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Breakthrough technologies to secure the supply of critical minerals and metals in the EU economy

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Purpose

This exercise was part of an EU FP7 Blue Skies Project aimed at piloting, developing and testing in real situations a foresight methodology designed to bring together key stakeholders for the purpose of exploring longer term challenges and building a shared vision that could guide the development of the relevant European research agenda. This approach was applied to the theme of "Breakthrough technologies for the security of supply of critical minerals and metals in the EU economy".

The Minerals Challenge

Minerals and metals are essential to almost every aspect of modern life and every economic sector. Aerospace, agriculture, culture, defence, energy, environmental protection, health, housing, transport and water supply are all highly dependent upon them. Plans for economic recovery and the development of new industries also depend on their availability – for example "green" energy production from solar cells and wind turbines, the green car of tomorrow and many more all require a range of rare minerals and metals for their production.

Although essential to our economies, development of this sector has been neglected in Western Europe during the past 25 years. This was mainly because of the very low price of these commodities – a consequence of abundant reserves discovered in the 1970s. As a result, the mining and metallurgical industry as well as related research and education almost disappeared from the present European Union, making our economies totally dependent upon imports.

Raw Material	Emerging Technologies
Antimony	Antimony Tin Oxide, flame retardant, micro capacitors
Cobalt	Li-ion batteries, synthetic fuels
Gallium	Thin layer photovoltaics, IC, WLED
Germanium	Fibre optic cable, IR optical technology
Indium	Displays, thin layer photovoltaics
Platinum	Fuel cells, catalysts
Palladium	Catalysts, seawater desalination
Niobium	Micro capacitors, ferroalloys, high speed low alloy steel
Neodymium	Permanent magnets, laser technology
Tantalum	Micro capacitors, medical technology

The EFP is financed by the European Commission DG Research. It is part of a series of initiatives intended to provide a 'Knowledge Sharing Platform' for policy makers in the European Union. More information on the EFP and on the Knowledge Sharing Platform is provided at www.foresight-platform.eu

Demand for these minerals and metals is likely to increase dramatically. Much of this new demand will come from rapidly growing, highly populated emerging countries, such as China, which have attracted large parts of the world industrial production due to cheap labour, regardless of raw minerals and energy issues. Already strong competition for access to natural resources, including mineral resources vital to any economy, is likely to accelerate further in the coming years with possible severe environmental and social impacts. The EU economy is more than any other exposed to these developments, as it produces very little of the minerals it consumes and almost none of the critical minerals it needs to develop its green technologies.

Against this background, the creation of a new research and innovation context in Europe has become essential, not only to reduce the EU's dependence on imported minerals and metals but also to chart the road ahead, to develop a win-win cooperation with developing countries and to stimulate the competitiveness of EU technology, products and service providers to the global economy.

However, these solutions can take a long time to be implemented, and it is important to identify today's priorities for knowledge generation and innovation so that action can begin. This in turn creates a need for a foresight approach that brings together the knowledge and interests of the main stakeholders. It is in this context that the FarHorizon project invited leading experts in the area from government agencies, industry and academia to take part in a success scenario workshop. The aims of the exercise were

- to identify the key challenges for raw materials supply in Europe;
- to identify breakthrough technologies or other innovations that could transform the picture, including substitution, new sources, ways to change demand and new applications; and
- to define in broad terms the research and innovation strategies needed to develop and make use of such technologies.

Success Scenario Approach

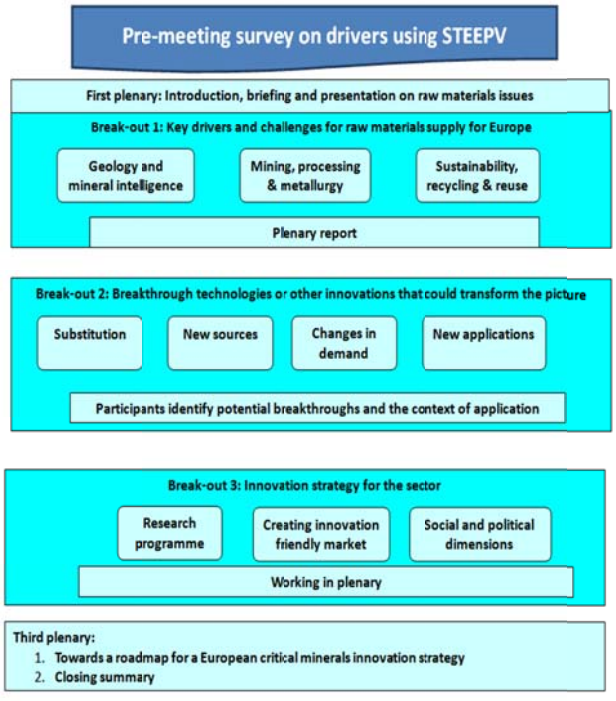
The "Success Scenario Approach" is an action-based approach where senior stakeholders develop a shared vision of what success in the area would look like, together with appropriate goals and indicators, which provide the starting point for developing a roadmap to get there. The purpose of having such a vision of success is to set a 'stretch target' for all the stakeholders. The discussion and debate forming an integral part of the process leads to developing a mutual understanding and a common platform of knowledge that helps to align the actors for action.

Important outcomes of these workshops are the insights they provide in terms of the level of maturity in policy design and development and the viability and robustness of long-term policy scenarios to guide policy-making. The workshops also provide indications on whether there is a need for further discussion to refine thinking and policy design and/or to bring additional stakeholders into the discussion.

The theme was developed in partnership with the French geosciences institution BRGM. The workshop brought together twenty representatives of scientific organisations, industry and government agencies to identify the role of technology in addressing the socio-economic and political challenges facing Europe in this sector. Briefs on key issues were prepared before the workshop, and participants took part in an exercise to identify key drivers using the STEEPV framework (social, technological, environmental, economic, political and values). Common themes were increasing demand and growing sustainability requirements. Geopolitical themes were also touched upon.

The basic structure was to identify the key challenges facing the sector and then to explore the potential role of breakthrough technologies in addressing those challenges. A third main session examined the key elements needed for a sectoral strategy for innovation.

The figure below gives an outline of the methodology:



Challenges in Three Dimensions

Informed by the drivers, participants were tasked to identify the key challenges for raw materials supply in Europe and to prioritise these. If these challenges can be met, we can expect to achieve a situation as defined by the successful vision for the sector in 2030 and realise its benefits to Europe. Three dimensions of the challenge were addressed:

Geology and Minerals Intelligence

1. Access to data on mining, production and geology
2. Knowledge of deeper resources
3. Better knowledge due to improved models of how deposits are produced
4. Better exploration
5. Systematic data sharing
6. Exploitation of 'exhausted' mines

Mining, Ore Processing and Metallurgy

1. Exploiting deeper deposits
2. Accessing seabed deposits
3. Better health and safety; prediction of seismic events and natural or man-made hazards
4. Using less water and energy
5. Reducing CO_2 footprint
6. By-product handling
7. Social and business organisation

Sustainable Use, Efficiency, Recycling and Re-use

1. Downstream resource efficiency
2. Better citizens' understanding/attitude
3. Building capabilities and providing training
4. Transforming waste into mines/urban mining
5. More systemic view of different critical minerals
6. Better use of other resources, e.g. water and energy
7. Global governance of new extractive activities

Against these challenges, breakthroughs were sought in four areas: new applications, substitution, new sources of materials and rare metals, and changes in demand.

Four Key Actions toward a Comprehensive Policy for Securing Raw Materials Supply

Policy recommendations geared toward securing the supply of raw materials in Europe were summarised in terms of four necessary key actions:

Key Action 1: Establish an integrated strategy for raw materials supply and support it by providing continuous funding.

Research in the area of raw materials supply needs to be clearly linked to creating the right conditions for successful innovation. There is some concern that the European Commission has no competence in minerals as such but rather in matters of environmental protection, trade or economic competitiveness. This limits the development of a holistic, complementary approach needed to tackle the various issues related to securing Europe's mineral resources supply within the sustainable development context. The sector needs a more horizontal approach – otherwise we may do research, but there is no innovation behind it. An innovation-friendly market can be created by developing stringent environmental and recycling regulations. Europe is at the forefront of a number of technologies in these areas. Regulators need to understand that part of their job is to stimulate innovation if not for today at least for tomorrow. Engaging them in foresight, along with technologists and users, is important for developing this horizon. There is a 7-8 year challenge to develop a new lead market.

Key Action 2: Move from stop and go to a lasting approach with three central aspects for a research, technology and innovation programme.

Support up to now has been project-based and provided only to a limited extent on a stop and go basis while continuous policies and knowledge development would be necessary.

2.1 There are three broad research priorities:

- Research dealing with mineral resources intelligence. This is research of a totally different kind, i.e. mainly interdisciplinary. It is needed to keep up with a dynamic situation where even what minerals and metals are critical changes over time.
- Research leading to new or better technologies with a focus upon whatever is needed by industry. The large scale South Korean national initiatives provide a good example of speed, scale and pragmatism and also represent the competition that Europe has to face. The US investment on rare earths in the Ames laboratory is another example.
- Research on mitigation and understanding of environmental impacts.

2.2 Adopt a holistic approach to the innovation cycle. Support for research should be long-term and structured so that most publicly funded research is open and shared internationally. The full range of mechanisms is needed: basic R&D, integrated projects or their equivalent and joint technology initiatives. However, 80% of the effort should be in large applied projects and the rest focused on longer term work. Partnership with the US, Japan and possibly South Korea could be meaningful in a number of areas.

2.3 Adopt a joint programming approach. Currently there is little or no coordination between European-level and national research. Some governments are in a position to take the initiative in this area – notably Germany, the United Kingdom, France, Finland and Poland.

Key Action 3: Increase the flow of trained people.

A supply of trained people is a significant constraint. The lack of investment in research and teaching in this area over the past 20 years has depleted the availability of expertise to undertake the necessary research and teaching. Training initiatives are needed and within the European framework a pool of excellence should be developed – a platform that coordinates the supply and demand for education and training in the area with some elements being in competition and some complementary. There is also a need to attract interest from researchers outside the area; many of those doing research in this field have a background in the minerals sector, but breakthroughs may be more likely to come from people currently working in other fields.

Key Action 4: Governance issues are critical.

Securing raw materials is a task that goes beyond the competence and capability of the individual member states and is inherently European. Even current European initiatives in other fields are dependent on action in this sector – rare metals are behind all the EU's proposed Innovation Partnerships. Collaboration beyond Europe is also necessary, but a collective voice for Europe is more likely to be heard in the international arena. There are also opportunities to exert a positive influence to halt environmentally damaging or politically dangerous approaches in other parts of the world, notably in Africa and parts of the CIS. The momentum from the current EU Raw Materials Initiative, aiming to foster and secure supplies and to promote resource efficiency and recycling, needs to be carried forward into the EU's Eighth Framework Programme, its innovation policies and also its wider policies including those concerning interaction with the African, Caribbean and Pacific States.

Sources and References

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