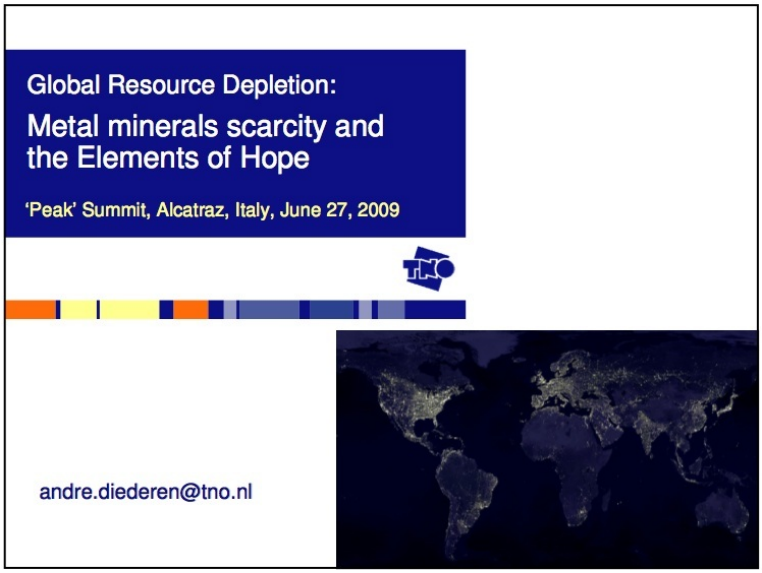
The Oil Drum: Europe
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

Metal Minerals Scarcity and the Elements of Hope

Posted by Rembrandt on July 9, 2009 - 10:53am in The Oil Drum: Europe
Topic: Environment/Sustainability
Tags: a.m. diederen, alcatraz conference, mineral scarcity [list all tags]

This is a presentation by Dr. A. M. Diederen, given at the Oil Drum/ASPO Conference at Alcatraz, Italy in June 2009. It can be downloaded here: Global Resource Depletion: Metal minerals scarcity and the Elements of Hope, PDF 24 slides, 0.5 MB



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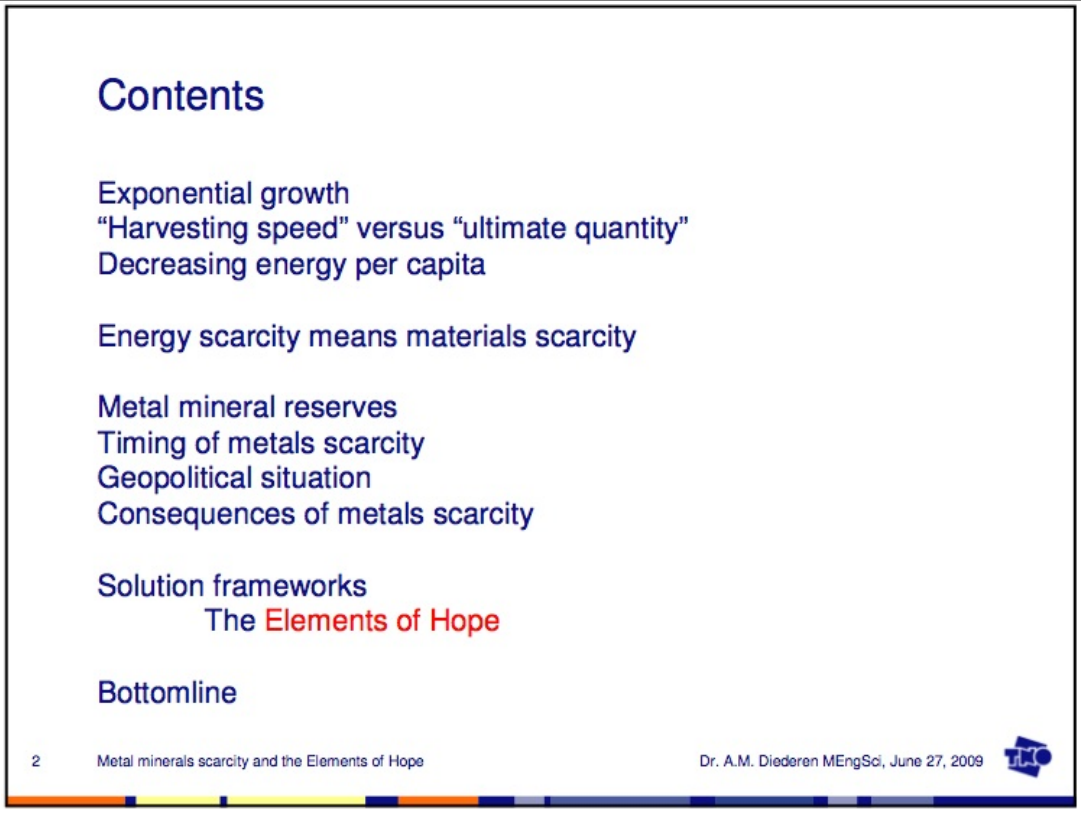
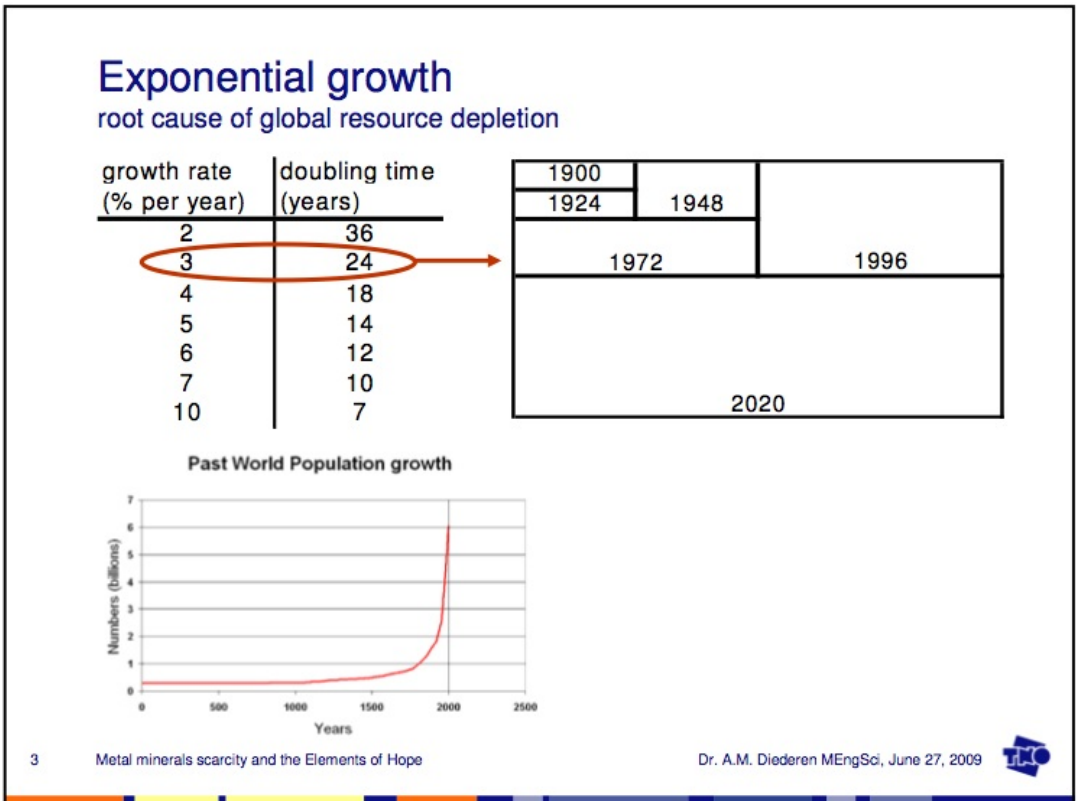
Slide 1
If policy does not change, the ongoing growth in global consumption of metals will cause shortages, aggravate energy scarcity and obstruct the transition towards a sustainable economy.

For my analysis the collective work presented by ASPO-members and at TheOilDrum has proven to be an invaluable source of information. I would like to especially mention the work of Prof. Ugo Bardi, because he has inspired me to look further into the issue of metal minerals depletion.

This presentation elaborates on my paper ""Metal minerals scarcity: A call for managed austerity and the elements of hope", published at the website TheOilDrum.com on May 4, 2009 (http://europe.theoildrum.com/node/5239) and at the TNO website on June 24, 2009 (http://www.tno.nl/).

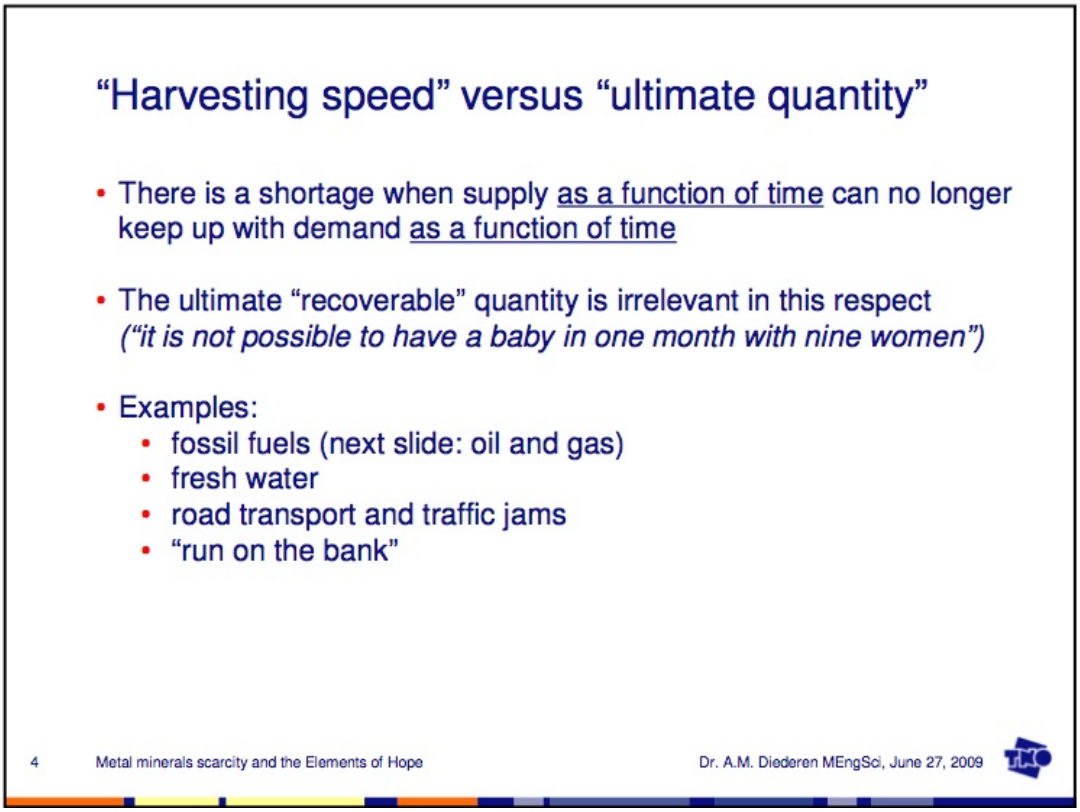


Slide 2
Metals scarcity is becoming one of the most urgent global problems, comparable with energy scarcity which is its root cause.



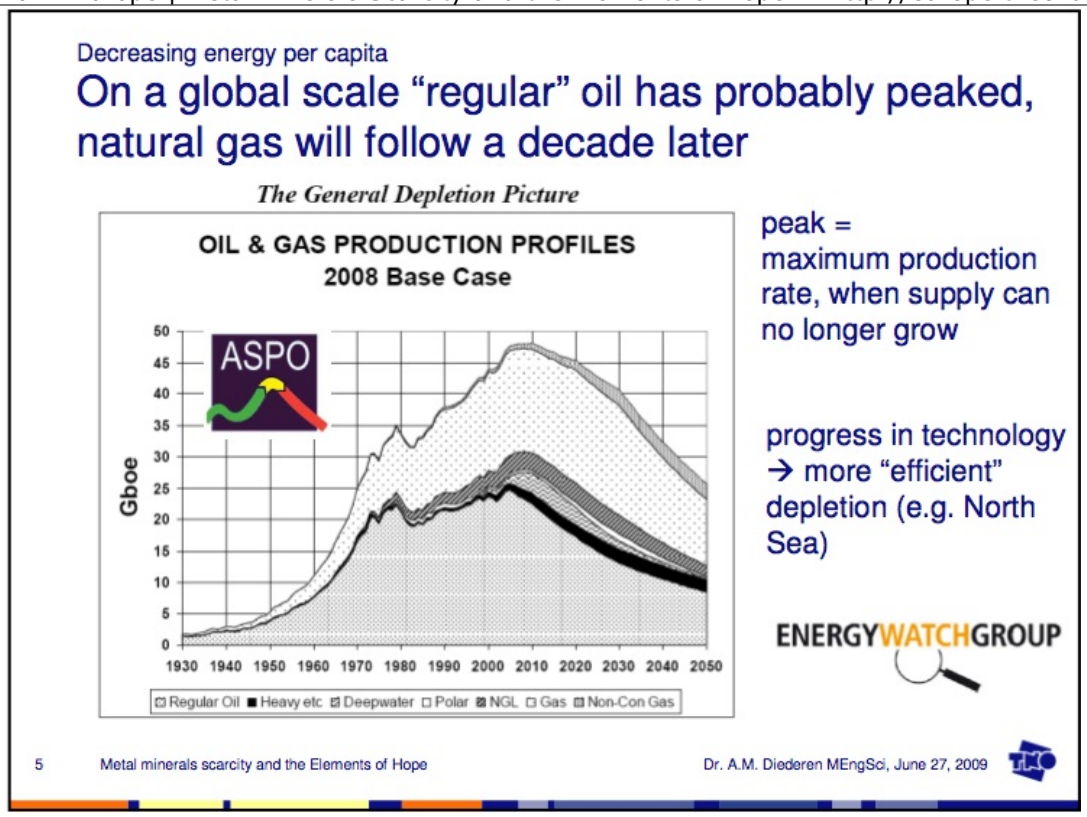
Slide 3
The underlying problem is exponential growth of the world's population and associated consumption of natural resources. Earlier this year, the IMF (within the context of the current

global crisis) stated that a "healthy" world economy grows each year with 3% or more. Sustained growth of 3% per year means a doubling time every 24 years. Compare this with the average growth of China's economy during the last 15 years and associated growth in metals consumption: 10% or more per year, meaning a doubling time of 7 years (or shorter). This is of course nothing less than a Ponzi Scheme.

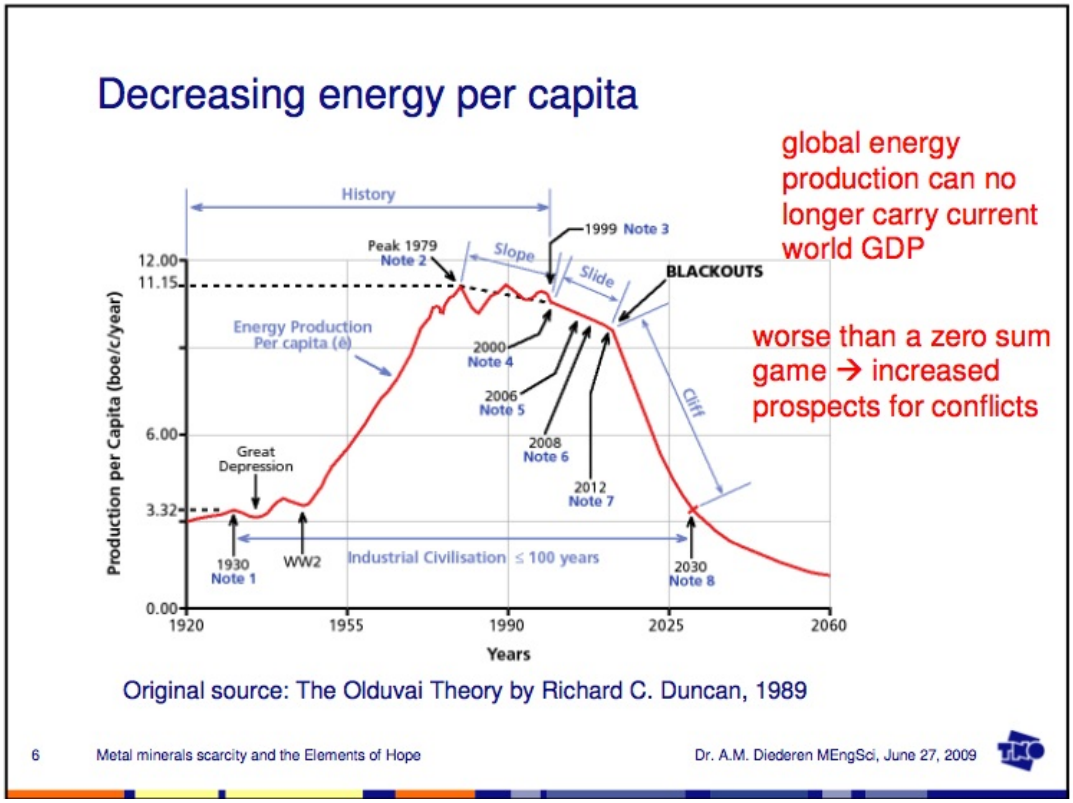


Slide 4

I would like to lend a phrase from the peak oil community and apply it to mineral resources as well: it's not the size of the well that matters but the size of the tap. About a quarter of the earth's crust consists of silicon, yet we are already short (for years) on pure enough silicon to make high efficiency solar cells. Of course we can purify the less favourable sources of silicon, but this takes (lots of) energy.

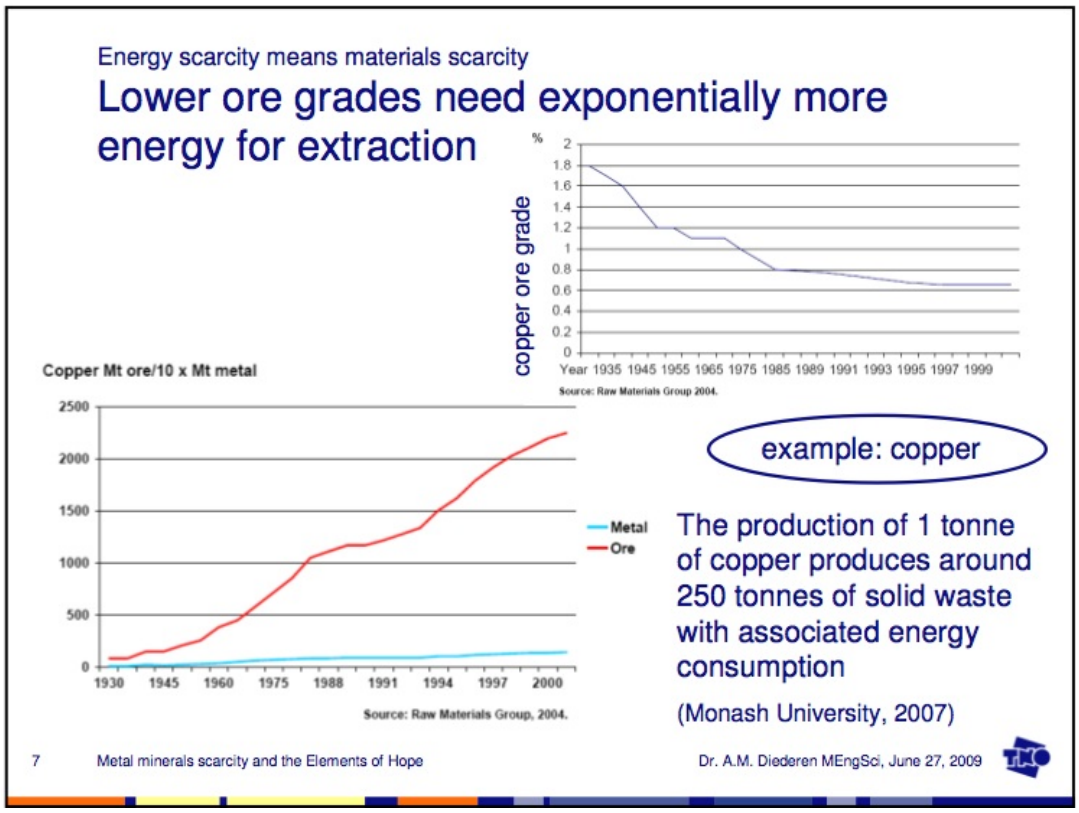


Slide 5
As with energy, also for metals one should not be misinterpreted as saying that we are running out (of metals). We are running out of "easy" metals, i.e. high ore grades at favourable locations.



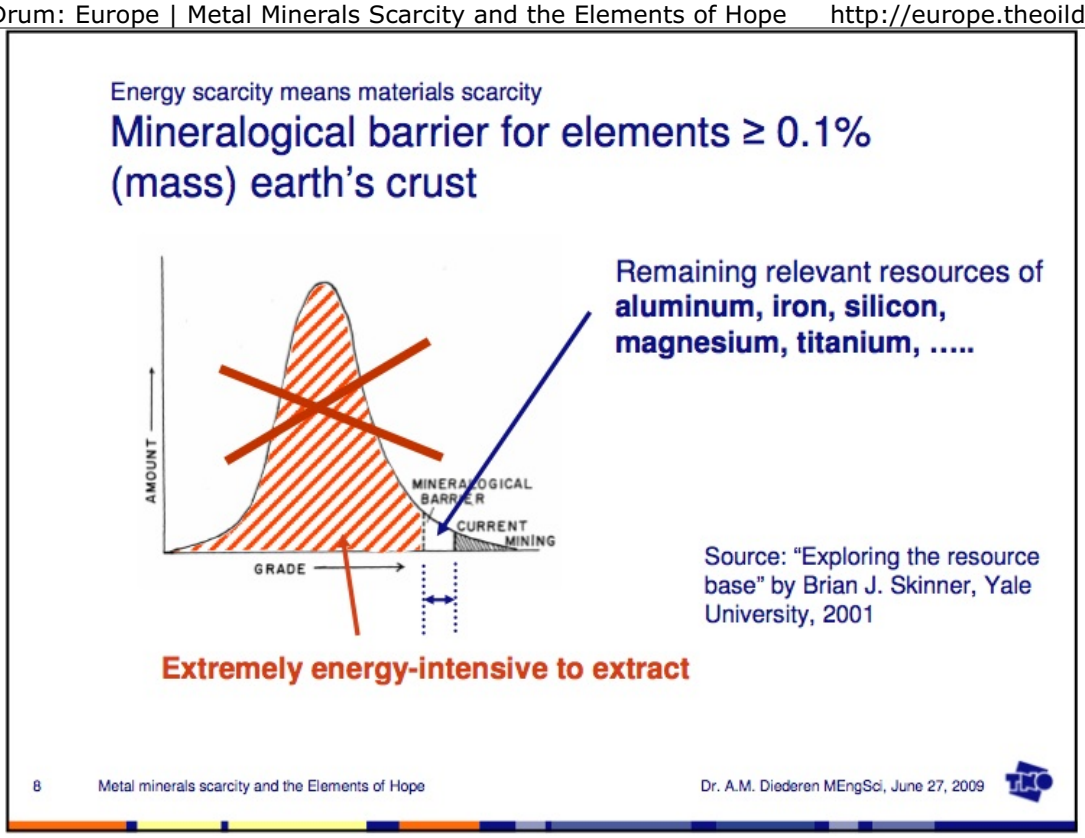
Slide 6
This graph is the scariest graph I've seen in years if you think about its implications. It's even worse than a zero sum game: even zero growth at one part of the globe will inevitable cause

shrinkage at another part of the globe (until we have some other economic paradigm). Looking at our history, I find it hard to be optimistic about a future without serious conflicts.

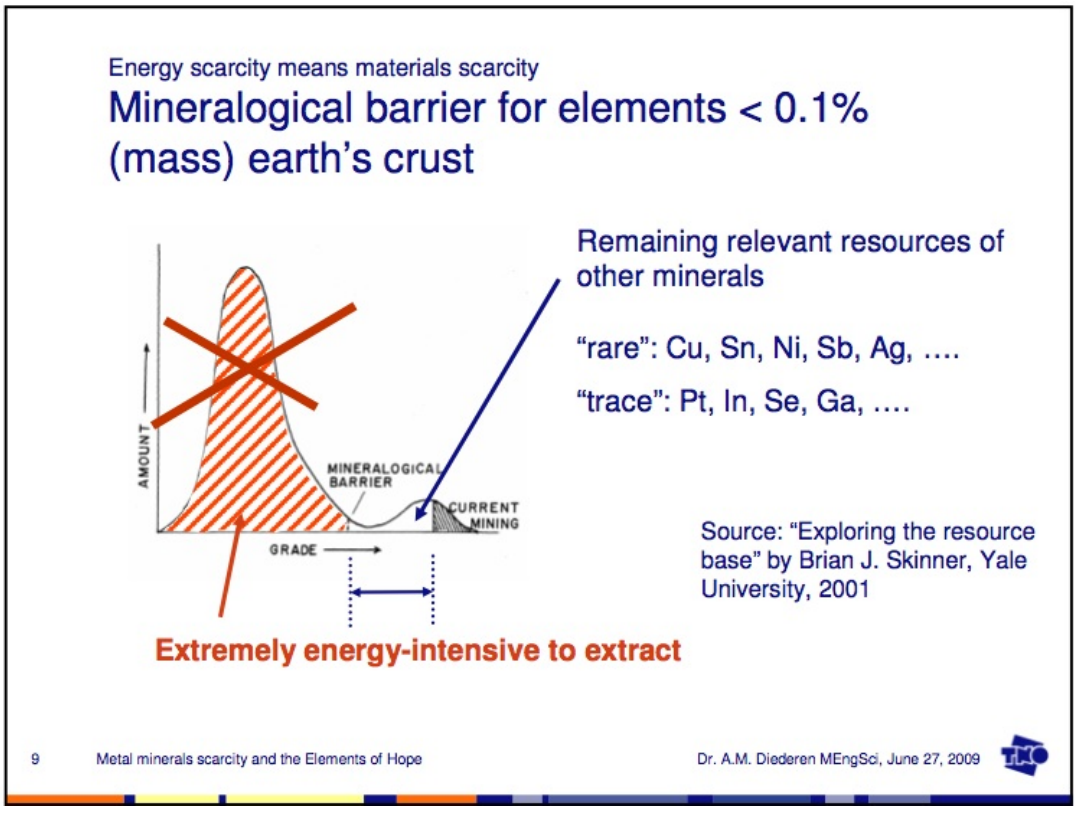


Slide 7

A typical critique on stating that we are running into metals scarcity is the notion that you will find 300 times more ore as you lower the ore grade with a factor of 10. This misses the point that you need much more energy to keep extracting the same amount of metal. Even when the ore grade is more or less stable (example: copper over the last few decades), you still need increasingly more energy to extract the same amount of copper because you have to dig deeper and handle ever more quantities of solids to get to the ores. Of course lower ore grades aggravate the situation and increase energy expenditures much more because of the amounts of solids which have to be processed to keep up the production rate of concentrated metal.

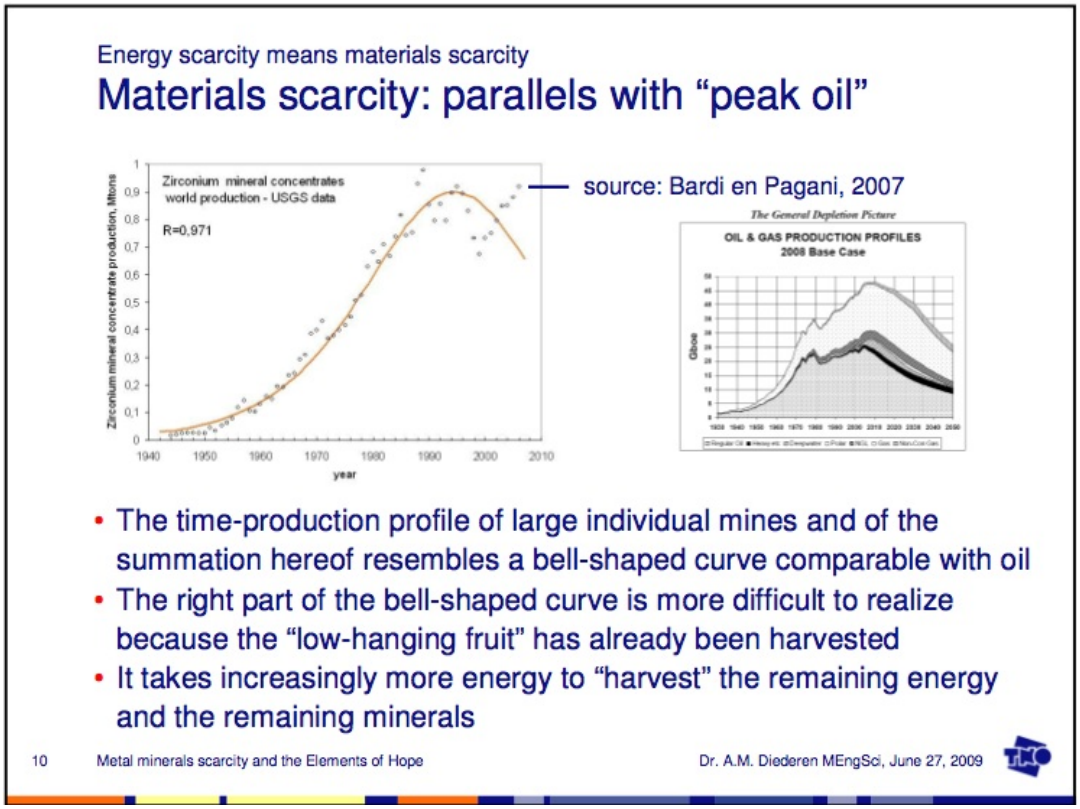


Slide 8
Below the so-called mineralogical barrier (a certain low ore grade), essentially you should pull the source material (e.g. a piece of rock) chemically apart to extract the individual metals. Combined with the enormous amounts of low grade source materials required to maintain a certain production rate of metal, in an energy constrained world the vast majority of resources is out of our reach.



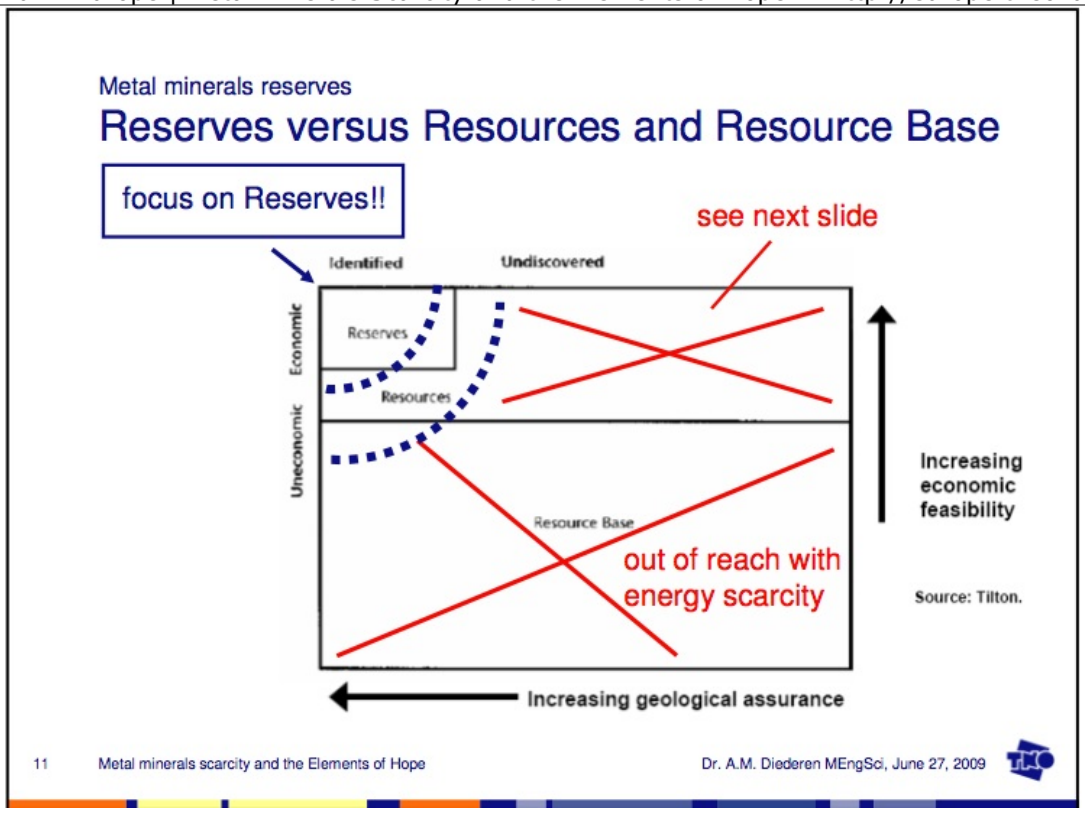
Slide 9

This graph could be valid for all non-abundant metal minerals and it shows that at lower ore grades the amounts of source materials first may tend to go down, not up. This may aggravate metal minerals scarcity.



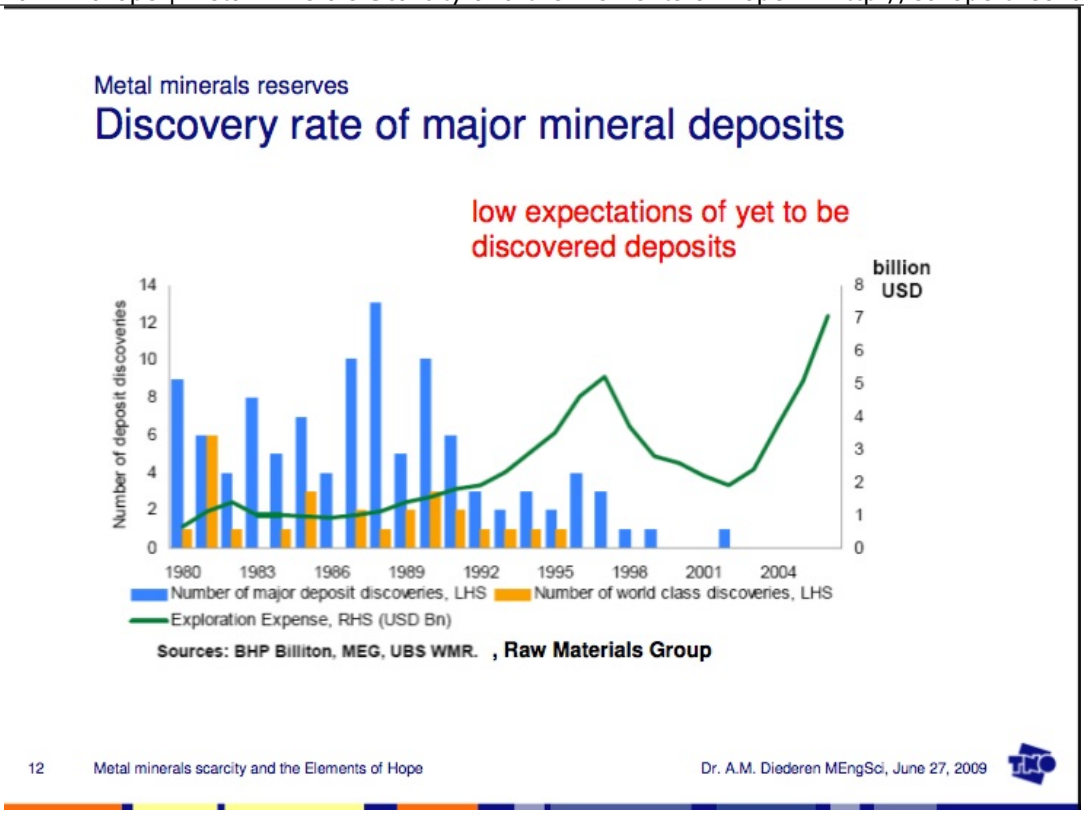
Slide 10

The work of Bardi and Pagani in recent years showed the striking similarities between peak oil and peak minerals.

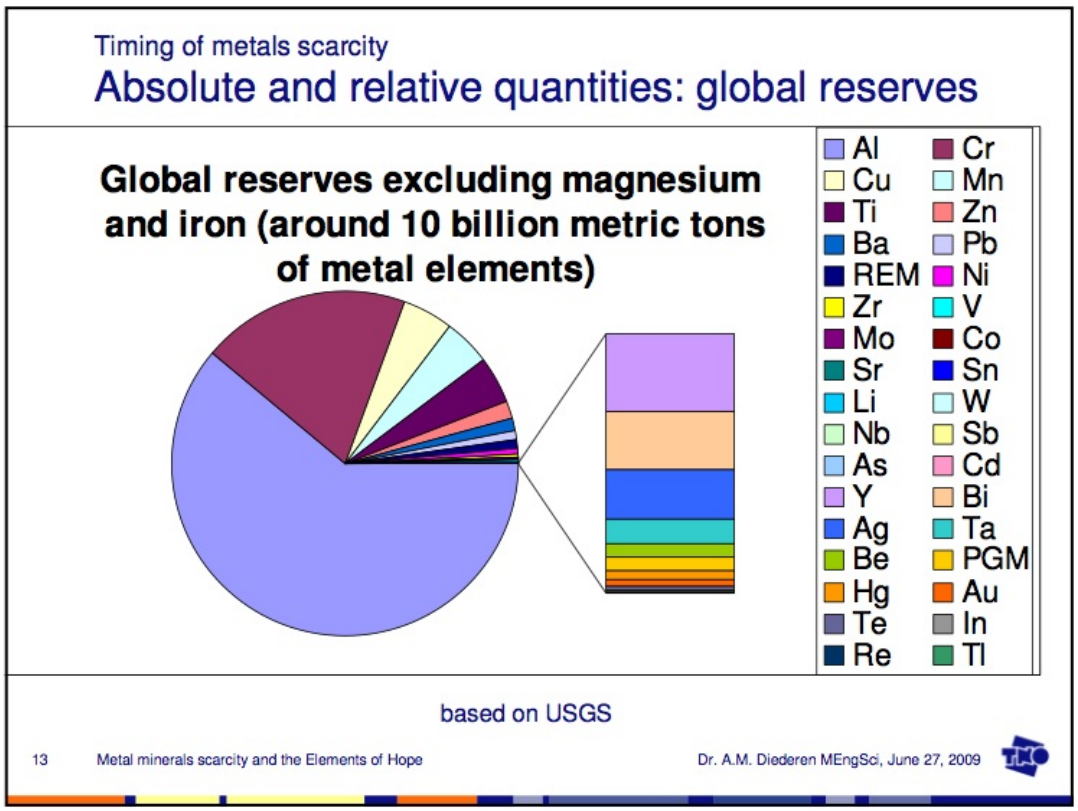


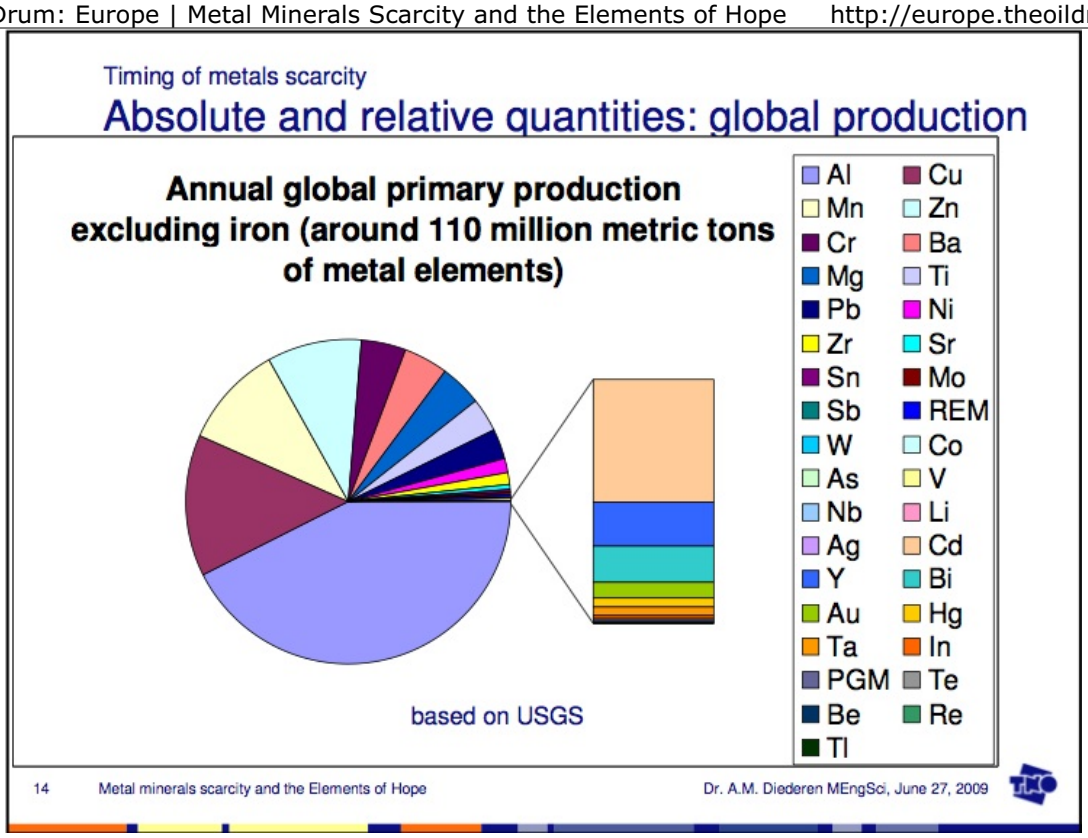
Slide 11
A typical critique on stating that we are running into metals scarcity is the notion that the free market (the laws of demand and supply) will upgrade parts of the resources or the resource base into reserves once reserves start to get tight. This has seemed to be true for decades when there was cheap and abundant energy available. However with energy scarcity, the big lower part of the graph in figure 11 is out of reach (red crossed lines). We should also let go of the notion that vast amounts of rich ore deposits lie waiting somewhere to be discovered (red crossed lines), see slide 12.

In short: it looks quite rational to focus on reserves instead of the huge amounts of resources and the vast resource base. Of course there are many cases to be made to argue that the boundaries of the reserves may be stretched in favour of larger quantities; however there are as many cases to be made to argue that with an energy crisis not even the currently stated reserves remain within our reach to be exploited (blue dotted lines).

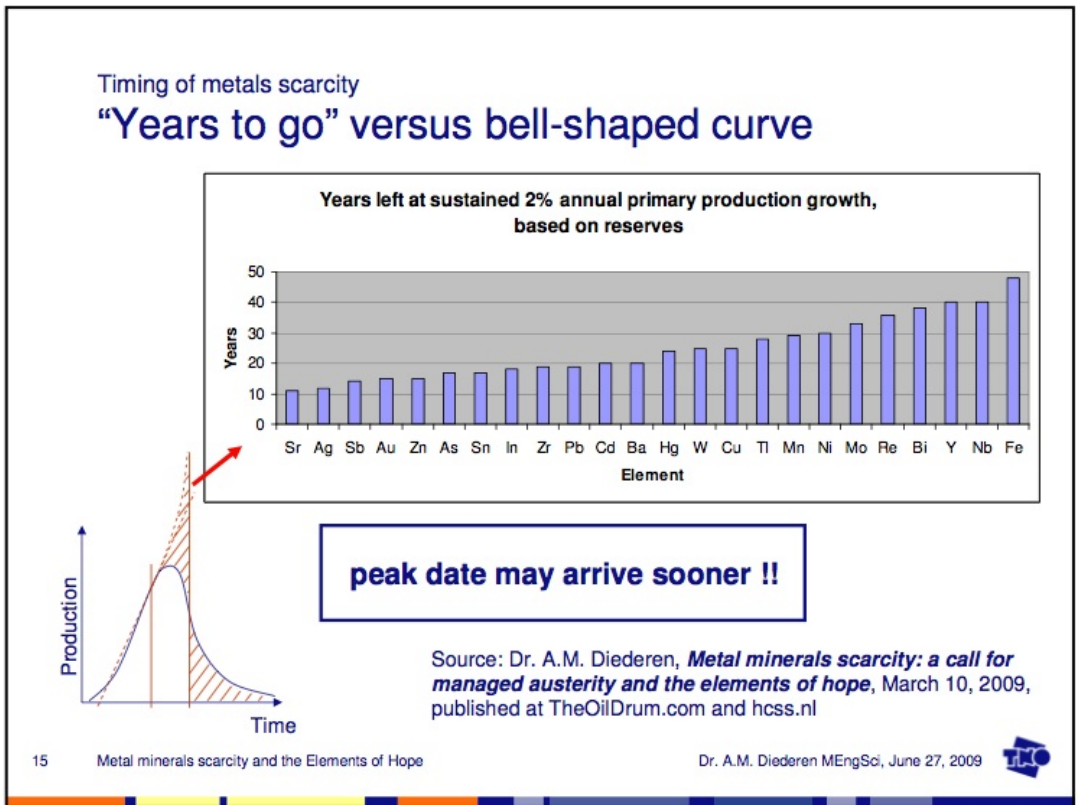


Slide 12
In analogy with oil scarcity: it's highly unlikely that we will find another "Saudi-Arabia" or another "North Sea" of rich mineral deposits.

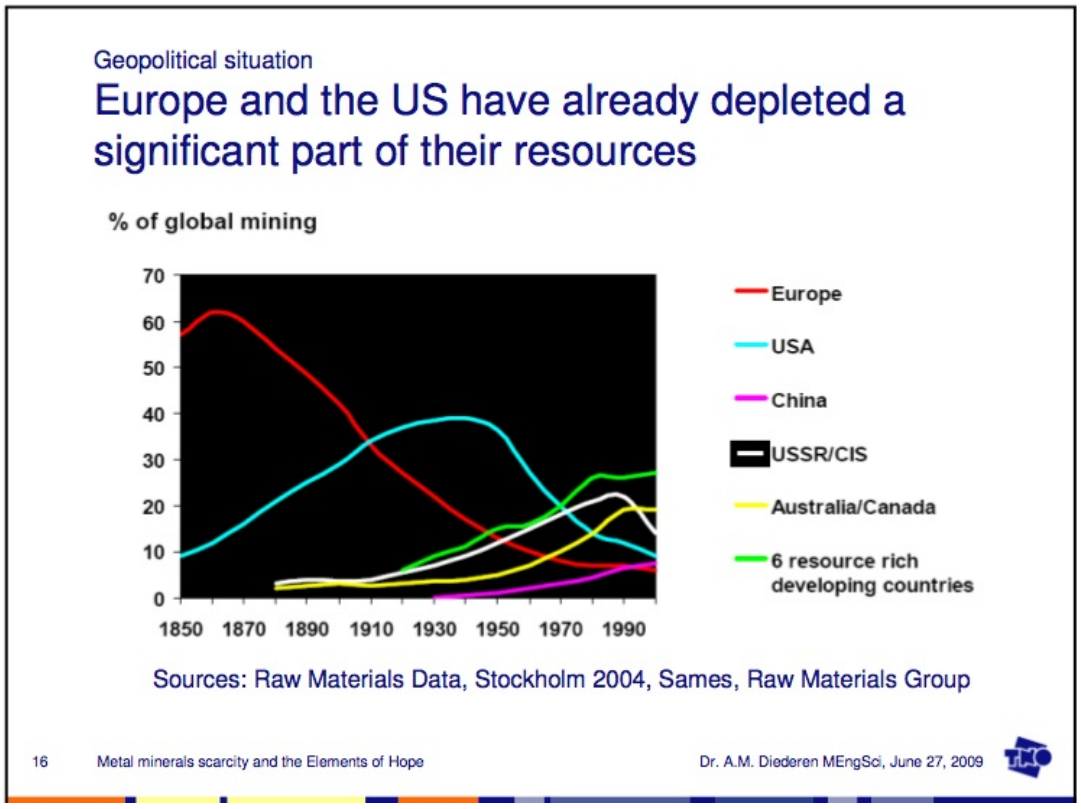




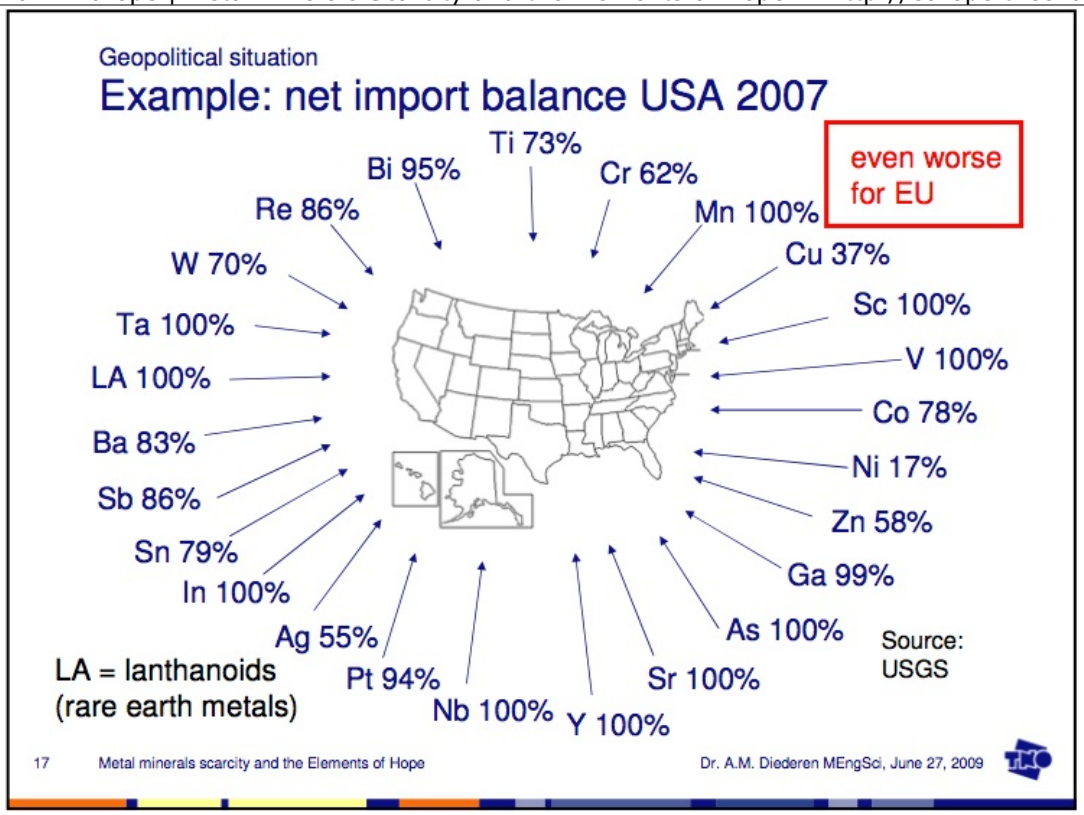
Slides 13+14
Using the only consistent global database (from USGS) on metal mineral reserves and global production rates, one can paint a picture what it actually means if we focus on reserves. All data from USGS are converted (where necessary) into metal element content for consistency, see the paper "Metal minerals scarcity: A call for managed austerity and the elements of hope", published at the website TheOilDrum.com on May 4, 2009 (http://europe.theoildrum.com/node/5239) and at the TNO website on June 24, 2009 (http://www.tno.nl/).



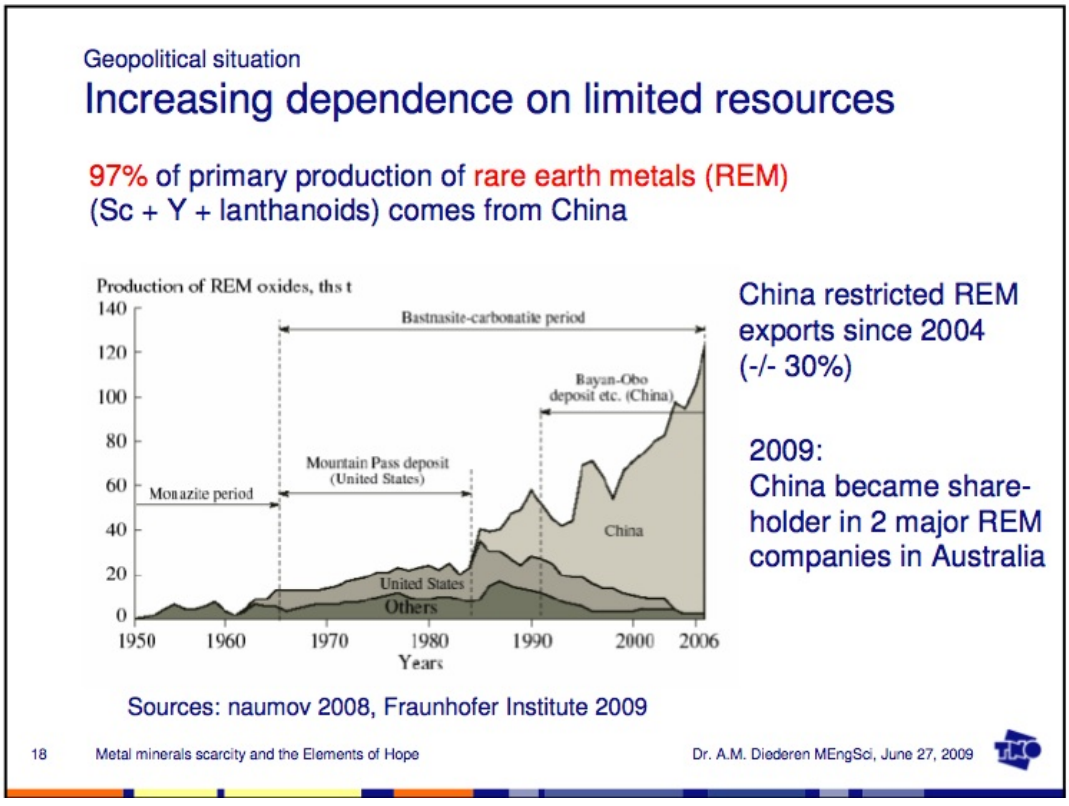
Slide 15
Using a simple calculation, including sustained annual growth of only 2% (the IMF states 3% growth or more is needed for a healthy world economy), the bar chart in slide 15 can be drawn to give a feel for the urgency of metals scarcity. Of course in reality we do not experience a sustained global production growth until year "n" and a subsequent drop to zero production in year "n+1". This is depicted in the graph in the lower left corner of slide 15: a production peak is reached years before the "lifetime" of the bar chart has been reached. Bardi and Pagani recently have published data on several metals which indeed already peaked.



Slide 16
To make things even worse, as with oil and gas, global (or average) metals scarcity will be preceded by spot shortages due to the non-linear distribution and depletion of metal mineral resources across the globe. The industrial revolution started in Europe and later the US became an industrial giant, so it comes as no big surprise that both Europe and the US have depleted a large part of their mineral resources.

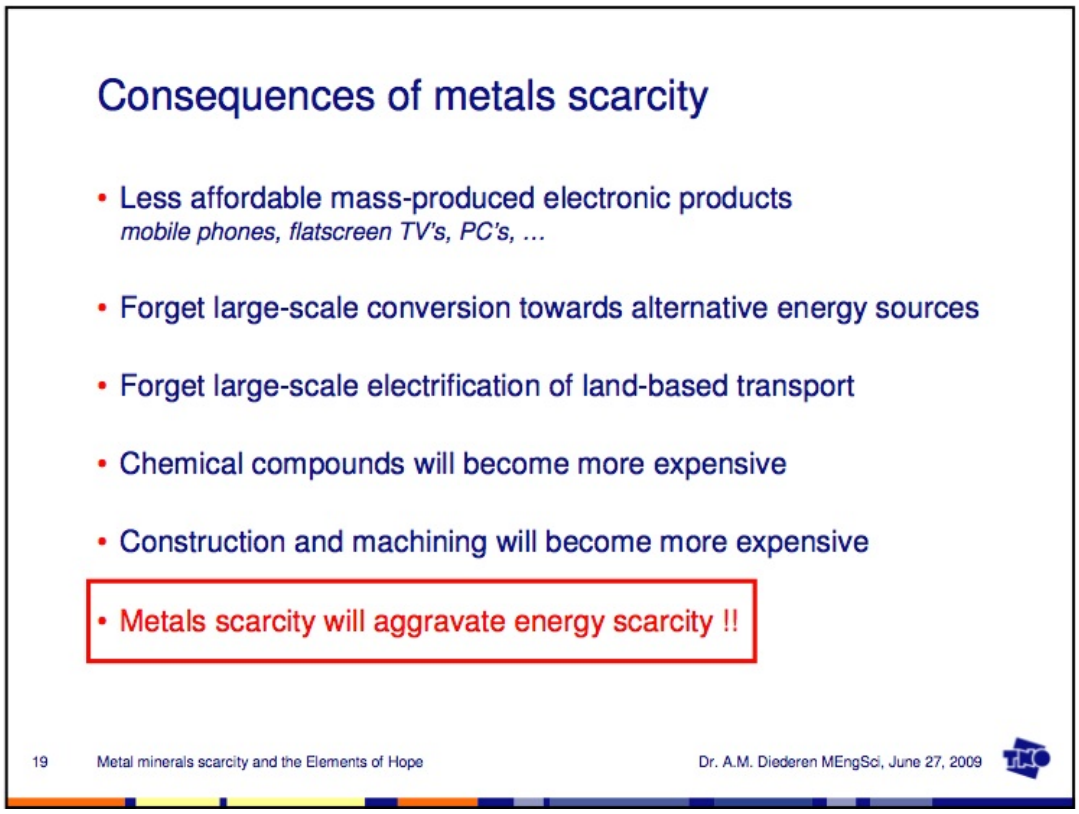


Slide 17
The United States, although still an important primary producer of metals, is strongly dependent on imports of various strategic metals, often 100%. The situation for the European Union is even worse than the picture of slide 17.



Slide 18
Many important metals are produced for a large part in only one or a few countries. A striking

example are the so-called rare earth metals (REM) for which China dominates world production. REM are required for various kinds of high-efficiency applications in technologies which are needed to make a transition towards a more sustainable economy, away from our dependence on fossil fuels. An example is neodymium, required for high-efficiency permanent-magnets needed for generators (wind mills) or motors (electric vehicles).



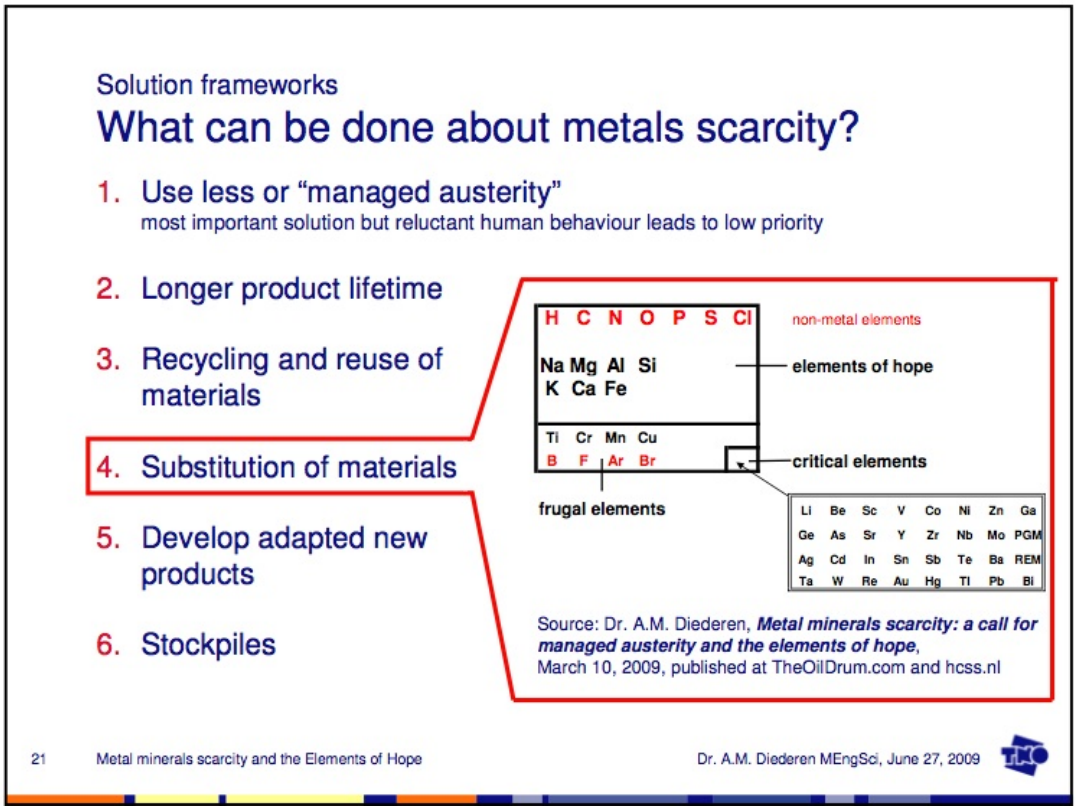
Slide 19

The consequences of metals scarcity will be serious. Not only various established sectors like machining and the chemical industries will be affected. Especially the promising "new" sectors will be hit hard. For example there are no satisfactory substitutes available yet for essential and already scarce metals for efficient and mass-produced solar cells, permanent-magnet drives/generators (wind mills, hybrid cars, electric cars), catalysts, fuel cells, batteries and various electronic devices (telecommunication, displays/ touch screens/ plasma screens, micro-electronics).

Without a shift from scarce to less scarce metals, a large-scale transition towards a more sustainable economy doesn't stand a chance. Moreover metals scarcity aggravates energy scarcity because the energy sector is one of the largest metals consumers. This applies to the whole chain from exploration, production, storage and distribution up to conversion into the desired forms of energy.

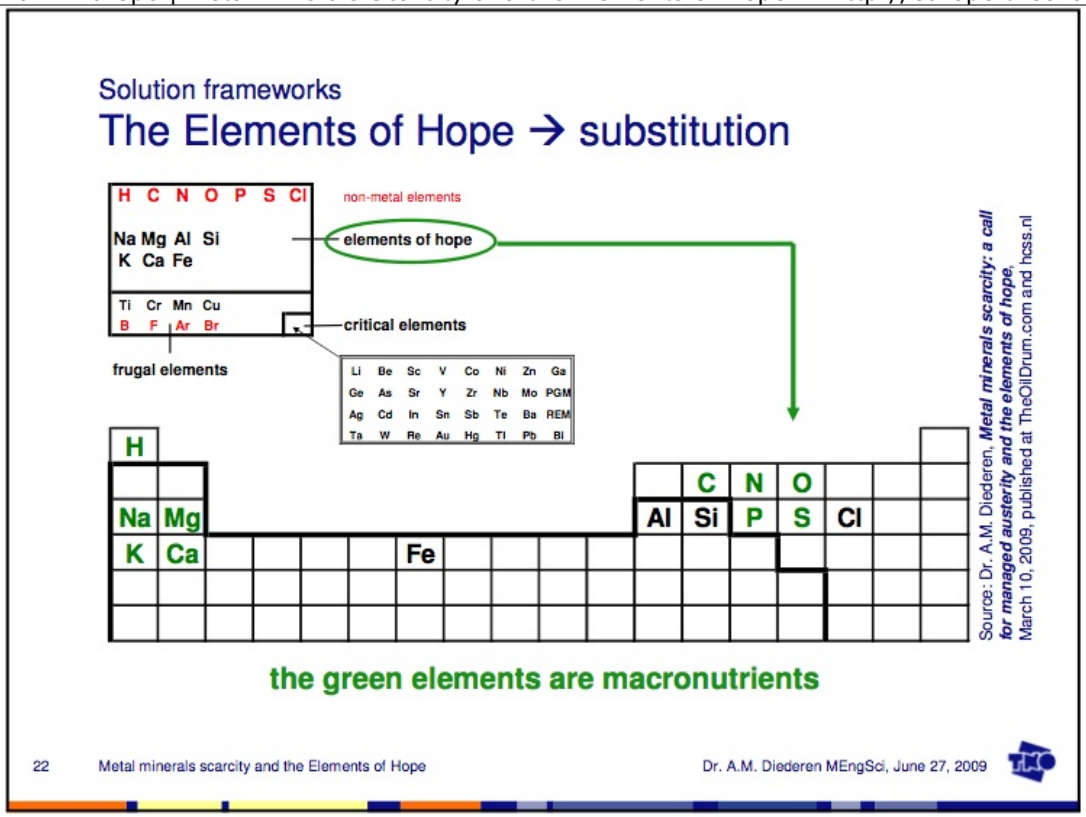
Slide 20
There are six solution frameworks to diminish our dependence on scarce metals: using less, longer product lifetime, more intensive recycling, substitution with less scarce metals, a new product design philosophy and adapted inventory management.

Realization of these solution frameworks challenges people's ingenuity and creativity and offers meaning and purpose. "Using less" requires nothing less than some form of managed austerity. Also technology can play an important role by enabling dematerialization (like film rolls which have been replaced by digital photos). A number of solution frameworks are facilitated by reducing complexity in order to enhance quality and diminish waste.

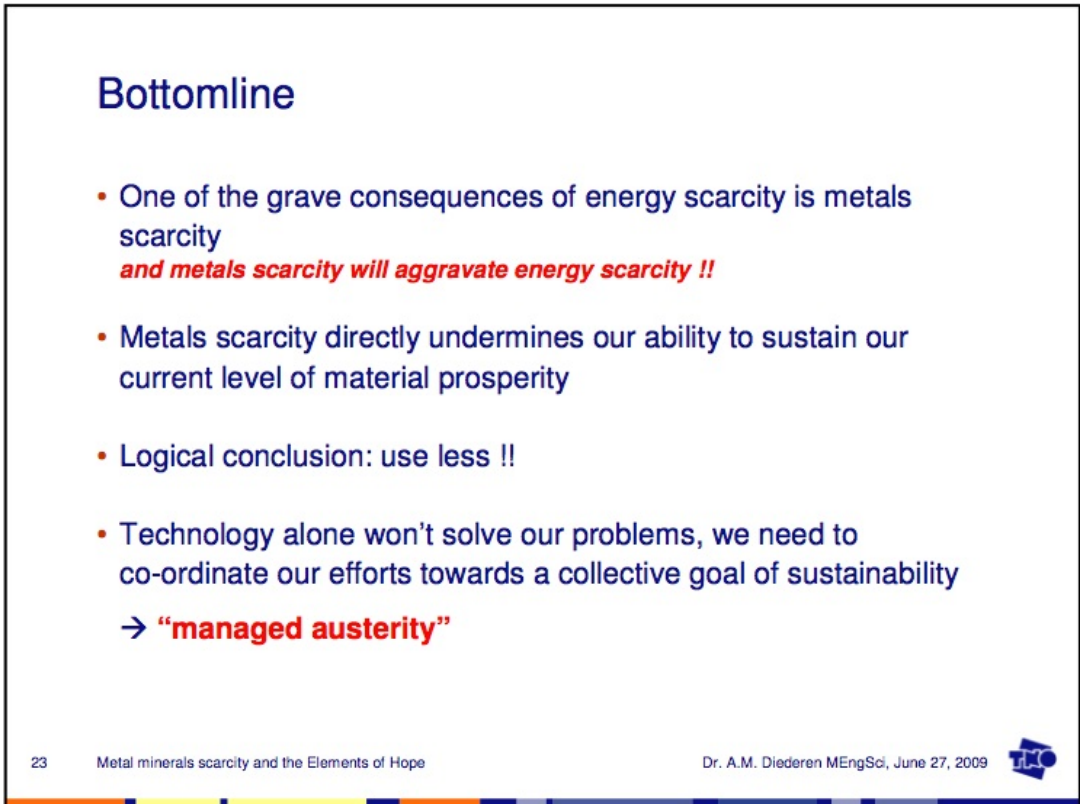


Slide 21

A particularly powerful solution framework is the substitution of scarce metal elements by the most abundant elements, the so-called Elements of Hope. This requires engineering sciences as well as disciplines like agriculture and biosciences. The scarcest metal elements are called the critical elements and these should be saved for essential applications where substitution with less scarce elements is not possible. The frugal elements are much less scarce, albeit scarcer than the Elements of Hope, and should be used predominantly for those applications for which there is not yet a substitute with current technology (example: chromium for stainless steel).

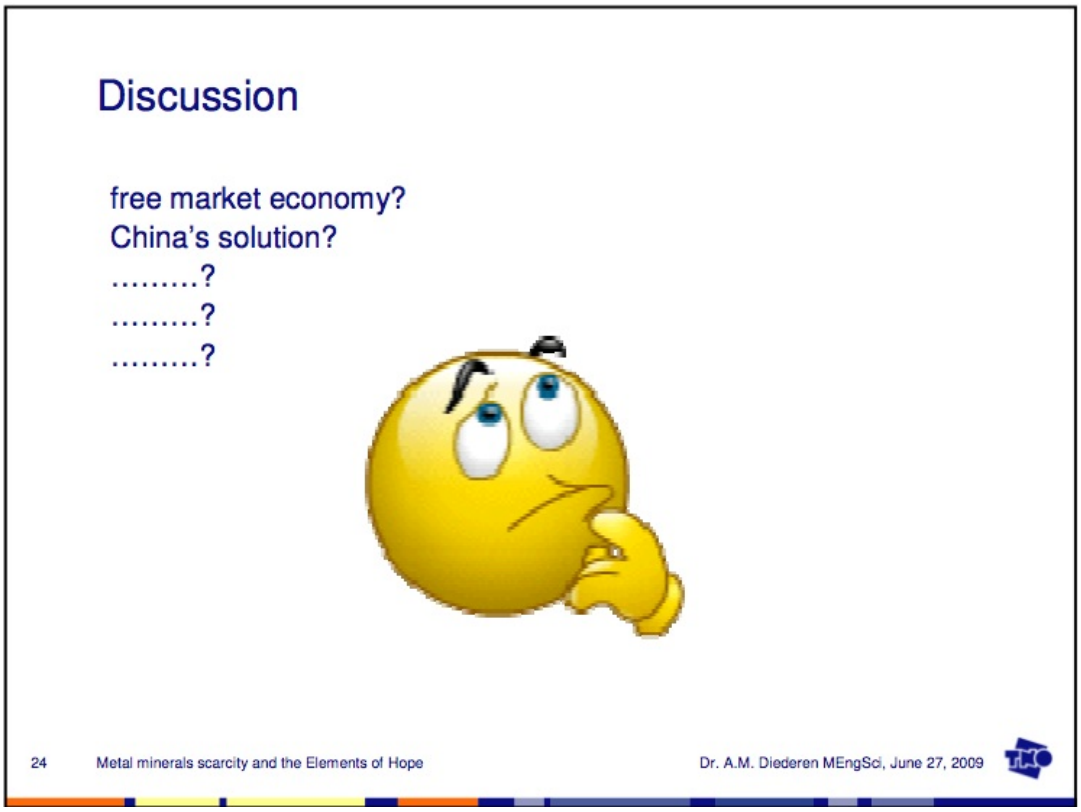


Slide 22
The Elements of Hope are potentially inherently environmentally friendly and sustainable as they contain all macronutrients of life and lack any heavy metal.



Slide 23
If policy does not change, the ongoing growth in global consumption of metals will cause shortages, aggravate energy scarcity and obstruct the transition towards a sustainable economy.

Technology alone is not going to save us. A holistic approach to the vast underlying problem of exponential growth and overconsumption requires involvement of various disciplines. “Using less” requires nothing less than some form of managed austerity and involves disciplines like psychology, philosophy, law, finance, economics, system dynamics and politics. Nate Hagens has explained during the discussion after this presentation that we need to understand and implement all that we know about human behaviour for any solution to stand a chance of becoming viable (see the recent excellent work by Nate Hagens).



Slide 24
The free market alone cannot solve these problems. Some form of government intervention for the sake of collective interest is required. How does a country like China approach these problems? Can we learn something from them?