Resource criticality and the ‘Energiewende’

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Review

- The resource challenge: not all resources are equal
- Metals as a special and difficult category
- Differentiation between economies thriving on primary materials and intermediates
- Conclusions

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Can we grow resource use another 100 yrs? The resource challenge: what happens at 7% growth with no decoupling

Doubles global economy every 10 years

Resource needs per year:

- Oil barrel the size of the earth: in 382 years
- Mining the whole earth crust: in 307 years
- Using all water including seas: in 190 years
- Energy use equal to the full solar influx: in 131 years

Of course with 2-3% growth it is better, but the long-term problem is clear

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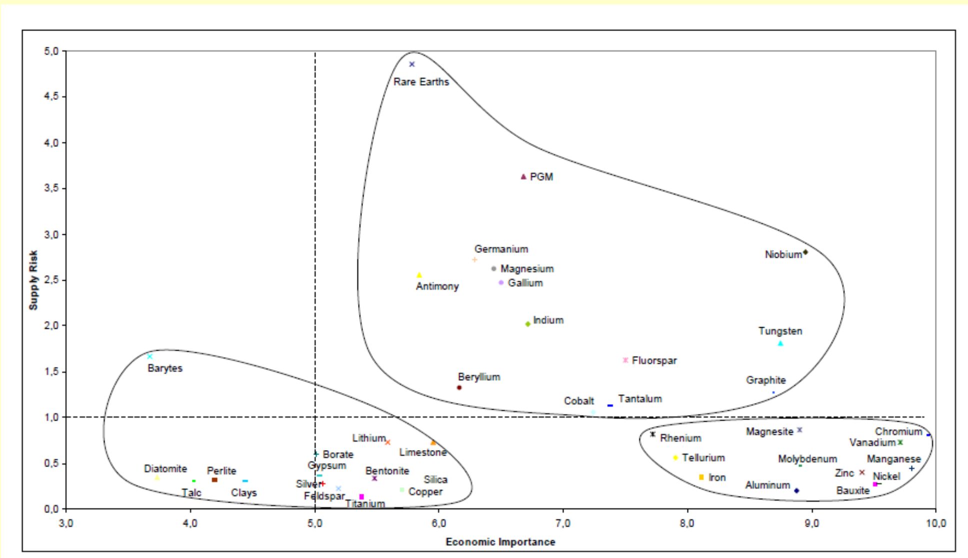
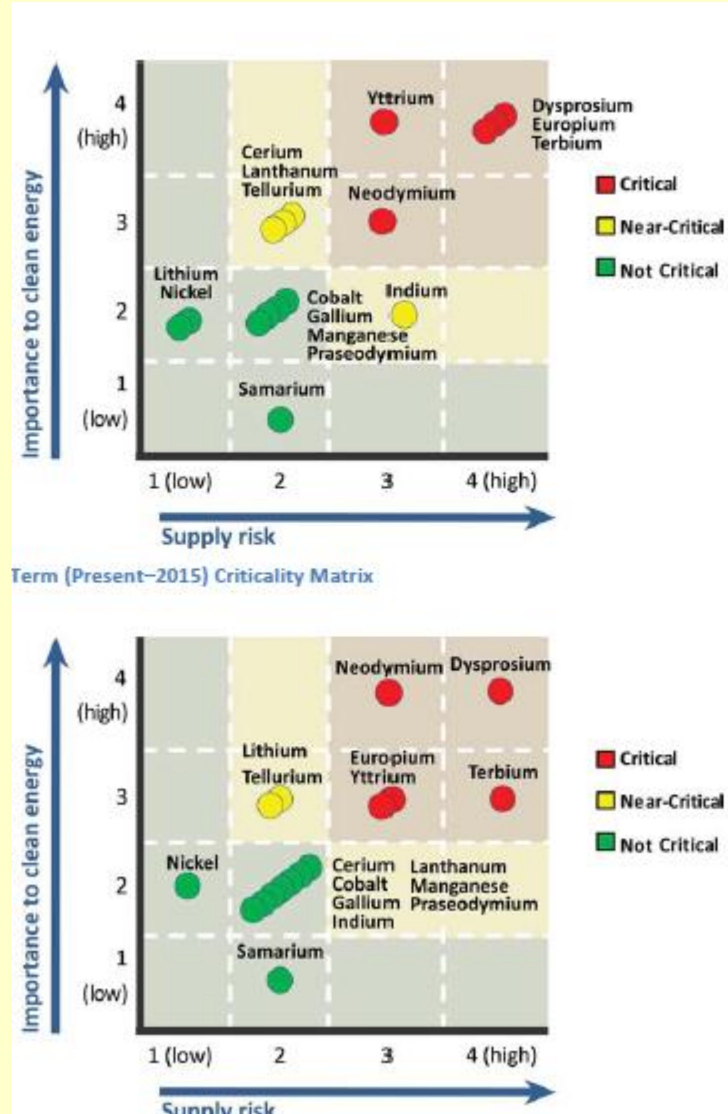
But on shorter term, not all resources are equal….

Type of resource	% global extraction	Basis for planetary limits	Potential limit	Reduction factor	Reference
Metal ores, industrial minerals	10%	Absolute scarcity (varies by metal).	EU 14 'critical materials' . Transition to renewables: absolute scarcity	Varies	EC (2010); Kleijn (2012), Graedel and van der Voet (2010).
Fossil fuels	20%	CO_2 emission targets	Factor 4-5 reduction for 2^{o}C target	>10	IPCC (2007), Stern (2006), Meinsausen et al. (2009)
Construc-tion minerals	40%	Absolute scarcity less relevant	CO2 emission targets for cement, steel, aluminium….	-	WRI (2006)
Biomass	30%	Max human appropriation of net primary production	HANNP = now 30-35% of available biomass	2	Vitusek et al. (1986), Haberl et al. (2007).
Land	p.m.	Available bioproductive land	?? (remaining land, productivity potential)		Erb et al. (2009), OECD/FAO (2009); Nature (2010a and b), WWF (2010)
Water	p.m.	Renewable supply (by region)	2030: Global 'water gap' of 40%		Hoekstra and Chapagain (2007), Water resources group / McKinsey (2009)

Metals: a differentiated case





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ERECON WG: it is market failure, not scarcity

- 800 times more deposits as current use
- 2 trillion value in end products, 5 bio needed for new mines
- Mining: Chinese monopoly, Western companies are small, we outsourced the dirty job for a reason
- Refining: Chinese build up huge knowledge base, Europe has limited capacity and knowledge
- Future demand is highly uncertain, supply inelastic (co-mining, opening mines costs 10 years and a few billion of investment)
- Bankers have less risky investment options
- There are hence massive market failures

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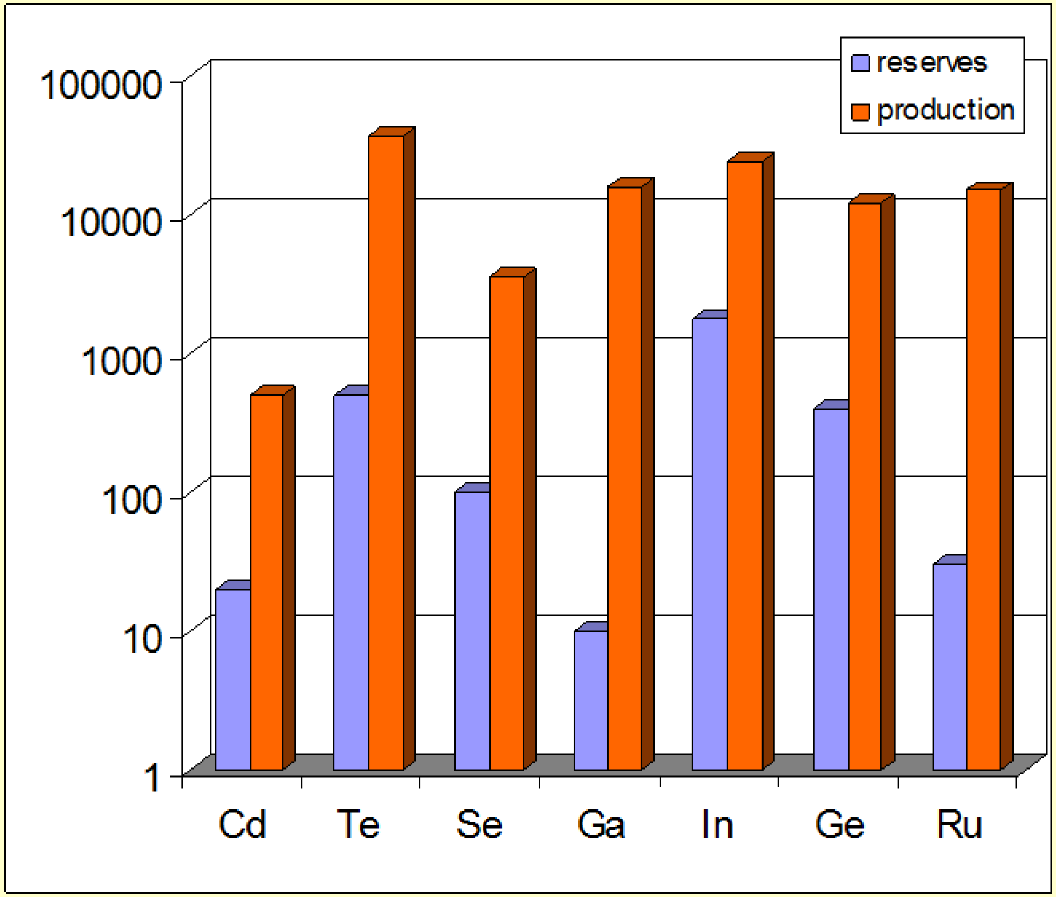
Amount of resources needed to build low-carbon infrastructure is massive



Material requirement for PV thinfilm cells (if 80% of 2050 energy supply should come from these technologies compared to reserves

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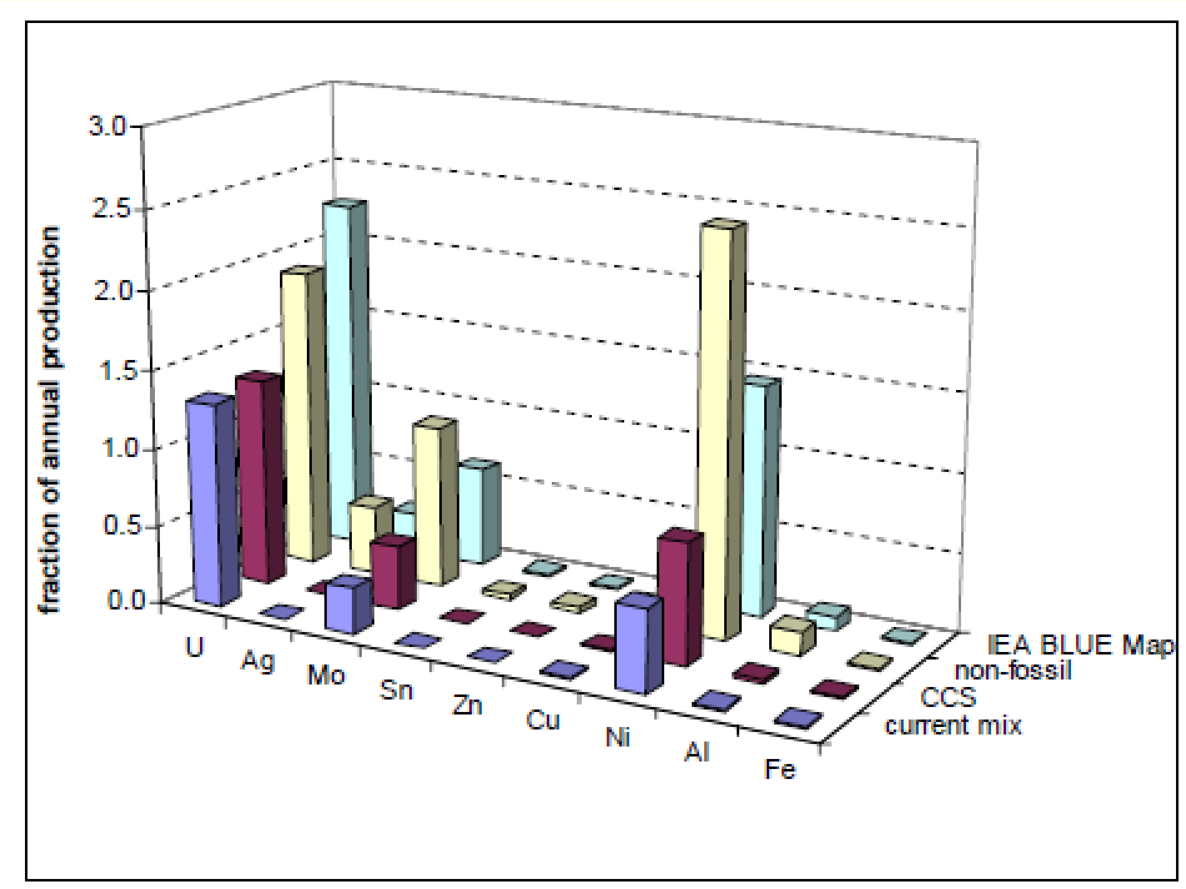

Annual metal requirements for 3 sustainable electricity generation scenarios – use by the electricity sector compared to total global annual production

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And more bad news

Graedel et al. (2013) claim substitutability is limited

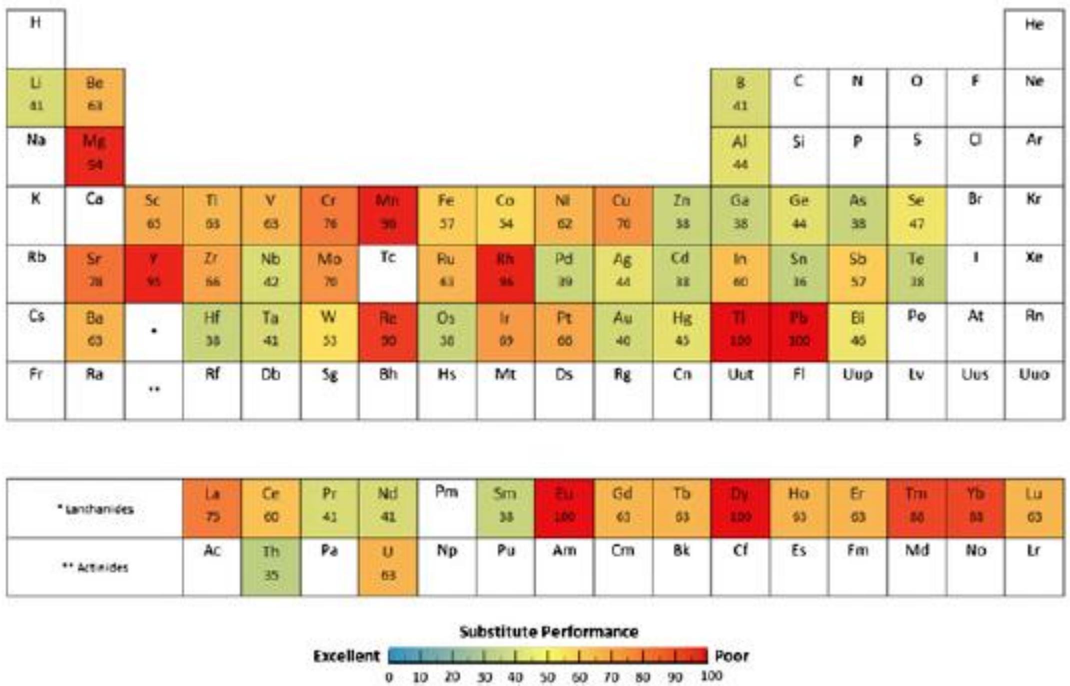

Fig. 5. The periodic table of substitute performance. The results are scaled from 0 to 100, with 0 indicating that exemplary substitutes exist for all major uses and 100 indicating that no substitute with even adequate performance exists for any of the major uses.

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Amount of resources needed to build low-carbon infrastructure is massive

- Country level
  - Use of critical materials (direct, intermediates)
  - Current contribution to added value
  - Impact on added value and competitiveness of price change and supply disruptions
- Company level
  - Knowledge if critical materials are part of their of supplies
  - Understanding number and stability of sources, also given position in value chain
  - Understanding (timing) of substitution options

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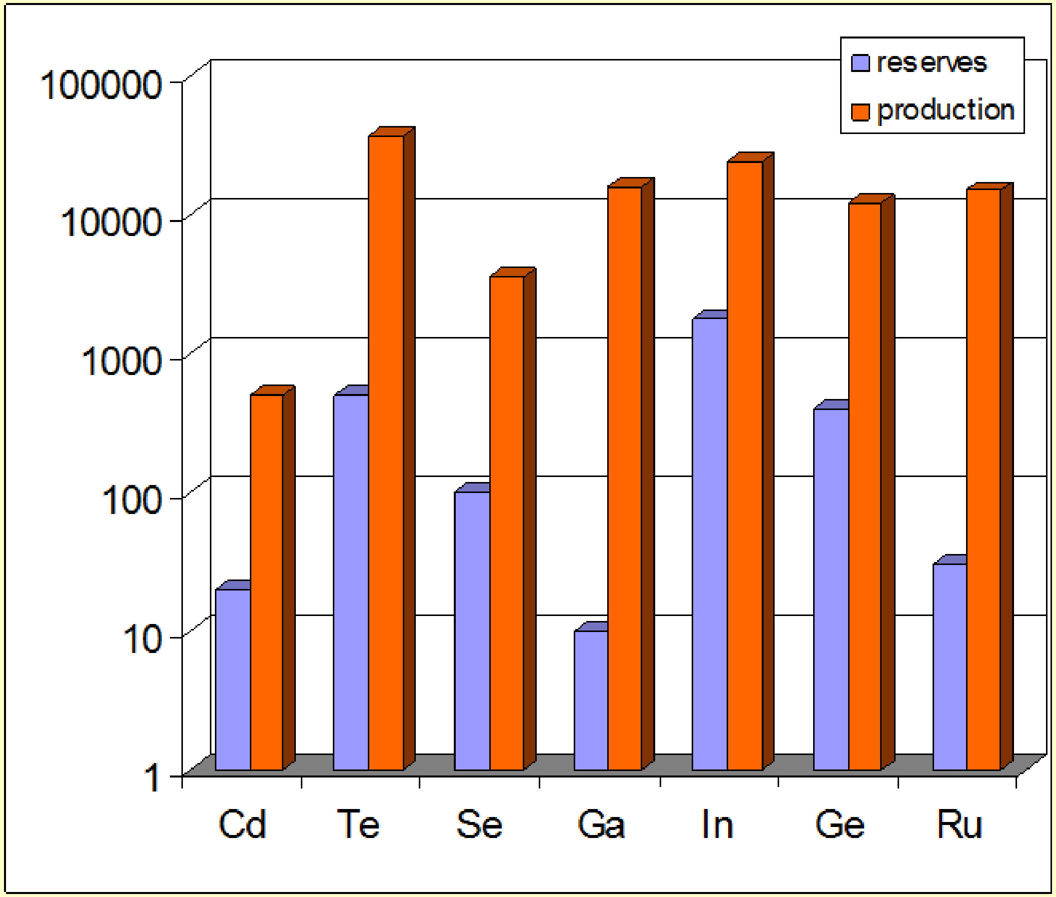
Amount of resources needed to build low-carbon infrastructure is massive



Material requirement for PV thinfilm cells (if 80% of 2050 energy supply should come from these technologies compared to reserves

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Conclusions

- We face already material criticality……
- ….currently mainly due to market failures and uncertain future demand
- A massive shift to renewables means a massive investment in infrastructure requiring up to dozens of times current production
- We hence have to work on
  - Substitution by new technologies, e.g. nanomaterials replacing critical materials
  - Overcoming the market failures that currently hinder investment in mining
- Otherwise the 'energiewende' will stall due to lack of access to relevant resources

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Thanks for your attention!

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