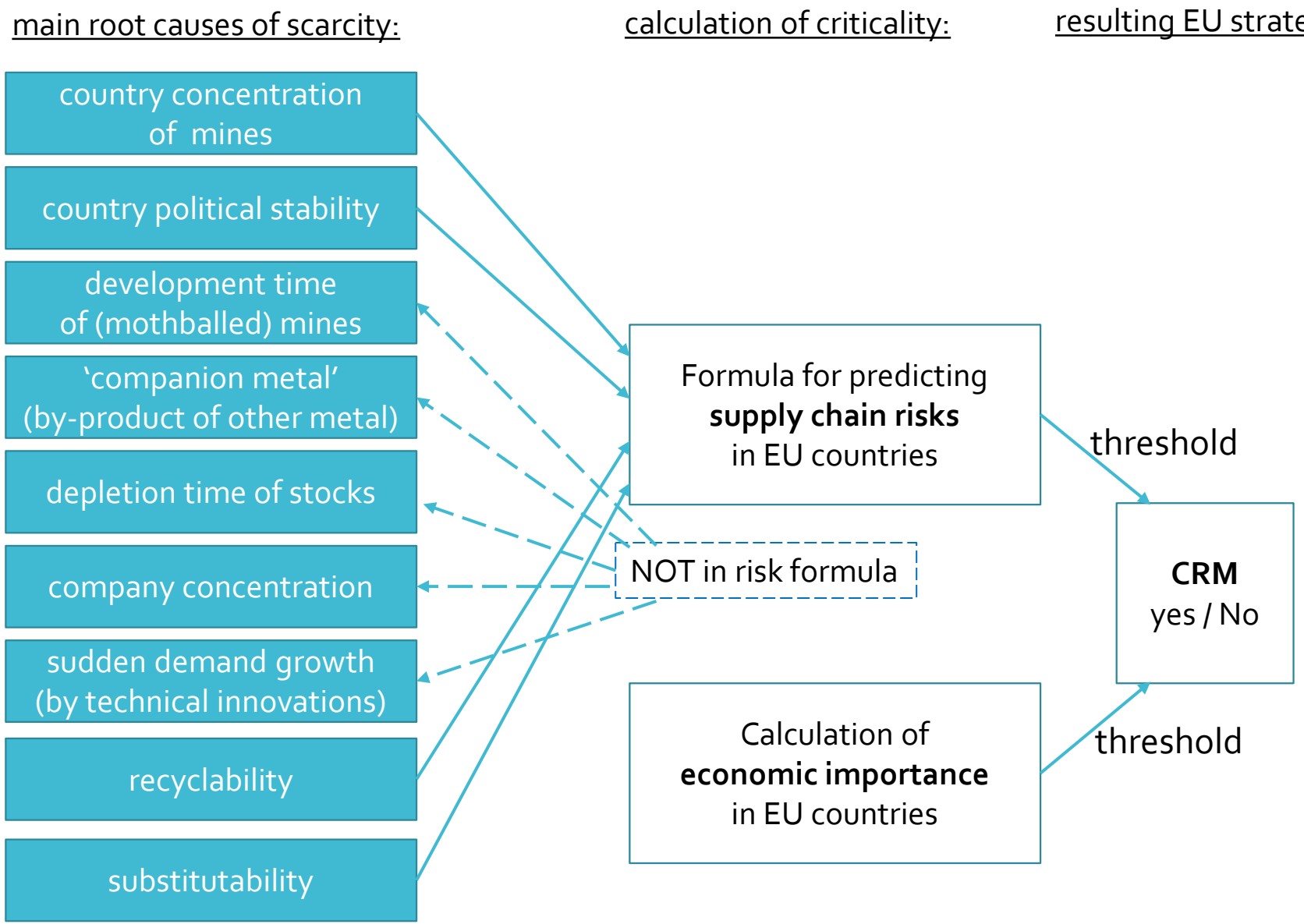
Critical Raw Materials combine:

- High risk of supply chain disruptions
- Economic importance

3 influential systems:

- European Commission EU list 'Critical Raw Materials' CRM
- British Geological Survey 'Risk List'
- US Geological Survey (USGS) NSTC subcommittee

Criticality of Raw Materials: the calculation for the EU

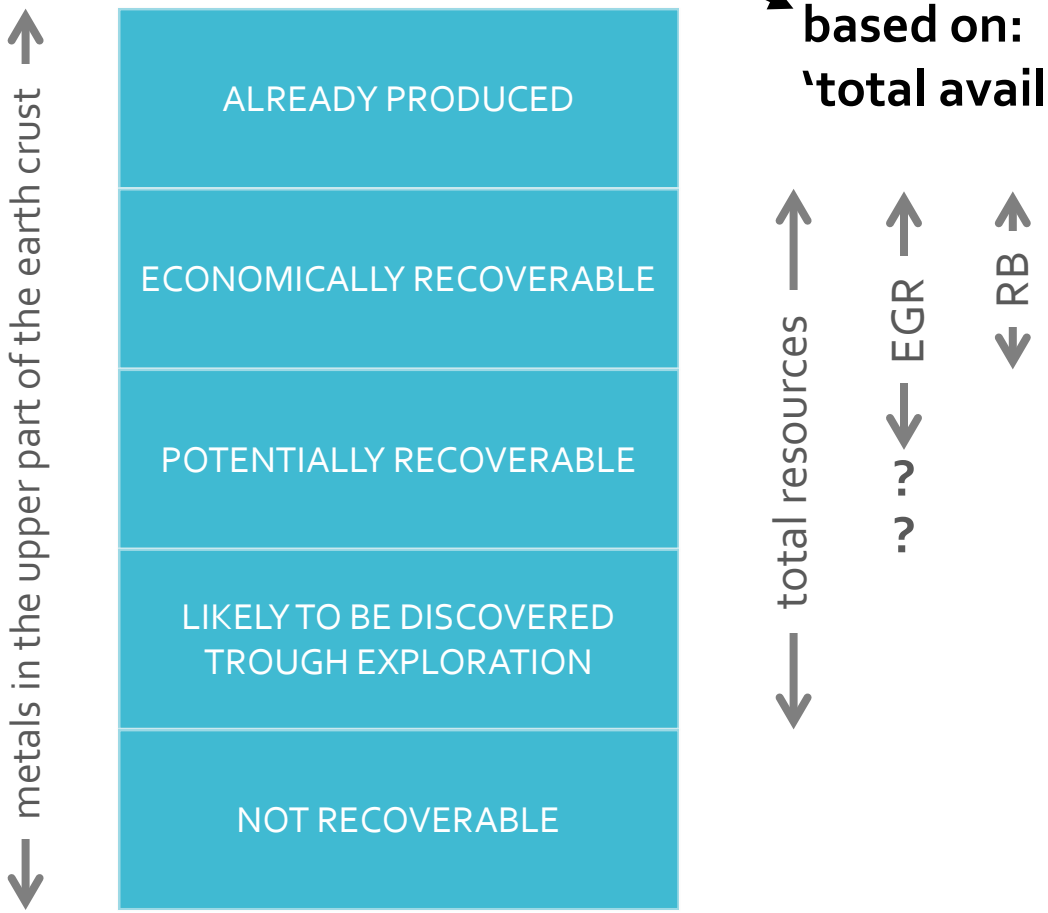


The CRM formula cannot be used in LCA, since:

- It is non-linear
- It contains thresholds
- It contains subjective 'value choices' that are not 'evidence based'

The classical LCA approach: absolute depletion in the long term

based on:
'total availability' / 'yearly deaccumulation'



Characteristics of this calculation approach:

- Long term (100 - 1000 years)
- The calculation is not related to shortages in the current supply chains, short term (10 - 30 years)
- "fixed stock" paradigm

The calculation of depletion is rather problematic ('highly inaccurate'), since:

- The amount of a metal in the earth crust is not known within a factor 1000
- The minable fraction is not known (new discoveries?, new technologies?)
- The deaccumulation rate is not known (recycling?, substitution by other materials?)

RB = the known Resource Base
EGR = Extractable Global Resource

The classical LCA indicator for materials depletion that is widely applied, is the so-called 'Abiotic Depletion Potential' (ADP)

The ADP is proportional to:

$$\frac{\text{Global consumption of a metal (kg/year)}}{\left(\text{Extractable Global Resource (kg)}\right)^2}$$

The ADP is a long term indicator for depletion

- The ADP is proportional to the **inverse** of:
  the estimated material depletion time multiplied by the estimated EGR
- Estimations of the EGR are rather inaccurate (uncertain), and this high uncertainty is squared in the formula (!)
- Calculations of the University of Utrecht (Henckens, 2016) show that less than 50% of the metals may deplete within 1000 years

The cause-effect pathway of the socio-economic effects and corresponding price peaks leads to a new approach in LCA

(geo) political instability

supply chain disruption

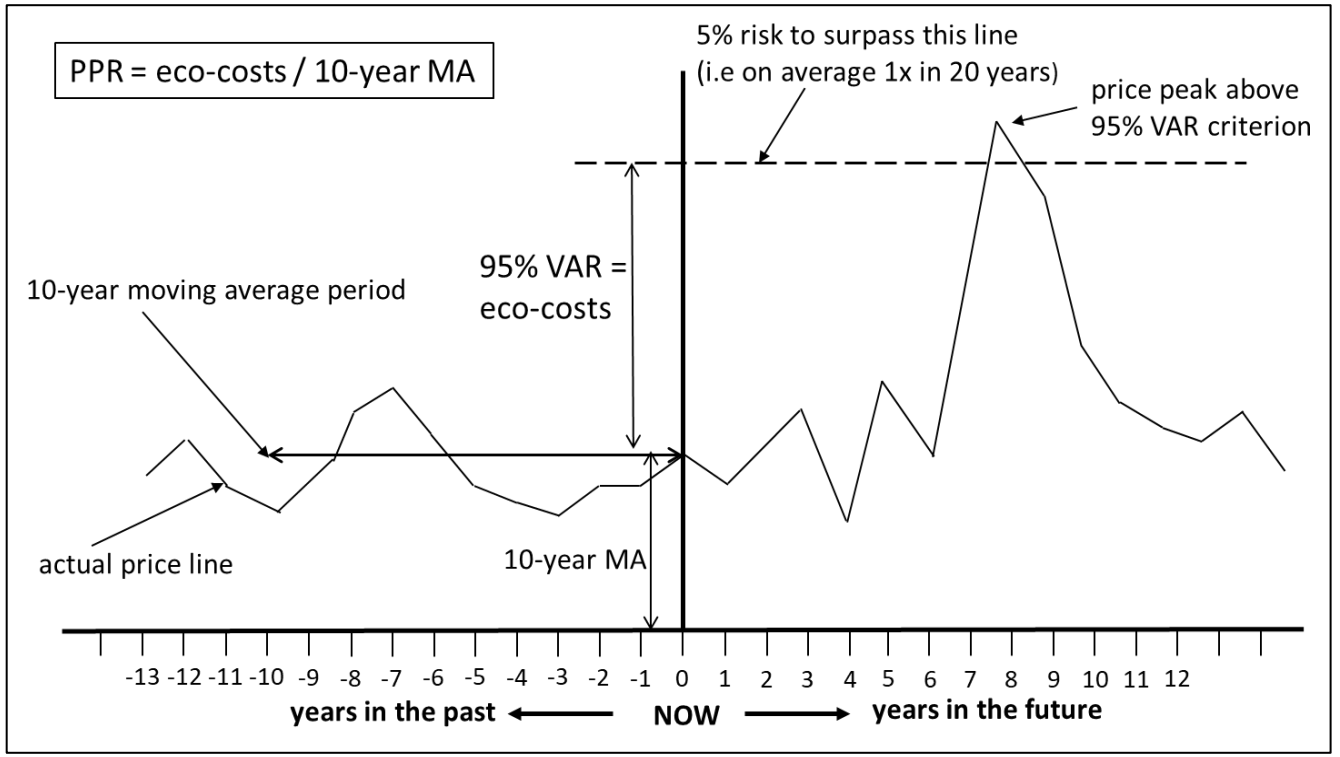
temporary shortages

sudden price jump

deteriorating profit margins

bankruptcies companies

growth of unemployment



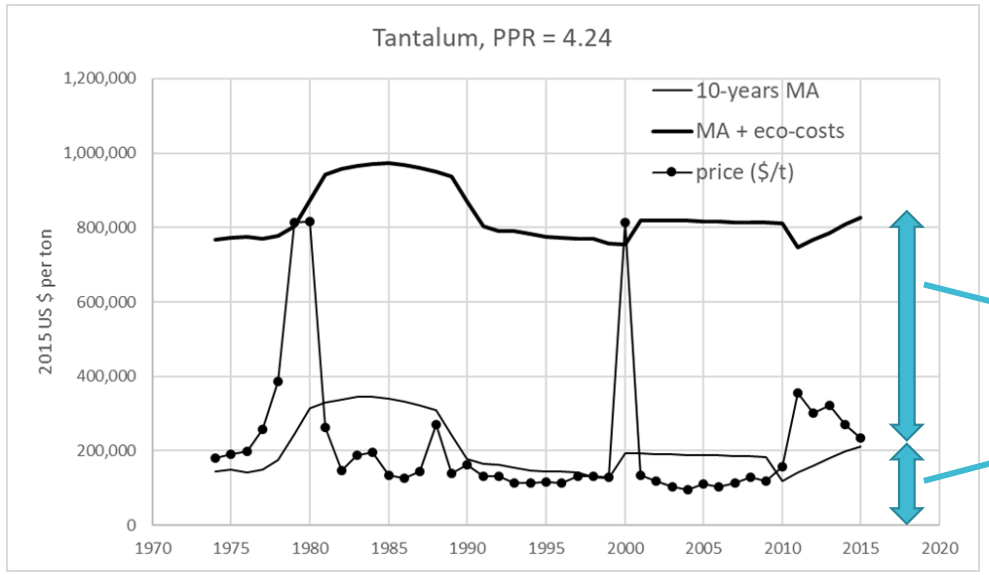
criticality for companies

criticality for society (countries)

The prediction of prices is impossible, but, the statistical chance of a peak is called 'Value at Risk':

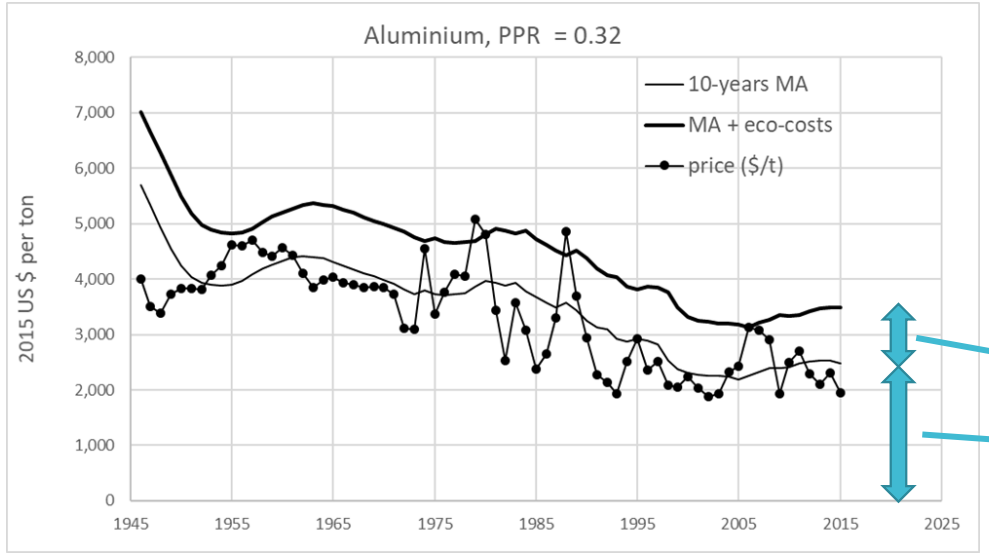
- A chance of 5% that the price peak is more than VAR
- So on average every 20 years a price peak above VAR
- This VAR, on top of the average price, is called 'eco-costs of materials scarcity'
- Price Peak Ratio (PPR) is extremely important for companies

Examples of critical (e.g. Tantalum) and not-critical (e.g. Aluminium): a matter of the Price Peak Ratio



Tantalum:

$$\frac{95\%\ VAR}{MA(10)} = PPR = 3.92$$



Aluminium:

$$\frac{95\%\ VAR}{MA(10)} = PPR = 0.32$$

The ratio between the 'eco-costs of materials scarcity' and the 'average price' is important for business and society:

- The 'eco-costs of materials scarcity' is directly related to the financial business risk
- These eco-costs, multiplied by the import volume, describes also the socio-economic risk at country level

Examples of reduction of Critical Raw Materials.

Recently developed magnets: replacement of Neonybium, combined with a better performance

	A	C	E	F	G	H	I	J	K
1				Process	Total eco-costs	eco-costs of human health	eco-costs of exo-tocicity	eco-costs of resource scarcity	eco-costs of carbon footprint
2									
3			unit		euro	euro	euro	euro	euro
456	**market intrioduction**	**A.100.21**	**Materials, metals, others, magnets**						
457	1952 by Philips	A.100.21.101	kg	Idematapp2020 Barium Ferrite magnet, ceramic 4 MGOe	1.23	0.09	0.20	0.26	0.69
458	1966 by aircraft industry	A.100.21.105	kg	Idematapp2020 SmCo (1:5) magnet, 20 MGOe	74.00	1.14	3.65	63.83	5.38
459	1983 by General Electric	A.100.21.102	kg	Idematapp2020 Neonybium magnet (NdFeB, NEO) 50 MGOe	61.30	0.30	0.86	58.69	1.45
460	1983 by General Electric	A.100.21.103	kg	Idematapp2020 Neonybium magnet (NdFeB, NEO) corrosion resistant, 50 MGOe	70.23	0.32	0.92	67.42	1.56
461	2019 by Niron (univ. Minnesota)	A.100.21.104	kg	Idematapp2020 Nitride magnet (Fe16N2), 130 MGOe	1.42	0.11	0.22	0.29	0.80
462									

Drastic reduction of Cobalt in Lithium-ion Car batteries:

The Cobalt in $LiCoO_2$ (as applied in smartphones and laptops) has gradually be replaced by Nickel and Manganese or Aluminium:

- Tesla would have had **0.9 kg Cobalt/kWh** if it would have had **laptop batteries**
- Tesla in **2012** had **0.18 kg Cobalt/kWh**
- Tesla in **2018** had **0.09 kg Cobalt/kWh**

Assignment 5: Check resource scarcity scores in eco-costs, ReciPe, and the EF (CML), for Cobalt and Nickel.
Which of these scores are aligned with the trend to minimize Cobalt in car batteries? And which are not aligned?

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End of Module 2:
Critical Raw Materials and LCA

You may read for additional information:

Vogtländer, J, Peck D, Kurowicka D. The Eco-Costs of Material Scarcity, a Resource Indicator for LCA, Derived from a Statistical Analysis on Excessive Price Peaks, *Sustainability 2019*

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