

High Tech Applications of Industrial Minerals

*Dr. Michelle Wyart-Remy,
IMA-Europe Secretary-General*

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Industrial Minerals? defined by its uses



Definitions¹

Metallic ore: mineral, from which a metal can be extracted economically.

Industrial mineral: mineral, which may be used in an industrial process directly due to its chemical/physical properties. Industrial minerals are used in a range of industrial applications including the manufacture of steel, chemicals, glass, fertilisers and fillers in pharmaceuticals and cosmetics, ceramics, plastics, paint, paper, and the treatment of gases and waste, etc. Industrial minerals include barites, bentonite, borates, clays, diatomite, feldspar, fluorspar, gypsum, limestone, silica sand, talc, and many others.

(1) **Critical Raw Materials for the EU**, Report of the Ad-hoc Working Group on defining critical raw materials,

Version of 30 July 2010 - http://ec.europa.eu/enterprise/policies/rawmaterials/documents/index_en.htm

The Industrial Minerals Industry in the EU

represented by IMA-Europe

Ground/Precipitated Calcium Carbonate & Dolomite (CCA-Europe)
Bentonite (EUBA); Borate (EBA); Diatomite (IDPA)
Feldspar (EUROFEL); Kaolin & Plastic Clays (KPC-Europe)
Lime (EuLA); Silica (EUROSIL); Talc (EUROTALC)
Andalusite, Mica, Sepiolite & Vermiculite (ESMA)

28 European Countries

**i.e. 23 EU Member States + Croatia,
Norway, Switzerland, Turkey and Ukraine**

500 companies (685 mines & quarries, 750 plants)

42.500 employees

180 million tpa, EUR 10 billion¹

(1) Reference year: 2007





Industrial Minerals

“Your world is made of them”

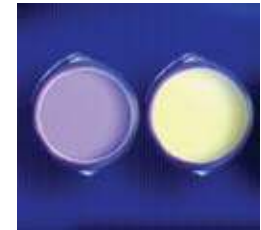


GLASS contains up to **100%** minerals

silica, dolomite, calcium carbonate, lime, feldspar, borate

50% of **PAINT** is made of minerals

calcium carbonates, quartz, cristobalite, plastic clay, talc, bentonite, diatomite, mica



A CAR contains up to **100-150 kg** of minerals in

rubber (talc, calcium carbonate, baryte), plastics (talc, calcium carbonate, kaolin, silica, wollastonite), glass, casting (bentonite, silica, wollastonite)



Up to 50% of a sheet of **PAPER** is made from minerals

calcium carbonate, talc, kaolin, bentonite

CERAMICS contain up to **100%** minerals

feldspar, clay & kaolin, lime, talc, silica



For one tonne of STEEL several minerals are

needed: bentonite, lime, olivine, silica sand

A family HOUSE contains up to **150 tonnes** of minerals

Cement (clay, calcium carbonate, silica sand), plaster & plasterboard (gypsum hydrated lime, calcium carbonate), insulation, ceramics, bricks & tiles, glass, paint, etc.



High Tech applications depending upon *high grade* Industrial Minerals



Oxygen Gas Sensor



Diesel Particle Filter



Catalysts supports

High added value ceramics (e.g. gas sensors, fuel cell plates, diesel particle filters, and catalyst supports) are only made possible because of the high level of process and purity that the Industrial Minerals industry is capable to bestow on high value raw materials

High Tech products depending upon Industrial Minerals development



Thinner PE Films

A very tightly controlled particle size distribution allows for thinner mineral filled plastics films. Therefore of lower weight, they contribute to saving resources and cutting transportation costs and therefore CO₂



Electronics



LCD TV

Tens or hundreds of computer processors and circuits are carved on each silicon wafers, through an optical process during which they are held in place in vessels of very highest purity silica. High purity silica is also required for the TFT glass screens (together with carbonates, lime, feldspar and borates).



ESA's FOC

Space Technology

The Hubble Space Telescope's primary mirror with aberration is made from a synthetic Ultra Low Expansion (ULE) glass ceramic material, composed of 92.5% SiO₂ / 7.5 % TiO₂. The Faint Object Camera (FOC) contains more than 60 individual Silica Glass based optical elements including transmission filters, lenses, mirrors and polarizers.

Minerals offer environmentally friendly options

Water treatment & filtration

Bentonite, carbonates, lime, silica



Geosynthetic Clay Liner

Bentonite



Gas treatment

Carbonates, Lime



H₂O borohydride fueled vehicle

Boron



Energy saver Tyres

Talc, quartz



Agriculture & Forestry

Borates, Carbonate, Lime, Talc



Self-cleaning Glass

Crystalline silica



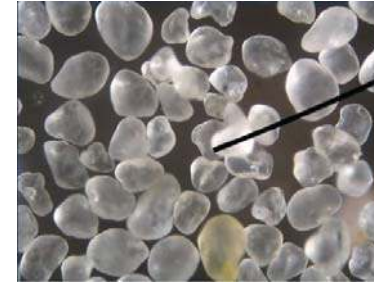
Minerals offer environmentally friendly options



Grease barriers in Pizza Boxes

In a food packaging a mineral-based coating which reduces wax consumption by 30% will improve the packaging carbon footprint

Carbon neutral buildings will require new mineral-based materials e.g. better insulation materials and bricks, and smart coatings



Frac Sand

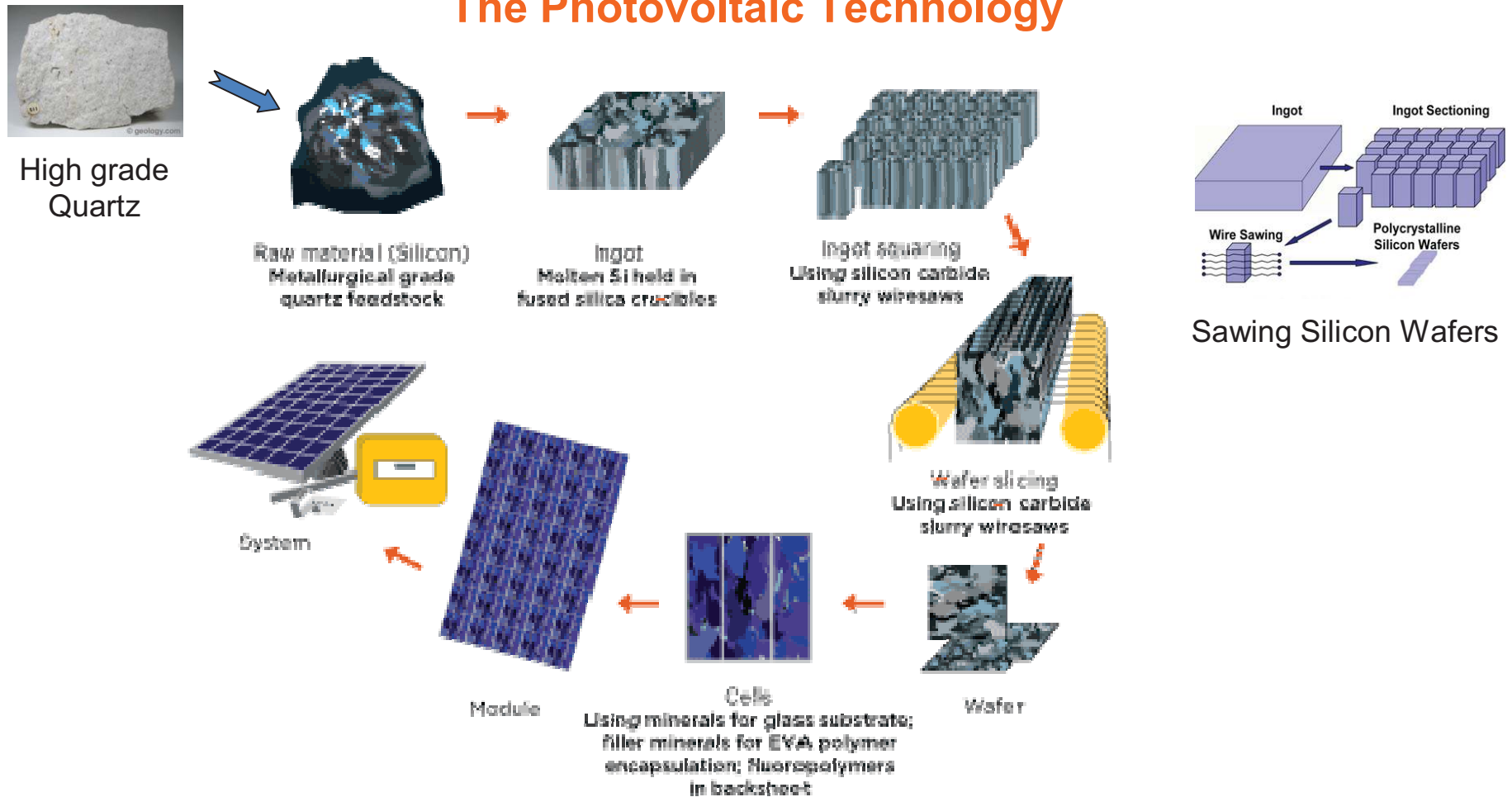
If a sand proppant can help get more gas or oil out of a fractured well, it means a global improvement for the oil or gas extraction footprint



Masdar City to be raised by 2013

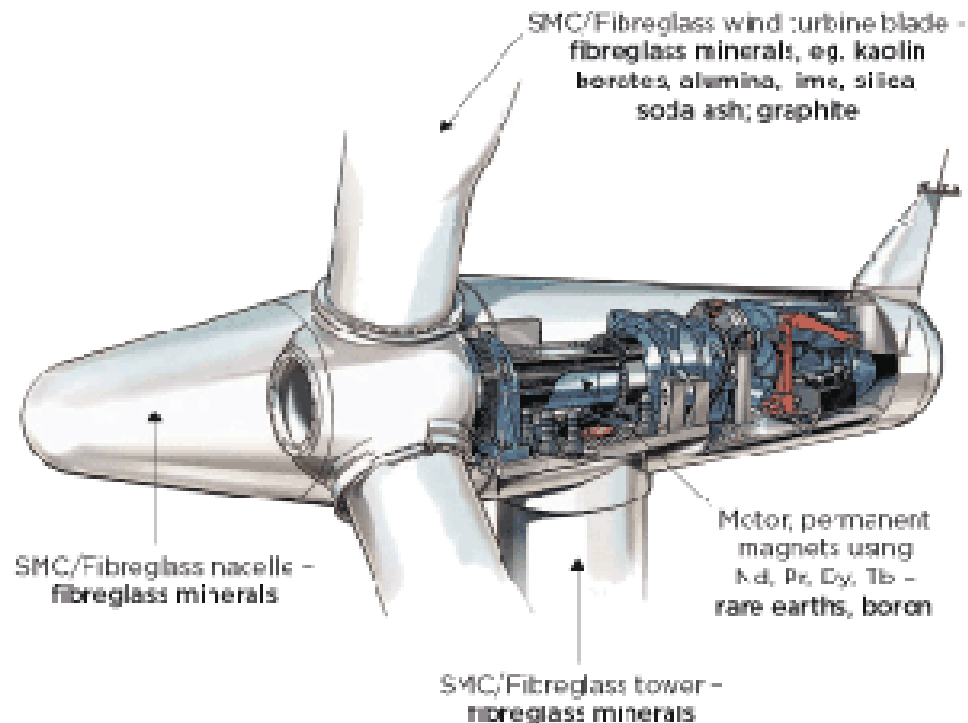
New generation of alternative power sources needs Industrial Minerals

The Photovoltaic Technology



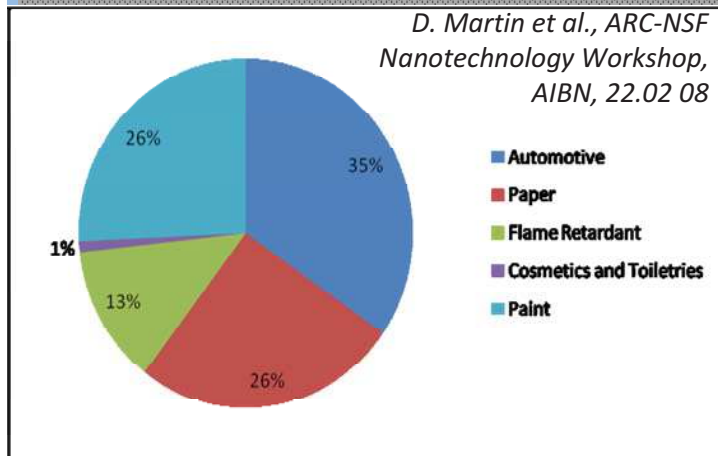
Photovoltaic solar cells require high purity silicon, as well as carefully calibrated grains of silicon carbide to saw the wafers

The Windmill



Wind turbines require fibreglass minerals, filler minerals and minerals for casting, boron, graphite and rare earths

Nanotechnology paves the way for new challenges and opportunities



Nanominerals end up in a wide range of products, eg memory chips, flame-resistant cables, sunscreens and other cosmetics and pharmaceuticals, but also self-cleaning surfaces and lighter automotive parts.

Mineral nanocomposites improve polymer materials mechanical properties, durability and stability. They may work as superior adsorbents and catalysts for organics removal and colour species removal in water.

Nanosilica is produced for semi-conductor wafers, optical fibres, and solar batteries, while nano-precipitated calcium carbonate is used in applications including sealants for the underbodies of cars, and for mastics, inks, rubber parts such as door seals.

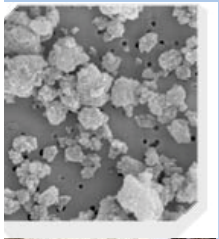
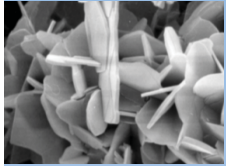
“If nano-research continues at this pace then the next few years should see an increased demand for non-metallic industrial minerals. The difficulty might not be making these minerals popular, but maintaining supply to meet demand”.

Matthew Brace, Sydney

Nanotechnology paves the way for new challenges and opportunities

- Bentonite has several important physical and chemical properties which make it important in a wide range of markets.
- A potential new value added growth market for bentonite is nanoclays.
- A nanoclay can be chemically modified to make the clay complexes compatible with organic polymers.
- Reinforcement with nanoclay improves the mechanical properties, gas barrier performance in packaging materials. Also heat distortion temperature is a limiting factor for polymers in many products.





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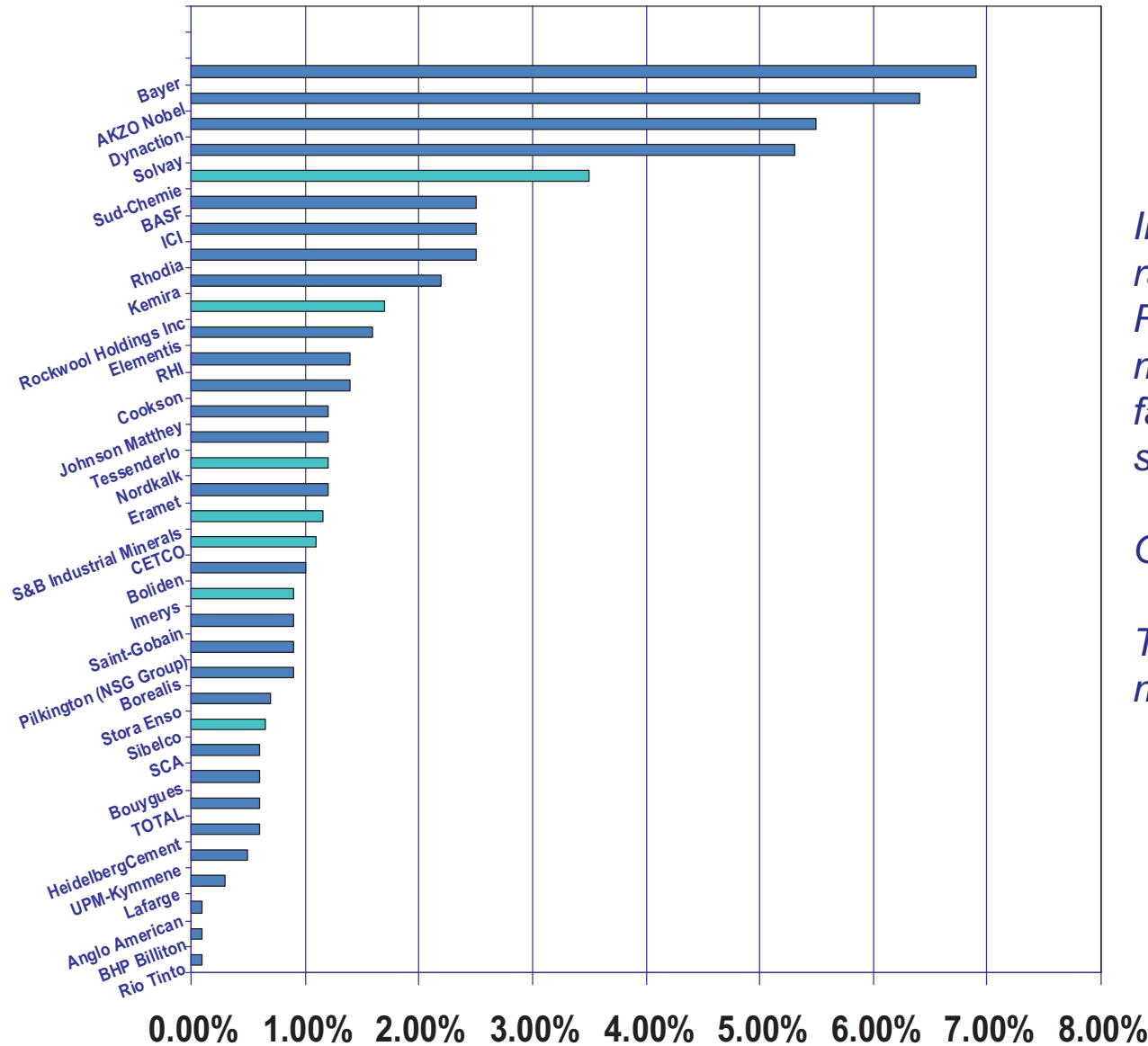
- Synthetic hectorite, saponite, mica and stevensite are all high performance synthetic minerals which are supplied commercially. Synthetic hectorite has been manufactured and supplied commercially for over 40 years.
- Benefits of synthetic minerals are:
 - Purity and consistency in composition
 - Ease of dispersion
 - Ability to modify or tailor their performance properties
 - Manufactured from sustainable raw materials

Synthetic Hectorite - Applications



- Provides pseudoplastic rheology in water based formulations
- Gives suspension of pigments and structure to Architectural coatings
- Controls metallic flake orientation in water based automotive coatings.
- Provides a strong “ribbon” structure while retaining excellent mouth feel with flavour release in toothpaste
- Provides a “non-sticky” skin feel in cosmetics and skin creams
- Used to provide anti-static coatings in the manufacture of polymer films used in thermal imaging which are not sensitive to humidity
- For use in composite materials to give clear, flexible and heat resistant films with oxygen and water barrier properties.

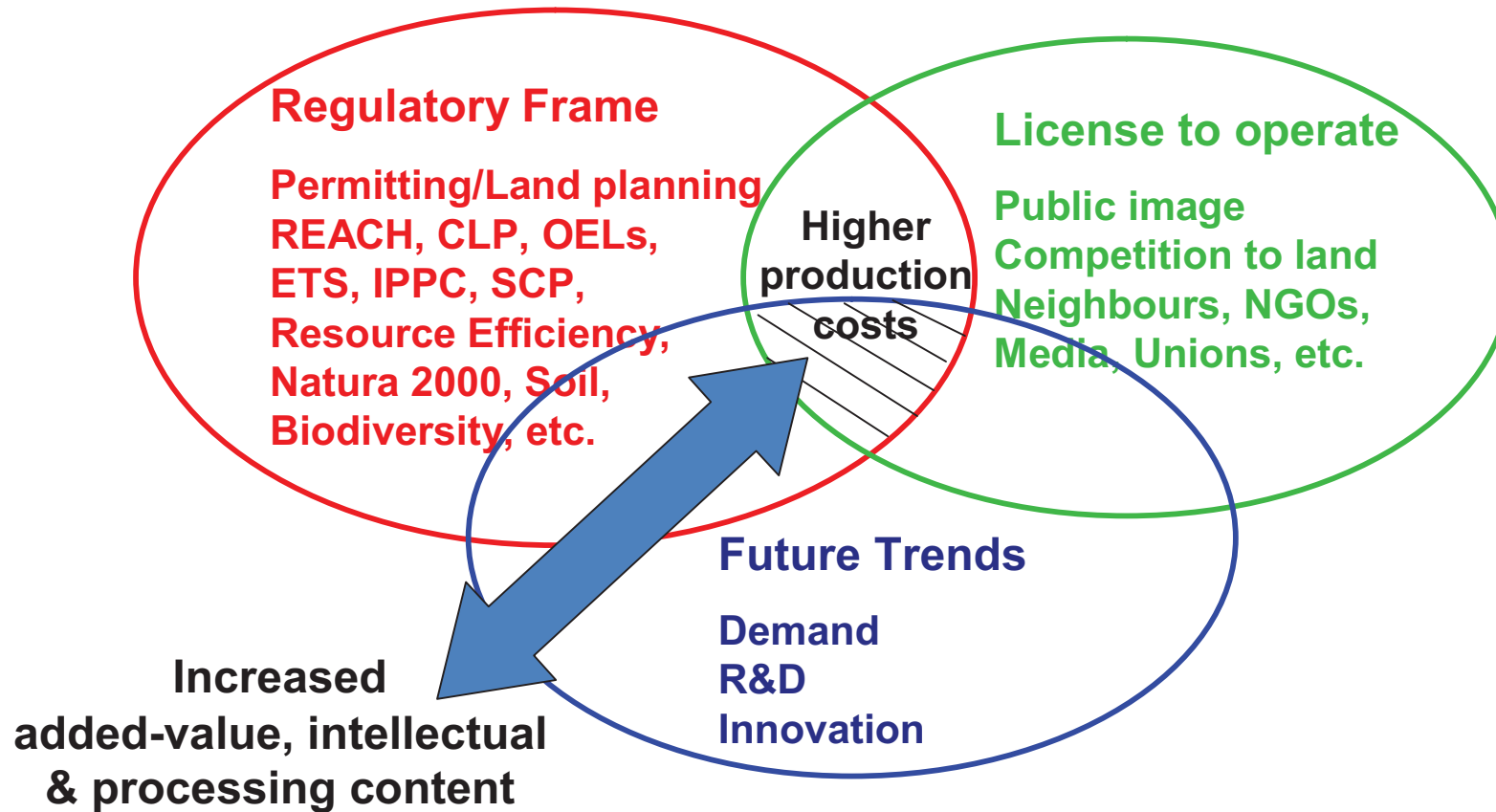
An evolving R&D and innovation policy



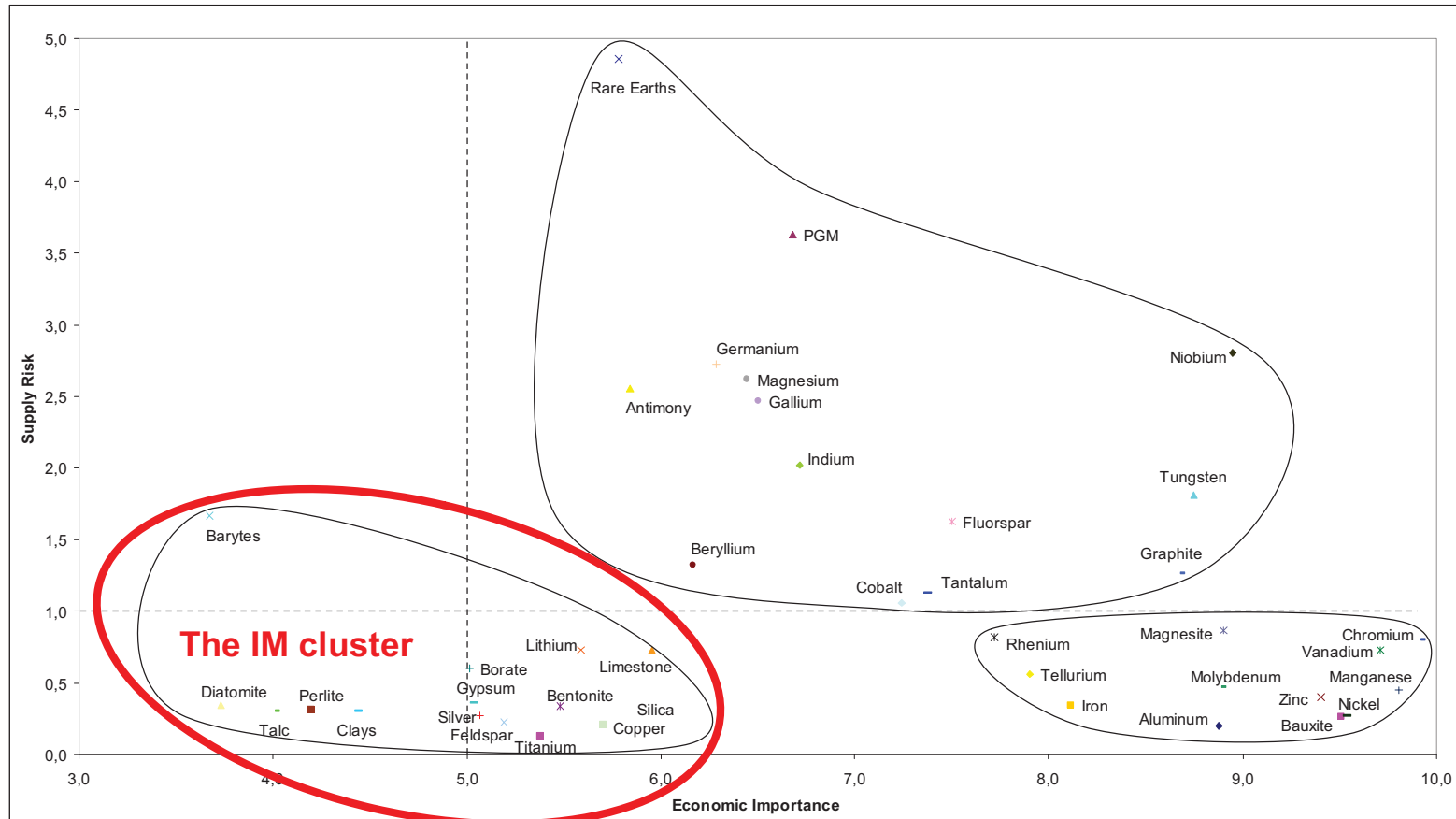
Industrial Minerals companies rank well when comparing their R&D expenditure/sales to other mining companies, but are still far below compared to the specialty chemicals industry.

Opportunities however are there

The demand for high grade minerals may increase



Industrial Minerals are not critical



“For several of the materials positioned in the sub-cluster in the lower left corner, notably the industrial minerals, the group considers that possible supply risks may occur within a longer time horizon should 'competition to land' continue to adversely affect production from quarries or mines in the EU.”

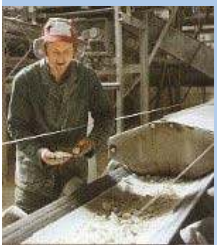


A few methodological limitations

- 10-year is not the horizon allowing to secure mineral reserve
- Access constraints to EU domestic resources were not taken into account
- Some minerals with no or minor production in the EU were not assessed
- **High purity grades cannot be distinguished from ordinary grades**
- **Market trends, consumption and future demand were not assessed**

...Require further improvement

Towards a Raw Materials Policy



- Favouring R&D and Innovation
- Attracting & preserving competent skills
- Building on EU industry experience and know-how
- Inspired by the better regulation initiative
- Reconciling EU competitiveness and a high level of consumer, workers and environment protection
- **Mining companies in the EU able to evolve into *Materials Science* companies**



*Thank you for
your attention!*

Dr Michelle Wyart-Remy
IMA - Europe, Brussels

Tel: +322 210 44 10
secretariat@ima-europe.eu
<http://www.ima-europe.eu>