European Technology Platform

on

Sustainable Mineral Resources

Implementation Plan

Version December 2007

The Implementation Plan of the European Technology Platform for Sustainable Mineral Resources (ETP SMR) has been compiled and approved by the High Level Group of the ETP SMR.

Members of the High Level Group of the European Technology Platform for Sustainable Mineral Resources

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- BHP Billiton
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- K + S AG
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- Deutsche Steinkohle AG
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Geological surveys:

- BRGM (France)
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- EneRG, the European Network for Research in Geo-energy
- EURACOAL, the European Association for Coal and Lignite (23 members)
- EuroGeoSurveys, the Association of the European Geological Surveys (29 members)
- EUROGIF, the European Oil and Gas Innovation Forum (15 members)
- Euromines, the European Association of Mining Industries
- EUROROC, the European and International Federation of Natural Stones Industries
- IMA-Europe, the European Industrial Minerals Association (300 members)
- MINFO, the Swedish Mineral Processing Research Organisation (14 members)

Associations (continued):

- MIRO, Mineral Industry Research Organisation (32 members)
- MITU, the Swedish Mineral Industry Research Organization (4 members)
- Polish Non Ferrous Metal Platform
- UEPG, the European Union Association of Aggregate Producers (19 national Federations of producers)

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Foreword

Welcome to the Implementation Plan (IP) of the European Technology Platform on Sustainable Mineral Resources (ETP SMR)!

The Implementation Plan is the second "big" document after our Strategic Research Agenda (SRA). It is to show our intention and the way and conditions on how to reach our goal to modernise and reshape one of the fundamental pillars of the European economy and society: the European extracting and processing sector of energy and non-energy minerals.

Implementing research activities always means planning for the future with a certain degree of uncertainty. Research is in itself unpredictable which means that no particular result can be planned. Especially breakthrough technologies needed to achieve what we have in mind may probably not work as predicted.

The only thing we can do from today's point of view is to plan our short and medium term activities as reliable as possible. This does not guarantee success but will give a relatively high probability to obtain the intended results.

This IP explains how the research priorities that were identified in the SRA can be implemented. For each research theme it describes in detail the issues that need to be addressed to realise its respective potential. It also illustrates activities required by ETP SMR, its stakeholders and other parties to facilitate this process. While the SRA focused on topics and themes, the IP focuses on activities and actions.

The time horizon of the IP is obviously shorter than that of the SRA as it is focusing on the most pressing short and medium-term issues. However, the ETP SMR will monitor the progress of the particular research activities and its results and update both the SRA and the IP from time to time whenever necessary and appropriate considering achievements made and new topics that need to be included.

The ETP SMR will continue to unite a wide variety of stakeholders around its vision. It is an open and transparent grouping of stakeholders: new stakeholders interested in all field of minerals engineering and processing can join at any time.

As chairman of the ETP SMR High Level Group I can say that we all are committed to continuing the highly valuable work during the implementation phase of the research agenda. The ETP SMR partners have already agreed on supporting ETP SMR beyond 2007. In this context we highly appreciate the recent political developments concerning the sustainable raw material supply and the recognition of the demand for a European raw materials policy.

However, the further evolution into the future of the ETP SMR is also very much up to its stakeholders so please get involved and help to shape the future of European minerals research.

Henryk Karas
Chairman High Level Group of ETP-SMR
President KGHM Cuprum R&D, Poland

Executive Summary

The European minerals industry, comprising producers and users of industrial minerals and metals, aggregates and ornamental or dimensional stone, oil, gas and derivates as well as coal and by-products, provides vital inputs to Europe's economy and social well-being. Because of their great diversity, minerals and their derived products are necessary for almost every aspect of life. Housing and construction, transport, energy supply, health, information and communication technologies, space technologies, and other sectors would either be nonexistent or suffer dramatically without constant mineral supplies to the EU economy. The EU minerals industry is also a significant exporter of both world-class expertise and technologies and of manufactured goods.

The European Technology Platform on Sustainable Mineral Resources (ETP SMR) unites hundreds stakeholders from industry, the research community, public authorities, the financial community, regulators, consumers and civil society around the major technological challenges to the sector, in order to jointly act towards a common vision. The Platform will contribute to strengthening one of the fundamental pillars of the European economy and society.

The ETP SMR Strategic Research Agenda (SRA) showed the research activities necessary to fulfil its vision and goals. The Implementation Plan (IP) focuses on ways and means to implement the most urgent activities outlined in the SRA. The IP therefore consequently describes how the identified short and medium-term research priorities can be implemented and which conditions are necessary for this paving the way towards meeting the objective of a sustainable raw material supply for Europe.

Minerals are an integral part of our life. Therefore it is clear that the issue of natural resources, secondary materials and waste is crucial for the competitiveness of EU manufacturing industry, and environment and energy policies. And this especially regarding that the demand for raw materials will primarily be driven by emerging market regions (China, India, etc.). However, in 2007 the problem of access to raw materials and sustainable raw material supply was more and more regarded and recognised on political level and addressed in several political documents. The ETP SMR provides a wide range of ideas and actions contributing to solving this problem, which is crucial for the European mineral industries to survive. The ETP SMR Strategic Research Agenda outlined these ideas and actions and this Implementation Plan shows the ways and condition for successful implementation.

This IP explains how the research priorities that were identified in the SRA can be implemented. For each research theme it describes in detail the issues that need to be addressed to realise its respective potential. It also illustrates activities required by ETP SMR, its stakeholders and other parties to facilitate this process. While the SRA focused on topics and themes, the IP focuses on activities and actions.

The IP also includes a general perspective on the necessary framework (such as policy, capacity building, public acceptance) to speed up innovation in the European minerals industries.

The IP shows in particular how the short and medium-term research priorities have to be implemented in order to guarantee keeping track towards the ETP SMR Vision. The ETP SMR decided to start with the implementation planning mainly on short and medium-scale. The research actions necessary on the longer run are to some extent dependent on the results of the short and medium-term activities. Therefore, detailed planning seems not to be possible from today's point of view and with the knowledge present today.

The Implementation Plan defines research priorities that are of major importance for the European minerals industries in terms of competitiveness, market expectations, societal demand and impact or for the sustainability of different industrial sectors. These research priorities are:

- Innovative concepts and processes for new high added value mineral-based products
- Technologies for a sustainable, increased self-sufficiency in resources
- New strategies and technologies for mineral resources transformation
- Reducing the environmental footprint of minerals and metals processing
- Process intensification in metals production

These priorities are already defined in the ETP SMR Strategic Research Agenda. However, the Implementation Plan focuses on the most immediate steps to be taken and their requirements and conditions. For each priority, a set of activities is proposed that need to be followed to enable the goals set forth in the ETP SMR Vision and Strategic Research Agenda to be achieved. These activities might be developed to real projects, however for the time being they only have in most cases the character of project ideas.

Apart from the mentioned priorities a set of concrete project ideas are already under preparation. These short-term activities are mentioned separately and described in more detail.

Finally, the Implementation Plan outlines ideas to create a supportive environment in order to successfully accompany the implementation of the research. The ETP SMR considers innovation to be the entire process that takes new knowledge and converts it into the products and services that will underpin future growth and jobs.

In this context the supportive environment is outlined in terms of identification of general innovation constraints, ways of cooperative efforts to make partnering more productive and possibilities to speed-up innovation in Europe. Further to that networking activities like linkages to downstream industries should be established as well as means to support innovative SMEs. Finally general capacity building activities and the sharing of knowledge in terms of communications, stakeholder dialogue and public engagement are addressed.

Contents

1. Introduction

The European minerals industry provides vital inputs to Europe's economy and social well-being. Because of their great diversity, minerals and their derived products are necessary for almost every aspect of life. Housing and construction, transport, energy supply, health, information and communication technologies, space technologies, and other sectors would either be nonexistent or suffer dramatically without constant mineral supplies to the EU economy.

The EU minerals industry, comprising producers and users of industrial minerals and metals, aggregates and ornamental or dimensional stone, oil, gas and derivates as well as coal and by-products, is also a significant exporter of both world-class expertise and technologies and of manufactured goods.

The European Technology Platform on Sustainable Mineral Resources (ETP SMR) unites hundreds stakeholders from industry, the research community, public authorities, the financial community, regulators, consumers and civil society around the major technological challenges to the sector, in order to jointly act towards a common vision. The Platform will contribute to strengthening one of the fundamental pillars of the European economy and society.

In order to be successful the ETP SMR showed in its first published document, the Strategic Research Agenda, the research activities necessary to fulfil its vision and goals. as well as the way contributing to achieving the goals of the Revised Lisbon Strategy[1] and the intentions of the Gothenburg Strategy on Sustainable Development[2]. The identified needs for Pan-European collaborative research aim at a sustainable supply of mineral resources to the downstream European industries, also taking into account the decoupling of economic growth from adverse environmental impacts.

The sustainable minerals supply for Europe has been emphasises recently at various occasions and documents. During the G8 Summit on 6-8 June 2007 a Declaration was adopted on "Growth and Responsibility in the Global Economy"[3] containing a chapter on "Responsibility for Raw Materials: Transparency and Sustainable Growth", which addresses the key priorities for a sustainable and transparent approach to this question. In addition the Competitiveness Council meeting on 21 May 2007[4] has called the European Commission to develop a coherent political approach to the issues arising.

Further to that the European Commission DG Enterprise and Industry recently launched a staff working paper on the *Analysis of the Competitiveness of the Non-Energy Extractive Industry in the EU*[5]**.** The paper stated that the present situation of the non-energy extractive industry in the EU calls for an integrated approach through which relevant EU policies and instruments work in concert with the aim of ensuring availability of essential raw materials, and sustainability in their extraction and use.

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1 Communication from the Commission, COM(2000) 6

2 Communication from the Commission, COM (2001) 264

3 Available for download here:
http://www.g-8.de/Webs/G8/EN/G8Summit/SummitDocuments/summit-documents.html

4 Press release no 9671/07 of the Council of the European Union, 2801st Council Meeting

5 Commission Staff Working Document no SEC(2007) 771, available for download here:
http://ec.europa.eu/enterprise/steel/index_en.htm

The document further identified the key aspects being: access to sites, access to land, investment and operating costs, the regulatory framework, the availability of a skilled workforce, research and innovation, and health & safety requirements.

The question of availability and use of raw materials was also analysed by the High Level Group (HLG) on Competitiveness, Energy and the Environment established by Commissioner Verheugen. Based on the work of different related working groups the HLG published on 11 June 2007 its 4th report on *Ensuring Future Sustainability and Competitiveness of European Enterprises in a Carbon and Resource Constrained World*[6]. The report delivered policy recommendations on sustainable use of natural resources and called, among other things, for simplifying and streamlining access to domestic raw materials and improving the EU's resources efficiency through the better use of resources embedded in waste. The HLG also called on the EU and Member States to support the development of a raw materials policy.

It seems that the problem of sustainable raw material supply has reached the political level. In consequence, better funding and support mechanisms have to be established in order to provide the more opportunities for problem solving.

Continuing to show the way forward and in line with the mentioned documents and political statements, ETP SMR published now the Implementation Plan as the second document in the series. The Implementation Plan focuses on ways and means to implement the most urgent activities outlined in the Strategic Research Agenda. The Implementation Plan therefore consequently describes how the identified short and medium-term research priorities can be implemented and which conditions are necessary for this paving the way towards meeting the objective of a sustainable raw material supply for Europe.

1.1. The European Minerals Industries in the Global Context

The European minerals industry, as it is represented in the European Technology Platform on Sustainable Mineral Resources, comprises of the non-energy extractive industry[7] and the extractive industry winning raw materials for energy production like oil, gas and coal. Further to these the related mineral processing industries providing the primary and secondary raw materials needed by the downstream manufacturing industries are part of the sector.

The position of the European non-energy extractive sector has recently been assessed in detail by the European Commission DG Enterprise and Industry and published in a staff working document[8]. This document clearly shows the importance of our sector for the whole European economy.

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[6] Available for download here: http://ec.europa.eu/enterprise/environment/hlg/hlg_en.htm

[7] The term „Non-Energy Extractive Industries“ is used by European Commission DG Enterprise and Industry for undertakings engaged in surface or underground extraction of construction, industrial and metallic minerals as well as the subsequent treatment of the extracted material.

[8] Commission Staff Working Document „Analysis of the competitiveness of the non-energy extractive industry in the EU”. DG Enterprise and Industry, SEC (2007) 771, June 2007

Non-energy extractive sector

Metals

About 250 EU companies are engaged in metals extraction, including three major multinationals with capitalisations of over 20 billion € ranking in the top five largest mining corporations in the world.

However, while the EU consumes about 25% to 30% of the world's metal production, EU metal extraction accounts for a mere 3% of world production. A better balance between production and consumption on one hand and security of supplies considerations on the other will, due to the demand within the EU, call for an increase in extraction within the EU.

Metals are traded on the international market which means that European producers are in direct competition with many lower cost producers. In order to maintain European EHS standards and remain competitive, European producers have to continuously cut costs through modernisation and innovation. If the mining, metals and minerals sector were not to remain in Europe the research competences as well as downstream industry will relocate, too, leaving Europe totally deprived of further possibilities of action. Economic, social and – at the end - environmental consequences would be dramatic.

At the same time the European metals industry has been one of the major technology providers in smelting technology around the world, aluminium and copper are just two examples. This technology know-how needs to be continuously developed further to maintain this European asset that provides considerable exports.

Industrial Mineral

The European industrial minerals sector is present in all of the EU Member States. Mainly composed of SMEs, it also includes the world's leading international production companies. It offers direct employment to some 100,000 people. With some 810 mines and quarries and 830 plants, Europe is a major producer of some industrial minerals, for example, feldspar, gypsum, magnesite, bentonite and kaolin, for which over a quarter of global production was recorded within the EU27 and candidate countries. The industrial minerals sector produces an annual volume of some 145 million tonnes, contributing a value of around 13 billion € to Europe's Gross Domestic Product (GDP). If downstream industries such as glass, foundries, ceramics, paper, paint, plastic, etc. are included, these figures are several orders of magnitude greater. In contrast to aggregates, the geological distribution of specific industrial minerals is more localised. This means there is much international trade in these minerals. Despite significant production of some minerals, the available data suggests that the EU is a net importer of all industrial minerals, even those for which the EU is a major global producer.

Construction minerals

The importance of construction minerals has increased significantly over the years. The European Aggregates Industry is the main supplier of materials to all types of infrastructure works within the European Union. Construction of roads, railways, airfields, buildings, sewage systems and other civil engineering works depend on large

amounts of locally and regionally extracted and processed aggregates. More than 3 billion tonnes of sand, gravel and crushed stone (with a value of more than 35 billions €) are produced annually to meet the demands of the European building and construction industries. Annual per capita mineral consumption varies within wide margins depending on the development status of the member states. It can be as high as 15 tonnes per capita per year in some Member States.

Ornamental Stone

Ornamental Stone often referred to as Dimension Stone is the most visible part in our daily life. Stone buildings, flooring, high rises with granite facades up to tombstones show the daily presence of stone. Around 60,000 small and medium sized businesses in the EU work with ornamental stone in all aspects. The work force of more than 500,000 people engaged in and around ornamental stone is impressive and highly specialised. The total turnover reaches the amount of 24 billon €.

With regard to the new member states, the non-energy extractive industry as a whole directly provides 1 million jobs and approximately 4 millions jobs in downstream industries.

Energy minerals sector

Energy is the major enabler for EU sustainable development. According to the International Energy Agency Outlook 2004[9], worldwide energy consumption will increase by almost 60% by 2030. Fossil energies, which represent today 88% of the worldwide energy consumption, will remain at the same global level in 2030.

Coal

Coal is a major energy source for the enlarged EU. Behind China and the US Europe is the world's third largest coal consumer. Together with other energies it forms a secure and well-balanced partnership for the EU's power generating structure and its role has clearly increased with the enlargement. Coking coal is essential for steel production in the blast furnace. Dramatic price increases and shortage in coking coal in 2004 / 2005 have drastically proven the dependence of the European steel industry from overseas imports. Present coal production and imports totals about 370 million tonnes, lignite production amounted to some 550 million tonnes.

Altogether some 32 % of the power generated in EU27 is based on coal and lignite. But this is not coal's only field of application as also the steel and base material industries are highly dependent on coal. The coal mining industries safeguard more than 350,000 direct jobs in the EU. The production value of generating power from coal in the enlarged EU amounts to almost 30 billion €. The production facilities of the coal power generating industries are capital-intensive operations that promise huge investments in the employment sector. The labour market therefore has an enormous significance as a value added factor that extends far beyond the actual mining regions. Coal-industry suppliers are mainly medium-sized companies.

[9] International Energy Agency; World Energy Outlook 2004, 550 pages, ISBN 92-64-10817-3 (2004)

Oil and gas

Oil and gas are forecasted to represent about 60% of the EU energy consumption in 2030. In 2000, 1.9 million people were estimated to be directly and indirectly working for the oil and gas industry in the EU/EEA, of which 200,000 in exploration and production, 750,000 in services and supply, and 950,000 in refining & marketing.

Annual investment in Europe by oil and gas producing companies is estimated to be some 25 billion €, directly benefiting many EU/EEA suppliers and contractors. The export value of oil and gas related supplies and services is more than 10 billion € annually. The oil and gas service and supply industry has a worldwide turnover of 115 billion $ (50 billion $ in Europe, and annually invests 2 billion $ in research and development at European level, while 6 billion $ are being invested worldwide).

Total oil production in Europe amounted to more than 300 million tonnes in 2002, which represents a share of more than 40% of the total oil consumption, while total gas production amounted to more than 200 million tonnes in 2002, which is equivalent to a share of more than 60% of the total European gas consumption. However, production in the North Sea is declining or expected to decline (UK, Netherlands, Denmark) over the next 10 years, or to be maintained at current level (gas in Norway). Production in other European areas is either also expected to decline or not expected to rise considerably.

Value-added products made from crude oil or natural gas are important for the chemical industry and keep civilisation rolling along.

1.2. The Future Demand for Primary and Secondary Raw Materials in Europe

Globalisation is radically reshaping economies; Russia, China, India, other Asian regions and South America are playing an increasing role in determining raw material supply and demand, and will continue to do so in the future. The growing global economy is putting significant strain on the availability of materials. Cost, security and diversity of feedstock supplies of, both raw and secondary materials, for the EU manufacturing industries are main questions in this context. At the same time, the current patterns of production and use of natural resources lead to significant environmental challenges. Globally, decoupling between economic growth and materials and energy consumption has not been achieved. The picture looks more favourable within Europe, where relative domestic resource consumption has gone down; however this is complemented by increased imports limiting the overall improvement in the EU ecological footprint. As such, efficiency is a central aspect in resource policy. All these factors make clear that the issue of natural resources, secondary materials and waste is crucial for the competitiveness of EU industry, and environment and energy policies.

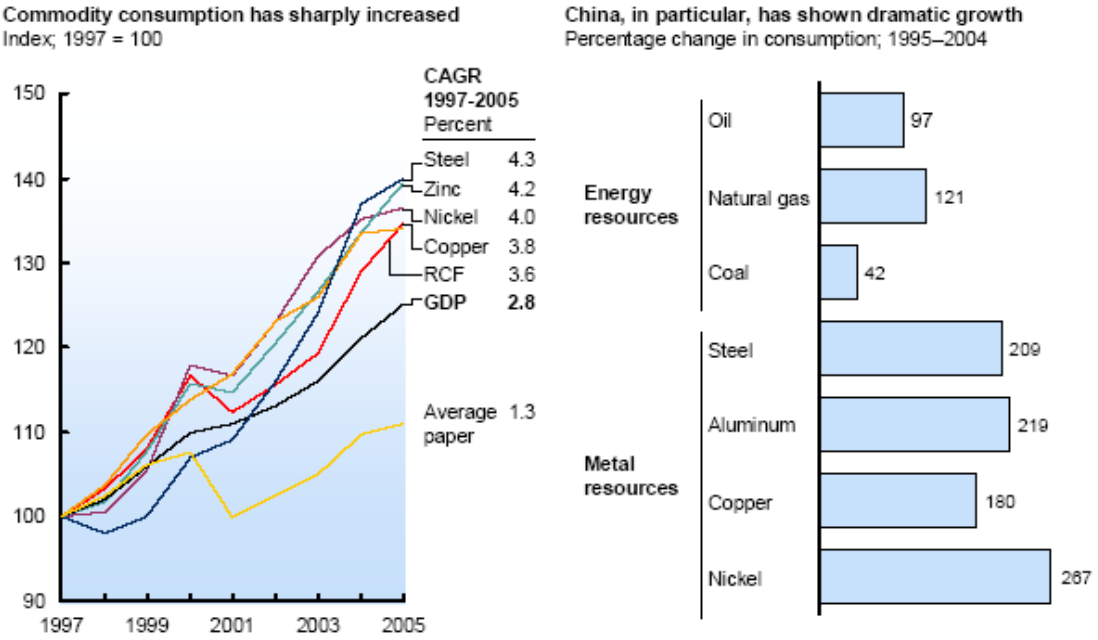
Minerals are an integral part of our life. A few examples may illustrate this:

- A car contains up to 100-150 kg of minerals in rubber (talc, calcium carbonate), plastics (talc, calcium carbonate, kaolin, wollastonite), glass, casting (bentonite, silica, wollastonite), and up to more than a tonne of metals.

- 50% of paint is made of minerals (calcium carbonate, sand, plastic clay, talc, bentonite, diatomite, mica).
- Ceramics contain up to 100% minerals (feldspar, clay & kaolin, talc, sand).
- A family house contains up to 400 tonnes of minerals (aggregates, cement, clay, calcium carbonate, gypsum, plaster & plasterboard, gypsum), glass, paint, ceramics, tiles, and depending on design many tonnes of metals.
- Glass contains up to 100% minerals (silica, feldspar, borate).
- 1 km of motorway requires 30,000 tonnes of minerals (aggregates, cement).
- The base material of computer chips and integrated circuits used in a wide range of technical application is silica.

All these examples show that modern life without minerals would not be possible. They also reflect the important issue that the demand for minerals is largely driven by downstream industries. The importance of the minerals industry is therefore much greater than its direct contribution to the national and European economies. The level of production of minerals within the EU is therefore also likely to depend on the competitive success of key manufacturing sectors in the EU and, for construction minerals in particular, the cyclic behaviour of the economy in different Member States.

Over the last 20 years raw material prices have increased enormously. The main driver of the price increases has been the enormous increase in global demand. Over the last five years, the increase in raw material prices has been especially strong, even partial shortages occurred (see figure 1, left side).



Source: BP statistical review; IEA; IISI; WBMS; RISI; Global Insight

Figure 1: Development of commodity prices and increase of consumption in China

The reason for the price increases and partial shortages lies in the significant changes in the commodity markets over the last years. The commodity markets exhibit high long-term demand, longer-term scarcity of supply, a changed supply structure and increasingly trade-distorting policies.

Although the markets for different minerals vary significantly, one thing seems to be generally valid. Demand for raw materials will continue to be strong across commodities, primarily driven by emerging market regions. On the demand side, the economic boom in China, being one of the fastest growing economies in the world, explains about a third of the worldwide increase in the demand for raw materials. China's metal commodities imports for example have multiplied by a factor of 4 to 10 over the past decade. In the same period, the related consumption more than doubled (see figure 1, right side). Crude oil is also affected, influencing not only energy prices, but also resulting in increased prices for chemicals and plastics.

Considering the stable, high growth rates in demand described above, supply over the last years could not keep pace, in particular in the area of metals, but also oil. This is compounded by the fact that during the past years, capacities were not increased as required. Since 2003, new raw materials deposits have been developed. However, the development of new deposits is time intensive and it will take some time until market supply will increase noticeably.

The situation is made more difficult by the fact that there are currently trends in particular in the growth markets to promote own imports of raw materials by means of trade-distorting state policies, and to hamper exports of raw materials.

In China there are quotas in place on the export of bauxite as well as of tin and taxes between 10 and 15 percent on the export of copper of various forms affect trades. The country has also an export quota with respect to wolfram.

The situation with respect to metal scraps is similar: Because of the substitutability of primary metal raw materials through secondary raw materials, prices of secondary raw materials have developed similarly. And secondary raw materials also have increasingly become the object of trade distortions over the last years: China imposes a 10 percent tax on the export of steel scrap, in the Ukraine and Russia there are taxes on the export of steel scrap (30 EURO per ton, 15 percent, respectively) as well as on the export of nonferrous metal scrap.

It is not foreseeable how long raw material prices will remain at a high level. The surge in demand significantly differs from past trends, and one can assume that the growth surges in the entire Asian region will not only affect the commodity markets in the short term. Hence, the development of the commodity markets will in future also be strongly determined by the considerable increase in demand for raw materials in particular on the part of China and India. The situation will be different depending on the commodities in question, because one cannot assume that all commodities are subject to major price surges to an equal extent.

Recyclable materials are commodities traded on a global market. The trade in recycled materials is defined by supply and demand. Due to price fluctuations on the European market Asia is a very interesting market for recycled materials as prices there are commonly more stabile.

Concerning recycled materials WTO and waste shipment rules provide the legal framework for cross-boarder trade in such materials. These rules open a global market for recycled materials. The global market at the end guarantees the sustainable production of recycled materials as it creates the demand for recycled materials necessary to ensure a stable market.

If left to market forces, the demand/supply balance will determine prices of raw materials. Raw material price increases affects trade flows and the competitiveness of user industries. Europe (EU, member states, and industry) needs to act in the global race for raw materials and ensure efficient use of own resources.

The efficient use of own resources is essential for Europe's economy and industries to not be affected too much by floating market prices. This needs proper policies to be established on European level. These policies were largely lacking until 2007. However, fortunately in 2007 the problem of access to raw materials and sustainable raw material supply was more and more regarded and recognised on political level (see chapter 1).

As the problem of sustainable raw material supply to European producing industries has reached the political level, better funding and support mechanisms have to be established in consequence in order to provide more opportunities for problem solving. The European Technology Platform on Sustainable Mineral Resources (ETP SMR) provides a wide range of ideas and actions contributing to solving this problem, which is crucial for the European mineral industries to survive. The ETP SMR Strategic Research Agenda outlined these ideas and actions and this Implementation Plan shows the ways and condition for successful implementation.

2. The Way Forward

2.1. ETP SMR – Vision, Goals and Strategic Research Agenda

The European Technology Platform on Sustainable Mineral Resources (ETP SMR) represents the European minerals industry, comprising producers and users of industrial minerals and metals, aggregates and ornamental or dimensional stone, oil, gas and derivates as well as coal and by-products. It provides vital inputs to Europe's economy and social well-being. Because of their great diversity, minerals and their derived products are necessary for almost every aspect of life. Housing and construction, transport, energy supply, health, information and communication technologies, space technologies, and other sectors would either be nonexistent or suffer dramatically without constant mineral supplies to the EU economy. Further to that, the EU minerals industry is also a significant exporter of both world-class expertise and technologies and of manufactured goods.

ETP SMR unites hundreds stakeholders from industry, the research community, public authorities, the financial community, regulators, consumers and civil society around the major technological challenges to the sector, in order to jointly act towards a common vision. The Platform will contribute to strengthening one of the fundamental pillars of the European economy and society: the European extracting and processing sector of energy and non-energy minerals.

In particular the ETP SMR will

- reshape a ‘traditional‘ industry from a resource-driven to a knowledge-driven industry;
- foster new and better jobs, particularly at SME level and in the New Member States;
- supply and secure the mineral resources needed by the EU economy, while minimising the related environmental footprint (decoupling);
- strengthen world leadership and competitiveness in minerals sector technology; and
- add value for customers and society.

The ETP SMR vision responds to the European societal needs related to raw material supply. The vision to secure the supply of mineral resources for Europe in a sustainable and competitive way using eco-efficient technologies being environmentally sound and producing no (hazardous) waste is a real challenge. The research and development activities necessary to fulfil the vision have to produce real technological breakthroughs in various technological fields related to the scope of the mineral sector.

Further development of technologies will provide further added value and opportunities for exporting goods, know-how, ethics, and best practices. For Europe being the home of important exploration, mining and metallurgical equipment manufacturers, engineering supply and service companies and consultancies engaged in global activities, the ETP will be a source of increased competitiveness and jobs.

Five Focus Areas have been established aimed at identifying the most important steps on the way to fulfil the overall vision. Many steps and real technological breakthroughs are necessary to achieve the goal. All steps along the value chain of raw materials, extending from exploration and extraction to re-use and recycling, need significant research efforts to meet all the objectives.

New exploration methods are required to fill resource gaps and to safeguard Europe's future supply of key raw mineral feedstock for its existing and new downstream industries and to reduce dependence on imports. New extraction methods have to maximise resource utilisation and energy optimisation preferably in a fully automated way. After the termination of the extraction, land use has to be optimised and liabilities should be turned into assets for the future.

The processing of minerals should move towards zero environmental impact and reduced energy consumption. Feedstock recycling and footprint-free production are further issues. The whole production process will in the future be guided by the "Zero Waste" objective.

The sector has to act in close co-operation with customers if it is to maintain its competitiveness. The sector should create new mineral and material product functionality through enhanced product and customer understanding and knowledge building as well as finding new areas of application for mineral products and designing the mineral products for tomorrow.

It is essential that European citizens understand how the European minerals industry contributes to their basic needs and improve their quality of life. In this context, well-functioning interaction between industry and society is crucial.

The work within the Focus Areas and following discussions on ETP level resulted in the formulation of so-called strategic research priorities and dedicated research priorities mainly based on short and medium-term activities. They describe the strategic research actions necessary for fulfilling the vision and the objectives of the ETP SMR and thus are the basis for developing individual projects in the future.

This Strategic Research Agenda shows the way the mineral industry has to proceed in forthcoming decades if it is to serve European society in the way necessary. Without a strong European minerals industry, the future development of the EU economy risks to be curbed significantly.

2.2. The Implementation Plan

The Implementation Action Plan (IP) is the second in the series of ETP SMR documents. After presenting the vision for the future and the Strategic Research Agenda (SRA) focussing on research topics and themes, the next logical step is to explain how exactly the research themes defined in the SRA are to be implemented and to describe what ETP SMR and its stakeholders need to, and will, do to facilitate this process, and which other parties to involve.

This IP explains how the research priorities that were identified in the SRA can be implemented. For each research theme it describes in detail the issues that need to be addressed to realise its respective potential. It also illustrates activities required by

ETP SMR, its stakeholders and other parties to facilitate this process. While the SRA focused on topics and themes, the IP focuses on activities and actions.

The IP also includes a general perspective on the necessary framework (such as policy, capacity building, public acceptance) to speed up innovation in the European minerals industries.

The actors who will eventually perform the activities as described in the IP are manifold. They include a variety of ETP SMR stakeholders (academia, industry, etc) as well as the platform itself and the partners involved in the organisation of ETP SMR, now and in the future. The future role of ETP SMR in the implementation phase and within the network of related and relevant European initiatives is to coordinate the activities for the benefit of the European minerals industries and to monitor needs for changes of and amendments to the SRA and the subsequent implementation phase of those.

The IP is written from today's perspective and sets a time horizon shorter than that of the SRA. The ETP SMR will monitor the progress in achieving the IP and revise the plan on a regular basis taking into account progress against targets, and adding new targets and topics from the SRA.

3. Generating Innovation – Implementing the Strategic Research Agenda

After identification of the research needs, which are detailed in the Strategic Research Agenda of the Platform and which are necessary to fulfil the vision of the European Technology Platform on Sustainable Mineral Resources, ways and means have to be identified about how to implement them. The ETP SMR had carried out basic work related to implementation of the priority project areas and especially for the research priorities.

However, this basic work was not enough to plan the implementation. More emphasis had to be laid on concrete planning of project ideas also in terms of necessary resources, budgets, timing, etc. This work has been done in the context of this Implementation Plan in order to show the view of the ETP SMR of the conditions for a successful way forward.

The following chapters show in particular how the short and medium-term research priorities have to be implemented in order to guarantee keeping track towards our vision. The ETP SMR decided to start with the implementation planning mainly on short and medium-scale. The research actions necessary on the longer run are to some extent dependent on the results of the short and medium-term activities. Therefore, detailed planning seems not to be possible from today's point of view and with the knowledge present today.

The ETP SMR therefore decided to postpone planning of longer term activities by a couple of years and wait for the results of the short and medium-term activities and more knowledge to be generated.

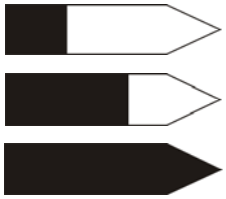
3.1. The Action Plan

The Implementation Plan defines research priorities that are of major importance for the European minerals industries in terms of competitiveness, market expectations, societal demand and impact or for the sustainability of different industrial sectors. These research priorities are:

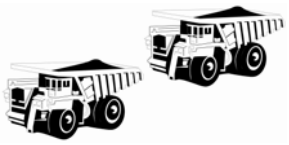
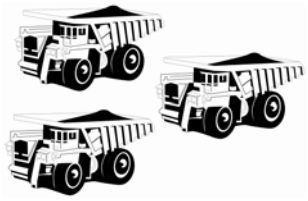
- Innovative concepts and processes for new high added value mineral-based products
- Technologies for a sustainable, increased self-sufficiency in resources
- New strategies and technologies for mineral resources transformation
- Reducing the environmental footprint of minerals and metals processing
- Process intensification in metals production

These priorities are already defined in the ETP SMR Strategic Research Agenda. However, the Implementation Plan focuses on the most immediate steps to be taken and their requirements and conditions. For each priority, a set of activities is proposed that need to be followed to enable the goals set forth in the ETP SMR Vision and Strategic Research Agenda to be achieved. These activities might be developed to real projects, however for the time being they only have in most cases the character of project ideas.

The requirements and the time frame for each activity are also presented in graphical form in order to allow easy visualisation. Beyond the graphical summary of activities, the subsequent chapters will also provide more details and other valuable information. For the diagrams, the following symbol keys are used:

Icon	Description
Timescale 	The arrows describe the approximate duration of the activities. An arrow of one third black indicates duration of less than 3 years, an arrow of two third black a duration between 3 and 5 years and a totally black arrow a duration of more than 5 years.
Activity Type     	Different types of activities might be needed depending on the particular aim of the research priority: ***Research activities:*** Possible projects ranging from basic research to in most cases applied, precompetitive research which primary aim is to generate scientific and technical knowledge which can be further used for the development of new innovative products and/or technology. ***Demonstration / Pilot activities:*** Activities aiming at demonstrating the industrial and economic feasibility and the sustainability of a technical concept. ***Studies:*** These activities, including surveys, feasibility studies, LCA or eco-efficiency analysis, aim at generating knowledge and information allowing stakeholders and decision-makers to make informed choices. ***Network / Coordination:*** Networks and coordination activities will allow better coordination between stakeholders, interdisciplinary cooperation, exchange of information and coordination between different levels of work. ***Education / Training:*** Exchange/mobility of researchers, courses, activities influencing curricular programmes.

Participation	These symbols indicate the estimated amount of expected or even necessary industry participation in a possible project in terms of budget shares. The meaning of the symbols is:
	Industry participation less than 25%
	Industry participation between 25% and 50%
	Industry participation between 50% and 75%
	Industry participation more than 75%
Budget	These symbols indicate the required financial resources for the total duration of the activity. The figures represent the total budget of a possible project.
€	1 EURO sign -> Budget less than 5 million €
€€	2 EURO signs-> Budget between 5 and 10 million €
€€ €	3 EURO signs -> Budget between 10 and 20 million €
€€ €€	4 EURO signs -> Budget bigger than 20 million €
Funding Source	Activity funding might come from different resources. The sources are indicated in plain text, like EU, National, Industry, etc.
Funding Share	These symbols indicate the contribution of industry to the total budget. The regular contribution for research activities is 50% whereas e.g. for demonstration activities the industry contribution amounts to 70% or more. The total amount of industry contribution to a particular project budget depends on several factors and cannot be predicted in any case. Therefore ETP SMR only roughly indicates this item in the following way:

	Industry contribution less than 40%
	Industry contribution between 40% and 60%
	Industry contribution more than 60%
Human resources	Activities require human resources with adequate training and expertise. From today's point of view it seems to be impossible to predict the necessary amount of human resources reliably mainly due the abovementioned nature of the activities. The figures presented are only rough estimations as follows:
	Work necessary less than 100 person-months
	Work necessary between 100 and 300 person-months
	Work necessary between 300 and 500 person-months
	Work necessary more than 500 person-months

3.2. The Short-Term Research Priorities

The short-term research actions have been defined as being finalised by the year 2013. This means that those actions are under preparation by the time this document was written. They are mainly looking for public funding and start in 2008 or 2009.

The following list gives the provisional titles of the short-term research projects derived from the list of short-term research priorities.

- New Exploration Technologies – 4D resource modelling
  (a more detailed description can be found in annex 5.1)
- Improved industrial processes for production of well defined mineral particulates with desired properties
  (this includes all kinds of physical and chemical properties, functionality, etc.)
- A new generation of innovative micro-perlite based materials providing double value to end-users
- Rapid, energy optimised and effective extraction
  (including sustainability aspects, safety, zero-impact extraction, resource efficiency, etc.)
- Subsea mining and deep offshore underwater extraction
  (a more detailed description can be found in annex 5.2)
- Energy and recovery optimised rock production process – from deposit to market
  (including drilling, blasting, crushing, etc.)
- Biohydrometallurgy is relevant to European resources of non-ferrous metals (designed as follow-up of BioMinE)
  (a more detailed description can be found in annex 5.3)
- Novel technology for mineral particle engineering
  (this includes all kinds of physical and chemical properties, functionality, etc.)
  (a more detailed description can be found in annex 5.4)
- Innovative methods for making value of tailings
  (a more detailed description can be found in annex 5.5)
- New technological processes for treatment of polymetallic materials with recovery of usable metals
  (a more detailed description can be found in annex 5.6)
- Complete utilisation of materials from secondary materials and scrap treatment
  (a more detailed description can be found in annex 5.7)
- Helping cities in mining regions secure their strategic land, water and biodiversity resources by the use of modelling and economic tools
  (a more detailed description can be found in annex 5.8)

The following table 1 shows the conditions and ways for a successful implementation of these projects using the previously explained pictograms.

Table 1: Project ideas in short-term research priorities

Project idea	Activity type	Time-scale	Budget	Partici-pation	Human resources	Funding source	Funding share
New Exploration Technologies – 4D resource modelling						Industry, National, EU	
Improved industrial processes for production of well defined mineral particulates with desired properties						Industry, National, EU	
A new generation of innovative micro-perlite based materials providing double value to end-users						Industry, National, EU	
Rapid, energy optimised and effective extraction (including sustainability aspects, safety, zero-impact extraction, resource efficiency, etc.)						Industry, National, EU	
Subsea mining and deep offshore underwater extraction						Industry, National, EU	
Energy and recovery optimised rock production process – from deposit to market (including drilling, blasting, crushing, etc.)						Industry, EU	
Biohydrometallurgy is relevant to European resources of non-ferrous metals						Industry, National, EU	
Novel technology for mineral particle engineering						Industry, National, EU	

Innovative methods for making value of tailings			€			Industry, National, EU	
New technological processes for treatment of polymetallic materials with recovery of usable metals			€€ €			Industry, EU	
Complete utilisation of materials from secondary materials and scrap treatment			€€ €			Industry, EU	
Helping cities in mining regions secure their strategic land, water and biodiversity resources by the use of modelling and economic tools			€			Industry, National, EU	

3.3. The Medium-Term Research Priorities

The following chapters describe the medium-term research priorities identified by the European Technology Platform on Sustainable Mineral Resources and laid down in its Strategic Research Agenda. The descriptions show the conditions and ways for a successful implementation of these priorities.

Additionally to the short-term research priorities we concentrate also on the medium-term priorities because only those we are able to plan with a certain degree of reliability. The long-term research activities depend in their way of implementation too much upon the outcome of the short and medium-term research.

3.3.1. Innovative concepts and processes for new high added value mineral-based products

One of the main characteristics of our modern society is the high consumption of natural mineral resources and the disposal in the environment of huge amounts of wastes resulting from the mineral processing industry. As mineral resources represent non-renewable natural resources, the main target of this sector is to secure the uninterrupted and sustainable supply of the European society with minerals. This can be achieved with the rational use of mineral resources, the maximum reuse of the by products and wastes of the mineral industry and the minimisation of the mineral wastes disposed in the environment. In this frame, the priority aims at the development of innovative, special functionality and high added value materials from industrial minerals, by-products and wastes of mineral and metal processing industry. This will be achieved through the design of novel industrial processes and technologies. Emphasis will be given to the development of the following innovative product groups:

- Materials of specific surface functionality with improved adsorption and catalytic properties
- Inorganic lightweight and incombustible materials
- Carbon fibres and carbonaceous materials from mineral oil
- Sustainable building materials from mineral wastes

The objective is to develop new or drastically improved mineral-based products with enhanced and diversified functional properties for use in metallurgical industry, paper industry, transport industry, high-tech industry such as optical/electronic/space or as industrial minerals and nanomaterials or for environmental protection as well as for extension in completely new markets not known today.

The main development issues and targets are:

- Development of novel large scale routes based on commissioning, growth using synthetic approaches, separation processes or new processes for production of discrete mineral particles tailor made for specific applications
- Development of techniques for particle modification facilitating subsequent preparation of designed systems of mineral particles
- Development of designed systems of mineral particles

The main deliverable is a knowledge platform facilitating creation of and new processes for environmentally friendly production of a new group of materials in the form of designed systems of mineral particles for pioneering applications and novel products and product functionalities for industrial and end-consumer products in light of new customer needs for tomorrow's markets or drastically improvement of existing mineral products.

The impact of the priority will be to secure the sustainability and the minimisation of the environmental impact of the mineral resources sector. It is necessary to significantly improve its technical, environmental and economic performance. The priority is expected to deeply affect all these areas for the following reasons:

- Technically: New processing technologies will be developed enabling the production of a series of innovative products. This will significantly broaden the palette of available products and applications.
- Environmentally: The re-use of many types of industrial wastes will be enabled and a big variety of new products will be produced from them. The target is to reduce the amount of mineral wastes disposed by 10%.
- Economically: The targeted materials in this RTD topic are of high added value and in many cases are produced from mineral wastes, which currently have a negative cost for their producer, due to their prior treatment and disposal cost. Moreover, the new materials are expected to be of equal or even higher value than the mother mineral material.
- Added value products will directly compete with similar products which are currently commercialized or under development by North American companies (US and Canada mineral industry is moving downstream very fast).

In general the results of the work in the priority will lead to multiplication of application areas for mineral based products by up to 50%, increased competitiveness of European mineral industry and reduced environmental footprint by mineral industry

The following table 2 summarises the basic information related to the individual topics of work necessary in this priority and as outlined in the Strategic Research Agenda. It gives a rough overview of the conditions necessary for success.

Table 2: Project ideas in research priority "Innovative concepts and processes for new high added value mineral-based products"

Project idea	Activity type	Time-scale	Budget	Partici-pation	Human resources	Funding source	Funding share
New technology for antibacterial and antifungi etc functionality			€			Industry, EU	
New technology for functional particulate systems, i.e. shear thickening suspensions, magnetic fluids etc.			€			Industry, EU	
Novel technology for catalysts and adsorbents			€			Industry, EU	
Control of particles for health and safety management			€€			Industry, National, EU	
Development of European Carbon Fibre production based on mineral oil			€€ €€			Industry, National, EU	
Definition of desired raw materials properties with respect to functionality of the building materials			€			Industry, EU	
Sensors readable (contactless) from distance which are put into the building materials before they are put into place (cast, sprayed..)			€€ €€			Industry, National, EU	
Material laws and simulation procedures for a wide range of classical building materials			€			Industry, EU	
New building materials, optimized with respect to CO_2 emission (reduction by 50%)			€			Industry, EU	
Stone materials for new optical and space applications (NASA) based on first laboratory research work			€€			Industry, National,	

						EU	
Clean technologies for raw materials treatment and product production, reducing environmental footprint or process emissions						Industry, EU	
New processes for treatment of complex or low quality scraps, industrial residues, and wastes, recoverable of usable components						Industry, National, EU	
Reuse, recovery and recycling processes for used stone end consumer products for new market application						Industry, National, EU	
Tooling, machinery development and switch from diesel driven machinery to alternative machinery						Industry, National, EU	
Use of selected by-products as raw materials aiming to increase the lifetime of building products and to contribute to more sustainable buildings						Industry, National, EU	
Feedstock recycling; improved methods for heat, recovery and re-use						Industry, National, EU	
Innovative processing of secondary resources						Industry, National, EU	
Innovative processing of mineral waste						Industry, National, EU	

3.3.2. Technologies for a sustainable, increased self-sufficiency in resources

The overall goal of the priority is to secure the future supply and sustainable processing of raw materials for Europe through R&D based technology leadership and to continuously implement best practices as well as innovative and sustainable production capabilities. It is further to continue to increase the competitive position of the European minerals industries at a global level. In technical terms new exploration, extraction and processing technologies will be developed.

New more cost effective exploration technologies are needed to secure the long term supply of minerals to Europe. In particular 4-dimensional geomodels to estimate resource for Europe and elsewhere can provide powerful improvements to the exploration sector. The improvement of exploration technology is of paramount importance for new discoveries and estimation of the economic potential of deep resources within the EU and abroad.

The primary extraction methods are basically different depending on the type of raw material to be extracted. Different raw materials therefore require different main research areas for extraction processes. Common to each field is the need of more cost-effective and selective extraction and processing methods consuming less energy and giving less environmental footprint.

The work in the priority will focus on development of new eco-efficient, knowledge-based exploration, extraction and processing technologies and concepts with less environmental footprint and sustainable processing of raw materials in Europe also providing conditions for continuous innovation and quick implementation of new knowledge.

The main development issues and targets are:

- New cost effective exploration technologies, in particular techniques for better ground penetration and remote sensing including MWD (measuring while drilling), 3D-seismics, hyperspectral sensing, and 4-dimensional predictive geomodels for modelling and providing the key spatial, geological, geophysical, geochemical and financial parameters
- New efficient methods and tools for mine planning and rapid mine development, including high advanced road heading systems and ultra high performance air conditioning systems and the use of modelling, simulation and virtual reality tools, for improved utilisation of resources and minimum environmental impact
- New knowledge-based, cost-effective, rapid and energy optimised extraction systems making use of e.g. intelligent systems, automation and robotics, intelligent and autonomous wireless sensor systems
- New extraction concepts, e.g. small-scale, in-situ or sub-sea mining, to cost-effectively exploit difficult or small deposits
- New processing technologies and strategies for footprint free production and elimination of emissions and wastes

The research will develop innovative cost- and energy-efficient exploration, extraction and processing technologies and concepts with footprint impact divided by 2 and with

potential to increase Europe's resource base by 50% thus reducing import dependencies. It will allow for new technology exports and secure domestic raw material supply to downstream industries by aiming towards total resource utilisation (in certain cases an increase of 50% is targeted).

The quality of the raw materials produced will be increased. The quantified targets however are well spread depending on the different minerals produced. It will ensure competitiveness of existing operations and create new technology providers and continuously innovative production capabilities, thus maintaining existing and creating new employment. New innovative technologies being developed will provide technology leadership worldwide.

The following table 3 summarises the basic information related to the individual topics of work necessary in this priority and as outlined in the Strategic Research Agenda. It gives a rough overview of the conditions necessary for success and the resources needed.

Table 3: Project ideas in research priority "Technologies for a sustainable, increased self-sufficiency in resources"

Project idea	Activity type	Time-scale	Budget	Partici-pation	Human resources	Funding source	Funding share
New exploration technologies for deeply buried mineral deposits onshore, e.g. use of onsite time- and cost-effective tools						Industry, National, EU	
New exploration technologies for joint interpretation of geochemical, geophysical borehole, seismic and satellite based information (implementation of the GMES initiative)						Industry, National, EU	
Safeguarding access to aggregates and dimension stones						Industry, National, EU	
Intelligent systems, automation and robotics						Industry, National, EU	
Intelligent and autonomous wireless sensor systems						Industry, EU	
New investigation methods and new mine planning tools for improved utilisation of resources and minimum environmental impact						Industry, National, EU	
New efficient methods for rapid mine development with high advanced road heading systems and ultra high performance air conditioning systems						Industry, EU	
Intelligent image processing and navigation						Industry, National, EU	
Basis/advanced training in salt/potash and other mines by virtual reality						Industry, EU	

In-situ rock quality characterisation for optimising production processes			€€			Industry, National, EU	
Methods for unconventional hydro-carbons			€€			Industry, National, EU	
Increased efficiency in oil recovery			€€ €			Industry, EU	
In-situ mining			€€ €€			Industry, National, EU	
Development of automatic mining systems in room and pillar mining methods			€€ €			Industry, National, EU	
New efficient and productive techniques for extracting ornamental and dimension stone for consumer use			€			Industry, EU	
Tooling, machinery development and switch from diesel driven machinery to alternative machinery			€€ €			Industry, National, EU	
Innovative Processing of mineral waste			€€ €€			Industry, National, EU	
Feedstock recycling			€€			Industry, National, EU	
Footprint free production, elimination of emissions and wastes			€€			Industry, National, EU	

3.3.3. New strategies and technologies for mineral resources transformation

The European metals and minerals industry is a very important, but small, part of the modern global metals and industrial minerals industries. While the EU consumes about 25% to 30% of the world's metal production, the European metal extraction accounts for only 3% of world production. Therefore, although the European raw materials sector must and can remain the starting point of the European material supply chain, it is equally important to support and strengthen ties with global raw material producers to ensure a sustainable supply of minerals and metals for Europe in the future.

The overall goal is to improve the competitiveness and sustainability of the resource processing and metallurgy segment of the mineral industry, The most urgent and promising areas addressed include improvement in energy efficiency through the implementation of improved technology, sustainability of minerals and metals production and a reduction in the environmental footprint through initiatives that facilitate improved practices and performance across all sectors of the industry.

The mineral and metal transformation methods are basically different depending on the type of raw material to be processed. Different raw materials therefore require different main research areas for transformation processes. Common to each field is the need of more energy and therefore cost-effective and selective processing methods resulting in reduced environmental impact.

Domestic resources will be produced in a much more energy efficient and environmentally friendly way attempting a footprint impact reduction by 50 %. The quality of the raw materials produced will be increased and adapted to new products (quantified targets are well spread depending on the different minerals produced). The downstream industries will have better access to domestic and better tailored raw materials. New technologies being developed will provide technology leadership worldwide.

The main development issues and targets are:

- Holistic processing strategies and technologies for eco-efficient production of new competitive products tailored to the demands of the customer and society
- New processing technologies for physical separation of minerals, fine and ultra-fine particle treatment and control of grain size and shape
- Optimisation of metallurgical processes to improve efficiency and reduce wastes and emissions
- Development of optimal chemical, physical and high temperature processes for the industrial minerals treatment with respect to physicochemical properties of the raw, the secondary material as well as the end-products
- Design of energy efficient transportation equipment

Following these development issues and targets we foresee to achieve the following goals:

- Move Towards Zero Impact processing - initiatives that facilitate improved practices and performance across all sectors of the industry, promoting

efficient and responsible use of natural resources and reducing the footprint (decoupling)

- Reduce energy consumption
- Develop sustainable economic processing, production and products ensuring the benefits are positive and useful to the community
- Knowledge building and transformation on a global basis to provide advanced technologies for the natural resources industry

It is estimated that a possible outcome will be the crowding out of certain North American chemicals and mineral-based products, which are currently dominating European markets, by reducing 15-30% the market share of those. A further penetration of the US/Canadian market by the above European products is foreseen within next 7-9 years.

The following table 4 summarises the basic information related to the individual topics of work necessary in this priority and as outlined in the Strategic Research Agenda. It gives a rough overview of the conditions necessary for success and the resources needed.

Table 4: Project ideas in research priority "New strategies and technologies for mineral resources transformation"

Project idea	Activity type	Time-scale	Budget	Partici-pation	Human resources	Funding source	Funding share
Holistic processing strategies			€			Industry, EU	
New processing technologies for physical separation of minerals			€€			Industry, EU	
Fine and ultra-fine particle treatment			€€			Industry, EU	
Electro-refining and electro-winning and heat recovery			€€			Industry, National, EU	
Optimisation of metallurgical processes to improve efficiency and reduce wastes and emissions			€€ €			Industry, National, EU	
Development of optimal chemical, physical and high temperature processes for the industrial minerals treatment with respect to physicochemical properties of the raw and secondary materials			€€ €			Industry, National, EU	
A suitable approach to complex and polymetallic sulphide minerals - new mine, concentrator and process solutions			€€			Industry, National, EU	
Equipment design to improve energy transfer and efficiency of fragmentation			€€ €			Industry, EU	
Control of grain size and shape, optimisation for downstream processing			€			Industry, EU	

Design of energy efficient transportation equipment			€€			Industry, EU	
Process simulation & optimisation modelling			€€			Industry, National, EU	
Holistic processing strategies towards full extraction approach: Optimisation of metallurgical processes to improve efficiency and reduce wastes and emissions			€			Industry, EU	
Continuous process control through novel process analysis technologies			€€			Industry, National, EU	
Intelligent systems, automation and robotics			€€ €€			Industry, National, EU	

3.3.4. Reducing the environmental footprint of minerals and metals processing

The priority dedicated to reduction of the environmental footprint of the various operations carried out in the sector may be seen as kind of horizontal activities being part of more or less each technical research action. This view is in fact true; however, the European Technology Platform on Sustainable Mineral Resources sees the field as being important enough to dedicate an individual Research priority to it.

The overall goal of the priority is to get to substantial improvement on environmental performance of the mineral, metallurgical and recycling industries. The most urgent and promising areas that should be addressed include improvement in energy efficiency, wastes reduction and recovery, ground water protection and by-products reutilisation as well as land restoration and post-industrial areas revitalisation

Specific technologies and solutions will be developed aiming at decoupling of sustainable exploitation and environmental impacts on the environment and the people. In addition the implantation of the mineral industry in (semi-)arid regions of developing countries can lever the integration of modern tools to allow regional communities monitoring and managing development issues (control on water and air quality, ground water protection, land occupation activities, desertification, ecosystem protection, infrastructure development). The proposed initiatives will deal with all kind of wastes and residual materials generated in mining and processing, quarrying, slating and gravestones as well as recycling of especial or complex waste and scrap, including WEEE, ELV, batteries, CDW, catalysts, slag, dusts, sludge, etc. In particular the extractive waste and land restoration issues in Eastern Europe need to be addressed and the research will provide lower costs methods in order to allow for successful, timely restoration. For the emission reduction from mineral resources and metals extraction processes the research is aiming to propose innovative solutions and radical changes based on novel technologies and applications like membranes, new chemicals and extractants, specific materials, etc., opening the way to commercial exploitation of the new technologies worldwide.

Large volumes of solid and liquid wastes are generating by mining and metallurgical industries, which needs a radical change in actual resources processing aiming to substantial increase of recycling rate, reducing environmental impact and decreasing energy consumption and associated greenhouse gases effect. The proposed actions will deal with innovative technologies for slag reduction and reprocessing, dust and sludge from metallurgical plants, spent batteries, wastes containing heavy metals, complex electronic wastes, spent finishing baths, etc. The intended initiatives are to get improved expectations, practices, and performance in the recycling and management of wastes in a sustainable manner along the entire minerals and metals value chain.

Other activities the participants of the ETP SMR have in mind and are necessary to reach the objectives aim at:

- Providing knowledge and tools to develop clean technologies to control and reduce emissions and wastes generation from minerals and metals processing sources
- Developing technologies of low fossil fuel or low energy consumption leading to significant reduction in CO_2 emissions

- Developing low to zero waste technologies
- Developing crushed rock aggregates replacing natural sand and gravel aggregates (especially concrete aggregates) for protection of ground water and better land use (present concrete aggregates are mainly based on natural sand and gravel deposits containing ground water with significant environmental impact)
- Reducing the environmental impact of mining activities on groundwater and soils through enhancement of the current knowledge base, development of mitigation or remediation technologies, and development of testing and monitoring tools
- Effective and sustainable regeneration of land and contaminated post industrial sites, including water management, soils cleaning and stabilisation, etc.
- Utilisation of mining process products (heat, inert residues, wastes, etc.) after mine closure
- Mineral industry-led pro-active regional development associated with the implantation of the mineral industry in (semi-)arid regions of developing countries

The main risks following the end of mining activities concern the groundwater and streams pollution, the seepage of mining gases, the long term mechanical stability of the mined area, and the degradation of mining residues in heaps, dumps and tailing ponds, etc. Therefore, in the interest of Europe, an important effort is required directed towards overall risk reduction in post mining activities. In addition, activities focused on regional development would enhance quality of life and future social and employment perspectives of mining areas where mining activities ceased and a new horizon based on sustainable development has to be planned.

The envisaged reduction of the environmental footprint of activities of the European minerals industries will contribute significantly to European sustainable development. It will enable environmentally sound provision of raw materials for the downstream European industry sectors.

The following table 5 summarises the basic information related to the individual topics of work necessary in this priority and as outlined in the Strategic Research Agenda. It gives a rough overview of the conditions necessary for success and the resources needed.

Table 5: Project ideas in research priority "Reducing the environmental footprint of minerals and metals processing"

Project idea	Activity type	Time-scale	Budget	Partici-pation	Human resources	Funding source	Funding share
New technologies for management of gases which are rich in SO_2 aiming to produce by-products, e.g. gypsum directly from gases						Industry, National, EU	
Environmental footprint reductions by developing new technologies and applications: water treatment, gas streams handling, etc.						Industry, EU	
Radical changes and innovations in mineral and metallurgical processes to improve efficiency and decrease environmental negative impacts						Industry, National, EU	
Protecting ground and surface water quality by treatment of acid mine drainage, recovery of contained metals, etc.						Industry, National, EU	
Waste water management optimisation in minerals processing and metallurgical facilities to reduce energy and waste production						Industry, EU	
Clean processes (hydro, bio, pyro) for treatment of complex ores and wastes aiming to reduce environmental impact						Industry, National, EU	
Materials and chemicals to reduce environmental footprint						Industry, EU	
Monitoring tools and sustainability environmental management standards						Industry, EU	
Monitoring and sustainability indicators						Industry, EU	

Stabilisation of hazardous substances in waste materials			€			Industry, National, EU	
Technological and administrative tools for reduction of mining waste			€			Industry, National, EU	
Management and disposal of wastes in mining operations			€			Industry, National, EU	
Quarries with crushed rock aggregates (mainly for concrete) replace sand and gravel deposits with high potential of ground water - new concrete use technology to be developed			€€			Industry, National, EU	
Stock pile wastes and tailings as mineral resources			€€			Industry, National, EU	
Assessment of the environmental impact of mining activities on groundwater and soils - evaluation of the current knowledge base, mitigation or remediation technologies			€			Industry, EU	
Effective and sustainable use of mining process products like heated water and air with an ongoing use after mine closure			€€			Industry, National, EU	
Rehabilitation and chemical and biochemical processes for extraction, sequestering or stabilisation of pollutants from contaminated land			€			Industry, National, EU	
Rehabilitation of brownfields: Works and activities including geotechnics, monitoring, and water management			€			Industry, EU	
Rehabilitation of brownfields: New technologies preparing shafts for filling; old shafts, excavations, shallow deep mining activities			€€			Industry, National,	

						EU	
Remote sensing technologies for assessment and monitoring brownfields reclamation process			€			Industry, National, EU	
Cost effective tools and strategies for the sustainable reclamation of brownfields			€			Industry, EU	
Pro-active policies of the mineral industry implantation in developing countries to improve and sustain regional development			€			Industry, National, EU	

3.3.5. Process intensification in metals production

The European non-ferrous metals sector is a fundamental, strategic pillar of the downstream fabricating, service and consumer industry in Europe. Non-ferrous metals have become such an integral part of our every day life that many of us no longer recognise them. Non-ferrous metals and their compounds play a major role in the pharmaceutical industry as they do in nutrition, housing, transport, communication and in the household.

The sector has in the past developed some of the worldwide leading technologies and many technology innovations have been exploited by other industrial sectors and around the world. Examples are motors for railroad locomotives, belt-transport systems to go round corners, industrial cables, measuring techniques, remote sensing, tunnelling etc.

As the non-ferrous metals industry in European Union covers several hundreds companies and EU consumes about 25% to 30% of the world's non-ferrous metal production it seems to be appropriate to dedicate a separate priority to this field. At the same time the European non-ferrous metals industry has been one of the major technology providers in smelting and new production technologies around the world. In the past the sector developed some of the worldwide leading technologies and many technology innovations have been exploited by other industrial sectors and around the world.

European metallurgical industry is one of the largest manufacturers of non-ferrous metals, such as copper, zinc, lead, as well as accompanying metals, e.g. silver, cobalt, nickel, selenium, platinum metals etc. Targeted actions are necessary in order to maintain European environmental, health and safety standards and remain competitive.

The objectives of this priority are:

- Development of new technologies for every kind of metallurgical processing to improve competitiveness
- Improvement of energy-efficiency of metallurgical processing
- Improvement of eco-efficiency of processing steps
- Complete utilisation of materials from secondary materials and scrap

The subjects mentioned above are very important for metallurgical industry in European Union. It is important to make the next steps towards modernisation of technologies, reduction in energy consumption and environmental protection, and create new solutions, which will confirm the leading position in new technologies on the world level. Since the European non-ferrous metals industry in a large degree relies also on import of raw materials and concentrates from other parts of the world, the application of innovative technologies is crucial to maintain the competitiveness of the industry.

The following table 6 summarises basic information related to the individual topics of work necessary in this priority and as outlined in the Strategic Research Agenda. It gives a rough overview of the conditions necessary for success and the resources needed.

Table 6: Project ideas in research priority "Process intensification in metals production"

Project idea	Activity type	Time-scale	Budget	Partici-pation	Human resources	Funding source	Funding share
Development of optimal metallurgical processes with respect to physicochemical properties of ores, concentrates and secondary materials						Industry, EU	
Application of flash-smelting process for direct production of copper form copper concentrates by preliminary treatment of the concentrates by leaching						Industry, EU	
Intensification of metals production processes by diversified application of oxygen						Industry, EU	
New installations and equipment for energy consumption decrease in pyrometallurgy						Industry, EU	
Changes in technology of metals production for reduction in slag and dusts generation						Industry, EU	
Complete recovery of metals and their compounds from dusts and slag						Industry, EU	
Complete utilisation of slags as a raw material for production of materials used in construction and road industry						Industry, EU	
Treatment of non-ferrous metals containing dusts and slag from other processes in the basic processes of metallurgical production of metals						Industry, EU	
Solving sulphur problem in metallurgy						Industry, EU	
Addressing metallurgical wastes problems e.g. jarosite						Industry, EU	

Application of process by-products – such as gypsum			€			Industry, EU	
Increase in recovery of accompanying metals – gallium, indium, germanium etc.			€€			Industry, EU	
Recovery not only metals but also compounds			€€			Industry, EU	
Recovery of acidic effluents (recovery of value from liquid effluents)			€€			Industry, EU	
Complete and safe utilisation of the waste which contains harmful metals – mercury, cadmium, arsenic			€€			Industry, EU	
Reduction in size of reactors in hydrometallurgy			€€			Industry, EU	
Development of new copper solvent extractants and enhanced Cu-SX systems			€€			Industry, EU	
New ion-exchange methods for zinc production			€			Industry, EU	
Development of new, more selective solvent extractants and improved Zn-SX systems			€€			Industry, EU	
Pressure and oxygen supported hydrometallurgy			€			Industry, EU	
Possibilities for application of biotechnology			€			Industry, EU	
Improvements in electrowinning – application of new technologies and materials, e.g. DSA anodes to decrease power consumption			€€			Industry, EU	
Low cost extraction methods			€€			Industry, EU	

Problems of extracting more by-products values			€€			Industry, EU	
Ion-liquids as electrolytes for electrorefining and electrowinning			€€			Industry, EU	
New additives			€			Industry, EU	
Electrorefining and electrowinning bleed streams treatment			€€			Industry, EU	
Waste treatment			€			Industry, EU	
Complete utilisation of non-ferrous metals containing scrap and waste from various branches of economy			€€ €			Industry, EU	
New technologies for treatment of scrap and secondary materials, such as batteries, electric and electronic equipment, household appliances etc.			€€ €			Industry, EU	
Treatment of flotation tailings as low-metal bearing material			€€			Industry, EU	
New technologies for treatment of precious metals			€€			Industry, EU	
New technologies in combining of ore processing, pyrometallurgy and hydrometallurgy, especially for recovery of metals from polymetallic materials			€€ €			Industry, EU	
Introduction of hydrometallurgy processes in non-ferrous ores treatment			€€ €			Industry, EU	
Super critical (high temperature and high pressure) water leaching			€€			Industry, EU	

Use of the energy contained in the lukewarm process water			€€			Industry, EU	
Combine fuel cells and electrowinning			€			Industry, EU	
Low cost energy efficient grinding/crushing of ore, and especially new equipments and methods for fine grinding			€€ €			Industry, EU	
Application of alternative (solar) energy sources			€			Industry, EU	
Development of chloride metallurgy			€€ €			Industry, EU	
Development of direct leaching of sulphide materials			€€			Industry, EU	

3.4. Long-Term Strategy

The research actions described and listed in the previous chapters are designed to provide results in short and medium-term. However, the Strategic Research Agenda also showed strategic research priorities on the long-term horizon.

Before thinking about implementation activities in the longer term it is appropriate to first regard, monitor and assess the results obtained from the short and medium-term activities. These results may cause the need for adjusting other actions planned from today's point of view.

Thus, the long-term strategy of the European Technology Platform on Sustainable Mineral Resources (ETP SMR) in terms of implementation activities cannot be shown now. We will regard, monitor and assess all running activities in the future and determine if, how and when the implementation plan of the ETP SMR needs to be revised and adapted.

The long-term implementation strategy as such is to permanently keep track towards the ETP SMR vision and objectives as outlined in the Strategic Research Agenda (SRA) and in chapter 2.1 of this document. Depending on the results obtained from research activities in the future ETP SMR High Level Group and Stakeholders will initiate necessary revisions to the SRA and the Implementation Plan. In this way the European Public will at any time be aware of the most recent developments on our way towards achieving our vision.

4. Creating a Supportive Environment

The business environment is increasingly governed by two factors – the increasing pace of technological development and the globalisation of the world economy. Customers, competitors, suppliers and collaborators may be located, quite literally, anywhere in the world. In consequence the requirement for companies to constantly strengthen their capabilities and find innovative ways to satisfy customer demands has never been greater. The same is essentially true for both Europe as a region and their national governments: they also need to find innovative ways to increase the capacity and attractiveness of their innovation offering and thus the competitiveness of 'their' businesses. In this context ETP SMR also considers innovation to be the entire process that takes new knowledge and converts it into the products and services that will underpin future growth and jobs.

Although a variety of funding sources already exist in Europe, there is an urgent need for Europe to do more and better in terms of research and innovation support. In general, European innovation performance has been weak compared to competing regions in the world. This has been realised by the European Union as well as different Member States. Consequently, several initiatives to promote research, and especially innovation, on a national level have recently been started or, in some cases, are already well established. These initiatives could serve as a role model for others (other Member States, the EU in general, or regions) to improve the overall (funding and support) situation for different players in the technology based innovation environment. An effective innovation infrastructure requires appropriate resources.

However, means like the UK *Technology Strategy Board* and *Knowledge Transfer Networks*, the *Dutch Leading Technology Institutes* and *Strategic Technology Areas* in The Netherlands, the *High-Tech Gründerfonds* in Germany or the *Pôles de compétitivité* in France suit well to emerging technology and high-tec fields but quite less to the mineral industries that are constantly seen as being less innovative.

The European minerals industries need more and better funding sources and support means. Europe has to realise that without a vital minerals industry the sustainable supply of raw materials to Europe and especially to the downstream manufacturing industries cannot be guaranteed. Fortunately, the problem of access to raw materials is more and more regarded and recognised, even on political level, as being of global dimension.

Access to raw materials was on the agenda of the G8 Summit on 6-8 June 2007. On that occasion a Declaration on "Growth and Responsibility in the Global Economy" [10] containing a chapter on "Responsibility for Raw Materials: Transparency and Sustainable Growth" was adopted, which will address the key priorities for a sustainable and transparent approach to this question. In addition the Competitiveness Council meeting on 21 May 2007[11] has called the European Commission to develop a coherent political approach to the issues arising.

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[10] Available for download here: http://www.g-8.de/Webs/G8/EN/G8Summit/SummitDocuments/summit-documents.html

[11] Press release no 9671/07 of the Council of the European Union, 2801st Council Meeting

Further to that The European Commission DG Enterprise and Industry recently launched a staff working paper on the *Analysis of the Competitiveness of the Non-Energy Extractive Industry in the EU*[12]**.** The paper stated that the present situation of the non-energy extractive industry in the EU calls for an integrated approach through which relevant EU policies and instruments work in concert with the aim of ensuring availability of essential raw materials, and sustainability in their extraction and use. The document further identified the key aspects being: access to sites, access to land, investment and operating costs, the regulatory framework, the availability of a skilled workforce, research and innovation, and health & safety requirements.

The question of availability and use of raw materials was also analysed by the High Level Group (HLG) on Competitiveness, Energy and the Environment established by Commissioner Verheugen. Based on the work of different related working groups the HLG published on 11 June 2007 its 4th report on *Ensuring Future Sustainability and Competitiveness of European Enterprises in a Carbon and Resource Constrained World*[13]. The report delivered policy recommendations on sustainable use of natural resources and called, among other things, for simplifying and streamlining access to domestic raw materials and improving the EU's resources efficiency through the better use of resources embedded in waste. The HLG also called on the EU and Member States to support the development of a raw materials policy.

It seems that the problem of sustainable raw material supply has reached the political level. In consequence, better funding and support mechanisms have to be established in order to provide the more opportunities for problem solving.

ETP SMR activities

A specific project activity is envisaged to further develop the required "Innovation Infrastructure". It is a follow up study to update the knowledge in terms of:

- The main funding and support models that currently exist at EU and country level.
- A first analysis of which of these are most relevant to ETP SMR, differentiating between those that directly fund public-private projects and those which fund Public Research Organisations that should also be of value depending on certain project objectives.
- A subsequent analysis of current best practices with an emphasis on applicability to SMEs.
- Recommendations for concrete areas for improvement at all levels (EU, national, regional).

The goal of this project work will be to develop the information needed to initiate a ETP SMR Innovation Service to support SMEs because as known a great number of companies in Europe dealing with minerals extraction and processing are SMEs. The aim of this service would be to speed up the adoption of "better practices" by smaller companies operating at the local level. Typical services would include:

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[12] Commission Staff Working Document no SEC(2007) 771, available for download here: http://ec.europa.eu/enterprise/steel/index_en.htm

[13] Available for download here: http://ec.europa.eu/enterprise/environment/hlg/hlg_en.htm

- Awareness raising of support systems that already exists.
- An easy to access web data base that would include some of the cost benefit data to support next commercialisation steps (including potential funding).
- Networking seminars with a focus on how mineral products can enable downstream innovations.
- Outreach activities including communication / dissemination tools specifically designed to be used locally in the local language.

4.1. The Innovation Framework

General innovation constraints

There are extensive structural, social and political factors that significantly impact on the ability for developing innovation dedicated to the minerals industries. Several of these "innovation constraints" have already been referred to in previous chapters and the ETP SMR Strategic Research Agenda. In this section the focus will be on clarifying aspects where ETP SMR can have a more meaningful impact on improving the "European framework for innovation".

Technology Platforms are industry driven, so an ongoing challenge is to ensure an increased and longer term commitment to innovation by the leaders amongst the key companies. These leaders are ultimately responsible for generating the motivation and employee behaviour that cultivates an environment conducive to successful innovation. There are well documented challenges such as:

- Ensuring people in addition to those working in R&D are actively involved in the complete innovation process
- Offering direct and visible support for new or different business models such as those that rely on open innovation and external collaboration

In the above cases the role for ETP SMR would be to provide facts and figures that would validate such "new models" and help to quantify both the benefits and risks involved. This would be achieved as part of ongoing ETP SMR communications and workshop activities. It would also rely on networks remaining active so that success stories could be communicated directly to large company management teams as well as indirectly (for example via associations) to smaller companies operating on a national level.

However there are other areas where sharing best practices will not be sufficient. An example relates to the fact that R&D is primarily considered as a cost rather than an investment. Thus as competitive intensity increases R&D costs will be further squeezed. This is aggravated by the cyclical nature of the industry which places additional pressure on longer term project spending during cyclical downturns. To develop an attitude within companies that would consider "Research & Innovation" as an investment will not be a simple task but further work in this area is needed to analyse potential positive stimuli such as fiscal incentives, increased reliance on external cooperative projects, and new risk sharing models with specialist financial institutions.

Cooperative efforts to make partnering more productive

Although the framework conditions for FP7 are finalised, the need to increase continuously simplicity and relevance whilst reducing bureaucracy remains very critical to support a framework that is more conducive to innovation. The known and very familiar challenge is minimising resources committed to administration so as to maximise resources dedicated to the actual innovation process. In this context the sharing of best practices would be a regular feature of intended innovation workshops. ETP SMR would also offer direct input to contribute to related governmental initiatives such as those aiming at improving the competitiveness of industry. Information provision would include items such as:

- Identifying potential partners.
- Developing a semi-generic process to help downstream users and SMEs to reduce bureaucracy with project submission.
- Ensure effective links to the business development support that would need to follow a successful project.

Speeding Innovation in Europe

Societal challenges will require more innovative technologies. These innovations will inherently carry differing risks. If too much time or resource is diverted in seeking to perfectly quantify these risks the critical (and typically more valuable) innovations will simply be driven outside the EU. There is an urgent need to speed up technology uptake and to accelerate the process of public acceptance of new technology.

This issue of building trust is absolutely crucial. Industry's commitment for increased transparency will also help in this process. However this will need concrete, coherent and continued public support via key governmental institutions. In this context integrating feedback from risk management and stakeholder dialogue processes will be a crucial ETP SMR role, as facilitating such support and acceptance of new technologies will support the pace of market demand needed to make the new technology commercially viable.

Downstream linkages

Especially innovations in mineral products primarily support progress at downstream customers. In general better cooperation up and down the supply chain should lead to increasing the probability of a successful innovation. The mechanisms and rules of Material Stewardship as described in various sources should apply here.

In this context a more structured interaction with relevant Technology Platforms provides a readily accessible means to create a better understanding of innovation priorities throughout the supply chains in which the mineral industries play an important role.

Workshops to stimulate this process would be the more visible contribution from ETP SMR, but the ensuing networking that follows such workshops would provide the bigger boost to the innovation process.

Ultimately this will require more effective use of the existing national, local and regional initiatives as well as associations that provide the most direct access to the

SMEs and other future downstream customers. An initial objective would be to simply speed up the sharing of good practices but longer term a more strategic approach to such alliances could be envisaged.

Clarity of Platform Priorities

In today's highly competitive world industrial companies do not survive if they do not adequately respond to the needs of the market which in turn are driven by societal needs. This and legal requirements are the drivers that form the basis for priorities within ETP SMR's research agenda. This should be equally applicable to the political priorities that impact funding at both EU and Member State level. Thus ensuring a good match between these priorities and the work programmes within FP7, and the other key funding initiatives and organisations is essential. A good match will also increase the likelihood of the research work being further developed by industry and ultimately turning the generated knowledge into a commercially viable innovation.

The two primary roles for ETP SMR would be:

- Better define methodologies that can increase success rates and alignment between calls for projects and ETP SMR priorities for FP7 and related programmes.
- Maintain a systematic feedback process with appropriate experts such as the programme officers that administer these programmes.

Supporting Innovative SMEs

The more effective interaction with smaller companies will be essential for improving innovation. This will be a continuing challenge where the ETP SMR network could be leveraged to propose specific services to SMEs.

To provide such services in an effective way would require ongoing financial support from the EU Commission for ETP SMR, for example to set-up specific workshops, networking and communication support for SMEs. These workshops and their related follow up would aim at increasing awareness of the most relevant ETP SMR opportunities, helping to navigate funding opportunities and direct access to companies having related interests.

4.2. Financial Resources

The ETP SMR Strategic Research Agenda (SRA) gives a good opportunity to focus the European spending in research related to minerals industries towards the most promising areas regarding their impact on the overall goals of sustainability, environmentally soundness and a high level of competitiveness. The ambitious plan to implement the research needs will require significant funding in order to be successful. Different funding sources including EU framework programmes, national and regional initiatives as well as private sector spending need to be accessed.

In the previous chapters the resources needed to fulfil this Implementation Plan have been outlined in detail. The amounts required, as well as the sources of funding in terms of private or public, European or national, as well as the necessary human resources and industry contribution have been estimated for each research priority identified in the SRA.

As the amounts needed and the contributions from the private sector have only been estimated in certain categories, it is difficult to give totals. However, the activities covered by this Implementation Plan - paving the way to achieving the ETP SMR vision - require budgets in the order of 1 to 2 billion € for their completion. The average mean value for the industry contribution to the budgets financing based on the very rough categorisation made in tables 1 to 6 will be a little bit more than 50% indicating that less than 50% public funding will be needed on average.

Assuming an average project duration between 3 and 5 years, the annual budget might be between about 170 and 700 million €. However, also these figures may only be understood as very rough indications.

It is easily to understand that the figures vary depending on the research priority as presented in table 7. It shows the distribution of budgets and private share of the budget related to the ETP SMR research priorities. The variations are due to factors like number of projects, technical relevance and type of project.

Table 7: Financial resources requested in the ETP SMR Implementation Plan

Research Priority	Estimated budget (million €)		Average industry contribution (%)
	minimum	maximum	
Innovative concepts and processes for new high added value mineral-based products	285	740	50.0
Technologies for a sustainable, increased self-sufficiency in resources	210	495	60.4
New strategies and technologies for mineral resources transformation	90	205	52.0
Reducing the environmental footprint of minerals and metals processing	55	185	47.4
Process intensification in metals production	210	480	49.3
Total	***850***	***2,105***	***51,7***

The figures show the expectations from ETP SMR stakeholders in terms of contributions especially from the European Framework Programme. They also give an estimate of the amounts the private sector should be willing to spend on ETP SMR research priorities provided that public co-financing is secured. Industry funding of collaborative projects very much depends on the accessibility of public funds and how easy it is for private businesses to participate in funding programmes.

4.3. Human Resources

In the tables 1 to 6 in chapters 3.2 and 3.3 we tried to estimate the amount of human resources needed for each activity from today's point of view. It is absolutely clear that this could only be a rough estimation and is in more or less any case matter of concretion in the project development process.

However, the figures gave an overview about the large amount of human resources necessary on the way to fulfil our vision. In general the question is: Does the mineral industries and related sectors currently have this necessary amount of human resources and is the sector able to provide them for research activities? If the answer is yes and it is likely though, the next question is: Is the education level of the personnel high enough for performing scientific tasks in research projects?

The answer to the latter question is not so easy. The minerals sector does currently not have a good standing in Europe. There are parts of Europe, where the minerals industries get a certain amount of support in their attempts to meet the challenges of globalisation and improve or at least only remain their competitiveness. However, there are even more parts in Europe, where the minerals industries have to struggle hard in order to only do its job.

The education related to the sector therefore is also affected to a large extent by this attitude of non-regarding. Since the eighties of the last century a number of educational courses in the fields of mining and minerals engineering have disappeared – most likely without any chance to re-appear again.

However, mining and minerals engineering was, currently still is and will continue to be a booming business worldwide. This causes a big demand in well educated and trained engineers and other staff in order to fill the gap raised by retirement of older staff. The companies realised some 10 to 15 years ago the necessity for pushing and also financially contributing to excellent education courses with the overall aim to be able to recruit enough staff also in the future.

Unfortunately, mining and minerals engineering is not a high priority in Europe. The consequence is that there is only limited and sometimes even no public money available to support at least the education in this field. But also Europe needs well-educated engineers because there are still a lot activities going on in mining, geology, mineral engineering or minerals processing. Even more, it is not seen that these activities will terminate in the future, because minerals are the basis for European prosperity.

The trend of industry contributing to education courses happened all around the world, e. g. in Australia, South Africa, America, Canada, etc. Also in Europe the education in mining and minerals engineering has been restructured and adapted to the emerging needs and the reduction of students. Some newly structured related courses are currently successfully running. Industry and academia had joint forces and founded the FEMP, which seems to be a success story in higher education although we can always learn from other countries and systems.

Europe still has a big need for well educated engineers in mining technologies, geology and minerals engineering and processing. Europe has to take care to at least maintain, better extent, the educational capacities in order to guarantee success of all

the research intentions outlined in the ETP SMR research agenda and in this document.

But different to the other parts of the world Europe also faces a gap between education and research. In the M.Sc. phase it is usual that education has strong links with research. M.Sc. students play an important role in assisting the PhD students by working on parts of their projects.

There are some 50 to 60 M.Sc. students in Europe per year. In order to fully utilise this potential it is essential to structure the research into a number of fields which are considered being of high importance for the industry in the upcoming years. Centres of excellence, which can be individual universities or even combinations of universities and probably also research institutes, can focus on particular fields.

Australia uses a similar concept since 1990. They have established the so-called Cooperative Research Centres (CRC) Program. The objective of this program is to enhance Australia's industrial, commercial and economic growth through the development of sustained, user-driven, cooperative public-private research centres that achieve high levels of outcome in adoption and commercialisation.

In order to improve the situation in Europe and especially for the European minerals industries the establishment of such a system is crucial. We have to continue with the educational system that currently runs quite successfully. Complementary to this we have to establish a research strand, where the students can carry out research work to the benefit of the industry.

Such a system needs the support of both, the industry and the public. Joint efforts in this direction will support a positive development into the right direction necessary for the ETP SMR to fulfil its vision and objectives. However, this means that the minerals sector needs significantly more public financial support in order to first stop the decrease of related educational capacity in Europe and afterwards reverse this trend and increase the capacity again according the need of the sector accompanied by adequate research capacities. The industry is already investing significantly in higher education related to the sector through supporting FEMP. However, significant public engagement is also necessary to guarantee that the European minerals industry will be able to successfully contribute to the recently formulated intentions of sustainable raw material supply in Europe.

4.4. Building Capacity and Sharing Knowledge

Communication, Stakeholder Dialogue and public engagement

ETP SMR technologies are in most cases seen as having a significant impact on society. Thus, public confidence in the minerals industry is generally low and some groups in society might perceive it as potentially high risk in terms of potential for negative impacts on health and the environment. Industry responses, if any, to such issues may be characterised as defensive, reactive and sometimes insensible. Many members of the general public are unaware of the sector's contribution to today's society and to sustainable development. Moreover there is often a gap between industry's vision of sustainability and how technology can contribute to it, and the vision of other stakeholders including the public. There is a need to understand what

the underlying elements of these, often dissimilar, visions are, where the common grounds are and how consensus can be developed.

For the ETP SMR technologies to get accepted by society and applied in a sustainable way, an informed dialogue between all stakeholders (industries, down stream sectors, academia, policy makers at EU and national level, environmental groups, and other interest groups) is needed, as well as innovative communication through media and targeted activities on the introduction of new products and technologies.

This social dialogue helps building trust, demonstrating that "industry cares" about sustainability and social responsibility, strengthening common core values and communicating them, but also help the industry by proactively understanding and responding to societal concerns leading to a truly sustainable and successful product and technology development.

The overall aim of this project is to develop an inclusive dialogue with all stakeholders to understand their concerns regarding the implementation of ETP SMR technologies, and through the dialogue to build-up an approach to address these concerns, including public engagement and communication activities.

Two parallel projects are proposed on: stakeholder dialogue and communication, which will set-up the first steps towards a societal approach to the implementation of ETP SMR products and technologies.

In order to initiate and run these activities, a working group will be established, which will include representatives of industry and academia, social scientists and communication experts. Successful implementation of these activities is based on commitment from ETP SMR stakeholders, including industry, regarding their active participation in this process, as well as taking on board the recommendations and best practices developed.

Stakeholder dialogue

The main objectives are:

- The identification of expert and stakeholder views regarding factors that can influence implementation and sustainable use of new products, processes and technologies.
- The development of a dialogue process based on current and improved methodologies, together with a monitoring procedure, including impact assessment, to provide feedback and improve the process.
- The application of the dialogue process in ETP SMR context on all the identified influencing factors and concerns regarding technologies and products, particularly perception, risk- and cost-benefit aspects.
- The formulation of recommendation to the ETP SMR stakeholders on how to address the concerns, based on the dialogue results.

The process of stakeholder analysis and dialogue needs to be systematic. Various approaches are reported in the literature and will be made use of in this study.

The proposed project will facilitate an analysis of stakeholder views and improve public stakeholder dialogue. The results will be used to develop a societal approach

for the introduction of new sustainable technologies and products. In turn is likely to improve public trust in the sustainability approach of the minerals industries and facilitate the acceptance of these technologies and products by society.

Key activities are:

- To conduct a background study / survey on the existing social and stakeholder dialogue as well as communication activities, and the issues already identified as creating concerns among the stakeholders and the public.
- To conduct a stakeholder consultation exercise to identify issues of concern specific to ETP SMR: The main objective is to identify and understand the views of stakeholders regarding impacts, products and processes in extraction and processing of minerals. The currently periodically running stakeholder forums should be part of this strategy.
- To develop ways of addressing the identified issues of concern in a transparent manner within the dialogue process.
- To monitor progress of the stakeholder dialogue both from a methodological and outcome perspective and to use this feedback for improving the dialogue process itself and the approach to address stakeholders' concerns.

Outputs of the entire project will include the following:

- A summary of the findings of the survey on stakeholder views
- Recommendations and guidelines regarding the development and maintenance of effective stakeholder dialogue on the implementation of innovative technologies.
- A raised level of awareness among stakeholders of the sustainability of actions of the minerals industry necessary to fulfil the demand of mineral based raw materials and the commitment of industries to sustainability.
- A well-defined consensus vision of what role sustainable minerals and raw materials provision could and should play in societal development along the three pillars of sustainability: people, planet, profit.
- Evaluation and use of innovative ways of communicating with stakeholders and the public.

The stakeholder dialogue is seen as an ongoing action. The start-up phase and implementation of the initial frame for the working environment will take some 1 to 2 years. In this phase of establishing the dialogue process we see the need for a budget in the order of 1,5 million €. Funding needs to come from the EU and from national research programmes, and may require industrial contribution. The work will be steered by the ETP SMR working group on stakeholder dialogue and the ETP SMR Steering Board. It will be carried out with the assistance of social and marketing researchers. The continuation of dialogue activities will require further funding.

The proposed activities will serve to develop a network interlinking activities across other existing and emerging technology platforms as well as European and national activities for enhancing a societal approach to the introduction of emerging technologies, processes and products.

Communication plan

ETP SMR has already communicated to the public and other stakeholders. However, there are still some issues of concerns to the public and decision makers and therefore need to be addressed rapidly in a coordinated way. The implementation of a improved communication strategy is a priority, although this will be continually refined according to new insights gained in other parts of the project and to results obtained. The following initial steps are required if an effective communication strategy is to be developed:

- Systematic analysis of existing communication activities regarding issues identified as relevant to ETP SMR, including how different approaches are focused on the needs of different target groups, and assessment of the impact of these communication activities.
- Prioritisation of the issues and target groups to be considered within ETP SMR communication plan.
- Build-up of a network of science journalists, and develop information specifically designed for the press to increase their level of understanding in the ETP SMR related technologies, as well as setting a reference point for press information.

Public communication activities developed on that basis should be initiated proactively using common PR tools to raise public awareness and interest in the benefits for the society of ETP SMR work. The success of existing and novel communication activities needs to be evaluated and the key ETP SMR communicators should be trained in public communication and media relations in order to improve their public impact.

These activities go beyond ETP SMR actions. It is therefore crucial to identify groups efficiently setting-up and carrying-out communication plans and work with them on ETP SMR issues.

To summarise, the horizontal activities proposed will facilitate the development of a consensus vision of the necessity of actions to provide the society with the demanded amount of mineral raw materials and products in a sustainable way and the role the industry sector could play in societal development along the three pillars of sustainability (people, planet, profit). It will well take into account the preferences and concerns of all stakeholders, end-users, and members of society as well as of the industry itself.

Education, Skills and Capacity Building

This point has already been discussed to some extend in chapter 4.3. The priority for a project on this issue is to establish how best to build the skills and capacity, within academia and industry, required to realise the vision on one hand and the needs of skilled workforce on the other hand. In order to do this, an initial study is required to evaluate if the current European education and training programmes meet the needs of ETP SMR as well as the needs of the industry.

The specific project activities include:

- Compiling information about best practice for stimulating an interest in minerals engineering and technology in school children and retaining the best students through to related university courses.
- Conducting a survey of industry to establish the degree to which current education and training programmes will be able to provide appropriately skilled workforce both in terms of quantity and quality.
- Running a series of workshops with participants from higher education institutions and industry aimed at disseminating the findings and stimulating the development of:
  - new education and training programs and courses
  - programmes and measures aiming at building-up an adequate capacity to provide appropriately skilled people
  - measures to improve the scientific excellence of people aiming at a scientific career.

The outputs from these activities will be:

- A report outlining best practice for integrating minerals engineering and technology issues into school curricula in order to motivate the best students to take related university courses.
- A report with recommendations based on an analysis of the ability of current education and training programmes to provide appropriately skilled workforce.
- A series of European workshops to communicate the results of above studies with a view to stimulating the development of new related courses and to increase the numbers of appropriately trained people to meet the needs of both the industry and the related scientific community.

Due to the longer term perspective of the issue the project will run for over 5 years. The total funding for the project is estimated to be € 200,000 for first 3 years for conducting two surveys and producing final reports. A further € 20,000 will be required for workshops to disseminate the findings and to develop actions to be taken forward. Industry, the European funds related to education and training, the European Social Fund, and other sources will be approached for project funding.

Education plays a part in most other Technology Platforms. There is a need to benchmark these other activities in the initial research phase of the study.

5. Annex: Detailed Description of Short-Term Research Priorities

5.1 New Exploration Technologies – 4D resource modelling

Issues to be addressed

The next generation geological information will be stored in 3D-GIS databases and the current 2-dimensional geological mapping will probably be redundant in the near future. By implementing available technology and develop the technology used for example within oil and gas exploration for use in crystalline bedrock it will be possible to start build 3D-resource models of areas of Europe where subsurface geological information is available either direct or indirect. This is the case in mature mining belts and this proposal therefore focuses on such areas.

Important issues to be addressed include:

- Mineral belt thematic mapping in detailed scale (c. 1:10 000). Data sets include e.g. geological units, hydrothermal alteration, metal zonation, geohydrology, deformation/tectonics, magnetics, gravity, seismics, electromagnetics, electric, radiation.
- The same parameters for depth information from mines, drill holes etc. Extractive industry today produce metals from depths down to over 1000 m in Europe and substantially deeper in other parts of the world. Information should be assembled so that robust 3-dimensional models can be achieved for the top 5000 m of the earth crust within mineral belts in Europe.
- Integrated genetic models for deposits, involving key predictive exploration signatures for each commodities (European world class deposits include VMS, Porphyry Cu-Au-Mo, mafic-hosted Ni-PGE, orogenic gold, epithermal base and precious metal deposits, and also intrusive hosted and skarn type Sn-W deposits).
- Mineral belt hydraulic modelling of fluid flow paths, present and ancient.
- Adaptation of new exploration techniques, remote and down hole equipment for 3-dimensional tomography
- GIS/CAD visualization of deposits, mineral belts including predictive test models. Models can also include financial and legislative limitations. A common European format is recommended for transparent evaluation of targets within the enlarged EU.

3D-geo-models are now becoming available for mineral belts in, for example, Australia, Canada and other countries where advanced science is devoted to buried mineral deposits. These cross-disciplinary geo-models are commonly termed “common earth models” (CEM´s). Currently 3D GIS in crystalline bedrock is developed in countries like Australia and Canada where economic geology research has been and still is at the most advanced state globally, in order to support their domestic mining industries which in both countries contributes substantially to the national GDP. Therefore, cutting edge state of the art experience can be gained from these countries. For Australia some of the largest ore belts have become the focus for 3D-modelling. The Australian examples are built with VRML (Virtual Reality

Modelling Language). VRML is an open source language, developed by the Web3D Consortium, where 3D data is derived from geological software modelling applications such as GOCAD®. Similar systems are also currently being developed in Canada, for instance in the ”Targeted Science Initiative III which is a national funded project at National Resources Canada for 2005-2010 targeting metals in existing mining communities (5MC$/year, approx 27 MSEK/year).

The proposed project will be the most ambitious multidisciplinary earth science project ever on this scale in Europe. It is the aim of the project consortium to attract a triple helix interest for the project, so that government and local authorities can work together with industry and academia to build the latest, most robust geo-models of subsurface Europe.

Why is the project needed?

EU is a large net importer of most metals and industrial minerals. While the EU produces only 3% of the global supply of metals it consumes over 20%. At the same time investment in exploration for new mineral deposits by European exploration companies is low compared to all other regions in the world. A sustainable supply of metals and minerals will in the future be based on a balance between production and consumption. There are no indications that the European demand for metals will decrease, but contrary most calculations points to an increase in demand which is higher than population increase. There are no geological reasons why a better balance between production and consumption could be achieved by EU. Many regions within EU_{25} are active mining regions with a large potential for further discoveries. However, since investment in exploration is not in line with most other regions the understanding in modern terms of the exploration potential for these regions is behind many other regions. While Europe hosts many world leading experts in economic geology, they are scattered in small research groups and their research is in many cases directed to regions outside Europe. The focus of many national geological surveys has also moved away from resource geology. Consequently balanced production and consumption figures calls for a better documentation of the European exploration potential, a focus of economic geology research on Europe, and building of critical mass in the scattered research community by either networking or concentration of research resources to a few world class research environments.

By providing better predictive mineral assessment data for European extraction industry more investment will occur within Europe. Increasing the domestic EU supply of minerals by 10% of EU consumption of the main metals Al, Pb, Zn, Cu, Ni, Fe and Au will lead to an annual increase in capitalization of c. 7 billion € invested within Europe. By increasing the investment in Europe, mine life of many mining regions can be extended and new mineral belts detected. This leads to work opportunities in many parts of EU with high unemployment figures and will help to sustain regions which otherwise would have negative demographic trends. This could be exemplified with the mature mineral belt, the Skellefte district in northern Sweden, where base and precious metals have been mined for almost 100 years. In this belt, as is the case with most other mineral belts in Europe, most deposits that outcrop have been discovered, but from the geological viewpoint just as much metals exist from 500 meters to 1000 m below surface as in the top 500 meters. The total in situ value of these yet undiscovered metals is estimated at around 100 billion €. Understanding of the sub-surface and successful exploration would lead to 1) substantial extension of mining activities >50 years, 2) employment opportunities for several thousand persons

in mining and downstream industries in an area remotely located, 3) Infrastructural drive for development of an EU-regional development funded area, 4) Technology drive for underground deep mining with minimal environmental impact and zero waste. The same estimation of quantifiable impact can be made for many other mineral belts within EU.

The justification of this proposal in relation to EU policies can be summarized as:

- Provide a knowledgebase of subsurface Europe in 3D-GIS
- Provide a knowledgebase for political decisions on land use in Europe
- Secure the supply of raw materials for existing/new downstream industries
- Less environmental impact of mining (increase in underground mining)
- Reduce European dependence on import of metals and minerals
- Avoid conflict in land use (NIMBY)
- Economics-value of reserves/resources
- Substitution by new commodities (industrial minerals/special metals)

What is likely to happen under a "do nothing" scenario?

As described above the concern for the supply of minerals to the EU economy is a key driver for this proposal. If Europe is not concerned about its domestic supply of metals and minerals the dependence on import will then be an unavoidable fact. In a scenario where the globalisation will drive the competition for resources parallel with the industrial boom in China, India, Brazil and other emerging world economies an increase in dependence of import of natural resources will harm the European economy in several ways. Less R&D within the sector proposed here will in the long term mean:

- Increase in unemployment in geographical areas with high unemployment
- Increase in costs for European downstream industry
- Threat of liquidation of local SME´s
- Vulnerability of EU in the case of global unrest
- Increase in land use conflicts
- Poor knowledgebase for political decisions on infrastructural development

Returns and benefits

If successful the proposed project will be a first step in developing 3D-GIS information on subsurface Europe. In other words the aim is to take the step from 2-dimensional traditional geological mapping (in traditional GIS systems) to implementation of standardized queriable 3D GIS. This step is now possible to take where we have good knowledge from remote (geophysics) and direct (drilling, underground excavation) methods, i.e. in mature mineral belts, or alternatively in urbanized areas with large underground infrastructure. This proposal focus on the former since the focus is on securing the supply of European mineral and metal resources.

The expected outcome of this proposal can be summarized as:

- Less EU dependence on imports
- Improved knowledge base for mineral resources
- Long term access to mineral resources (access to land bank)
- Increase world exploration by EU companies
- Increase awareness of policy makers/public
- Increase in employment in remote areas of EU
- Economic sustainability of mining regions

Proposed actions

The project is intended to constitute a matrix where scientific components constitute one dimension and geographical areas constitute the other dimension. Within each geographical area a subproject consortium will be built that develops a detailed roadmap for this area. This means that the various scientific components will not be implemented in all areas (depending on state of the art of existing geological information in relation to the complexity of the bedrock in the area. The proposal is broken down into the following actions:

- Identify geographical areas (see detailed project outline)
- Identify scientific components necessary for each geographical area
- Identify project consortium for each geographical area, incl. financial commitment
- Construct road map for each geographical area
- Schedule field components
- Build 4D models for each geographical area
- Standardized 4D models for Europe. Data base construction, visualization, maintenance
- Reporting

Project outline and timeframe

This proposal will require a setup achieved by a FP7 Integrated Project (IP). The time frame for logistical reason would be a minimum of 4-5 years in order to implement technology in all geographical areas.

Project consortium, strengths and commitments

This proposal is identified as a project which has gained a large interest from industry, national geological surveys and academia. So far emphasis has been on establishing a strong consortium among industry and geological surveys. It is anticipated that when this consortium is in place academia will follow from already established research links with industry and geological surveys. The reason for including both industry and geological survey are twofold: 1) These organisations are together the owners of most

pertinent datasets and also in house employ many leading experts and 2) these organisations will both be utilising the results from the project.

The project consortium at the present is:

Boliden (Sweden, Ireland), BRGM (France), GTK (Finland), KGHM (Poland), Luleå University (Sweden) members HLG: support from CzGS (Czech Republic), G.E.O.S. (Germany), IGME (Greece), IGME (Spain), Hellas gold (Greece, tbc), Lundin Mining (Sweden, Ireland, Portugal, tbc), INETI (Portugal), Pyhäsalmi Mines Oy (Finland/Inmet), GSR (Romania), Petrosani Mining University (Romania), MINVEST Deva (Romania),Baia Mare Northern University (Romania), Geological Survey of Slovenia (Slovenia)

Implementation

Implementation has currently reached item 3 on the action list where commitment from individual partners of the proposal is discussed. This includes financial commitment and the status varies between geographical areas. For the Scandinavian consortium a financial commitment is already established between industry and academia for the geographical area “the Skellefte district”. In other parts of Europe discussions are ongoing and currently a itinerary to visit key partners in each area is being established.

EU co-financing sought

The proposed budget is 30 M€. This is based on 6 regions for 5 years and 1M€/belt/year. At a 50% EU-financing of the project the amount sought from EU will be 15 M€. These are indicative figures. Exact figures depend on the need for new data collection and are individual per region.

5.2 Subsea mining and deep offshore underwater extraction

The exploitation of raw materials located in deep offshore (i.e. water depth > 500 meters) is nowadays a solution to tackle a worldwide difficulty: the unavoidable increase of the consumption in hydrocarbon and minerals, and therefore of their price.

New technologies have to be developed to reach the future areas of extraction with more cost-effective solutions. This will also enable to keep our market leadership against the severe worldwide competitiveness.

The skills and the long experience developed in the offshore oil and gas sector will be useful to other industrial sectors with which a share of issues will enable to elaborate a common solution that automatically will be less expensive for all and be for the benefit of our community and our environment.

The public research – including both research institutes and universities - associated to a particular industry sector is an accelerator and a cross fertiliser of technology solutions between different industrial sectors. The public sector is the ingredient to accelerate the competitiveness of SMEs.

New R&D programmes aiming at the development of new systems have to be launched now to produce deep offshore raw materials in the mid-term (by 2012).

The goal of the future project “Subsea mining and deep offshore underwater extraction” is to achieve this issue through the building of pilot units in order to:

- Speed up the pre-industrialization of our products to cut the technological risks due to the commissioning;
- Own a know-how showcase to attract new clients from France, Europe and abroad.

The targeted markets are linked to the potential of the deep offshore reservoirs and to their economical values guaranteed by the development of cost-effective technologies. All the oceans and different raw materials are concerned: oil and gas, polymetallic sulphides, manganese nodules, ferromanganese crusts, etc., where deposits of copper, zinc, lead, silver, gold, barium, cobalt, nickel, manganese and iron can be extracted.

The project will be partially funded by national French public agencies targeting such cutting-edge innovations. The project is multidisciplinary and involves numerous various actors (SME, public research centres, multinational, etc.) from Europe.

5.3 Biohydrometallurgy is relevant to European resources of non-ferrous metals

Why this initiative?

The European resources in base metals are characterised by a major occurrence of complex and low-grade ores, sometimes in large reserves. The ores of European deposits are thus generally difficult to concentrate in materials which are poor materials for feeding pyrometallurgical installations.

Consequently, Europe is almost totally dependent on importation for the metals it needs for its industry.

The question of securing the supply in metals in Europe was not seriously considered as long as the global demand was more or less stable and below the potential capacity of the current installations of production.

The sudden rise of the economic growth of the emerging countries has radically turned upside down an apparent picture of stability and of over-production compared to the needs. As the growth of countries like China and India is predictably going to continue and is already followed by the wake-up of other regions of the world, it is largely admitted that the metal demand and thus prices are going to remain at high levels.

On another hand, the hibernation of the development activities in mineral processing in Europe for many years has resulted in a lack of capacity of innovation to tackle if not the issues of the present time, the problems of the future. The fact is that metal producing companies of worldwide magnitude have focused their activities on resources to be mainly exploited with relatively conventional technologies in other regions of the world than Europe.

Meanwhile, European mining companies have not had the critical mass of RTD means individually and the support of the European Union to aggregate too scattered capacities to invest in research for technological innovation that could result in a breakthrough required for making European mineral resources technically and economically accessible to a viable exploitation.

Another issue that Europe has hardly addressed until now is concerning the abundance of wastes that mining and metallurgical industries have produced after centuries of activity (mining wastes, metallurgical slag, metal bearing scrap and combustion/power plant ashes) and that could be regarded as secondary resources of metals. These potentially new deposits are often sources of environmental pollution that could be remedied by an economically viable exploitation in using innovative and sustainable technologies.

The Integrated Project BioMinE and the STREP project Bioshale supported by the European Commission in the frame of the FP6 have investigated the application of biohydrometallurgical treatments to the European mineral resources. The objectives of the projects have been to assess the techno-economic feasibility of biotreatments on benchmark resources and to evaluate the sustainability of these processes applied in the European contexts.

From the exploitable results of these projects it comes out that the maturity and the diversity of the biotechnologies developed have reached such a level of confidence that biohydrometallurgy can display various alternatives of processes that could enable the exploitation of the typical sulphide complex ores of base and other metals of Europe in economical conditions. The upcoming start-up of the Talvivaara industrial project of recovery of nickel, zinc, and copper from a black shale ore in Finland is a demonstration of the capacity of biohydrometallurgy to propose solutions for processing ores that could not be exploited in conventional ways.

It has been confirmed through the two RTD projects that Europe has a solid basis of competences at the academic level in the Universities and of expertise in scaling-up of processes in research organizations and engineering companies covering the whole spectrum of hydrometallurgical technologies from the transformation of the minerals to the recovery of marketable metallic products.

BioMinE and Bioshale have produced results that are convincing for the application of biohydrometallurgical treatments to primary and secondary resources in Europe through experimentations up to the pilot scale. Demonstration-scale operations are now required to obtain the data that would validate the feasibility of these processes on as many resources as possible.

Scope of the proposed action

The proposed action has two directions.

The first one consists in the realization of demonstration operations of biohydrometallurgical processes as developed in BioMinE and Bioshale that have been identified as technically and economically relevant to the European resources.

The applied objective of the technical action would be to evaluate at a feasibility level the engineering of such processes applied to real cases covering the following aspects:

- Effect of the variability of the composition of the resources
- Determination of the following sets of data:
  - Operating conditions after optimisation of the process flow sheet
  - Detailed specifications of the equipment
  - Capital and operating costs
- Environmental assessment
- Sustainability

The second action would have the aim of networking the European expertise through the screening of the scientific and technical groups that could contribute by innovative approaches to an optimised control of the processes from the use of high-tech biomolecular methods to hydrometallurgical downstream treatments of the effluents. This action would provide a strong background of technical and scientific support to Europe initiatives ensuring a high-level position in the development of these technologies.

Outline of the action

The demonstration action would cover the feasibility assessment of the application of the bioleaching technique to three resources as identified as the best candidates for a full assessment of the bioleaching techniques to typical European resources. As a result of the investigations in the two projects of the FP6, it would concern one copper-bearing material treated by bioleaching in agitated tanks, one zinc-bearing concentrate treated by indirect bioleaching and a secondary resource treated by bioleaching in a low-cost bioreactor. These operations should not last longer than two to three years.

The coordination action which would stimulate the focus of capacities in universities and research centers on applied subjects for the development of biohydrometallurgical technologies would have the first task of defining the scope of works that have the highest level of relevance for accompanying the demonstration operations. The selection of the RTD topics would be carried out with the end-users that would contribute to the assessment of the technologies. The topics would be exclusively focussed on the applications selected for the demonstration operations. It might also include a screening and an evaluation of the European secondary resources of some interest for a possible treatment for metal recovery by the biotechnologies developed and cleaning of brownfield sites.

The implementation of this action should follow the definition of the targets of the demonstration operations. The duration of the coordination action should exceed the duration of the demonstration operations to constitute a support to the industrial implementation of the processes.

Who are the beneficiaries?

These proposed actions want to give a strong momentum to the implementation of biohydrometallurgy in Europe as it is applied in all other mining areas of the world because it is relevant to European resources and can help to impulse the constitution of an active community of experts in biological and hydrometallurgical applications.

The main beneficiaries must be the mining operators of Europe in reminding that a specificity of the biohydrometallurgical processes is that they are particularly profitable for small scale operations according to a mine-to-metal concept. Beyond the mining operators, that is all the sectors of the metal industry that are likely to benefit from a stronger local production of base metals.

Expected impacts

The main evident impact is to stimulate the mineral processing activities in Europe where it can be implemented for the benefit of the population in sustainable conditions with the highest requirements for the respect for the environment.

Such actions should catalyze the development of mining operations in Europe but also help the existing operations in improving the efficiency of recovery of metals and therefore in extending the life of the exploitations and potentially reducing the environmental impact as well.

The demonstration of the feasibility of the treatment of secondary resources for producing value through the recovery of metals and simultaneously reducing the footprint of mining activities would be of great impact on the credibility of the mining activities to be sustainable.

Promoters of the project

The promoters of the project should firstly be the end-users of these technologies, the European mining operators, interested in evaluating them through demonstration operations.

There should also be the research centres that need to update the portfolio of the technologies in order to diversify their capacity to deal with the mineral resources available that are more and more complex to exploit.

Available experience

BioMinE and Bioshale (http://biomine.brgm.fr , http://bioshale.brgm.fr) have enabled to identify more than forty organisations (Industrials, SMEs, Universities, and Research Organizations) which have gained a practical experience in this field of activities and on real cases of collaborative works. Many of them have very high level of expertise and are very motivated to confirm their results into real applications through demonstration operations.

5.4 Novel technology for mineral particle engineering

In the processes of non-ferrous ore enrichment the irrecoverable loss in flotation tailings reaches about 10% of the total usable mass of the metal contained in the ore, i.e. recovery of the metal, e.g. Cu, is 90%, while recoveries of Ag, Zn and Pb are lower.

The vast majority of the irrecoverable loss results from fine grains of minerals and their distribution within the ore, which does not allow those fine minerals to be transferred into the froth product – concentrate.

The main idea of the research project is selection of flotation multicomponent collectors and modifiers introduced in a form of flotation reagents, which are used for collecting fine grains of minerals or changing their properties, to transfer them into the froth product. In many cases that activity will involve also chemical treatment, for transferring the minerals into dissolved form, and than precipitation into a product which can undergo flotation.

Economical aspect of the subject refers to increase of recovery and decrease of irrecoverable loss, which means higher efficiency of the ore enrichment process, while the environmental one is related to better utilisation of the excavated ore and protection of resources, which are not needed in such a volume to produce the same mass of metal.

The planned project should extend for about 5 years. Polish side performers – Institute of Non-Ferrous metals and Institute of Catalysis and Surface Chemistry of Polish Academy of Science.

Estimated budget is 3 M€. The main beneficiaries are copper ore enrichment plants and Zn-Pb enrichment plants (from the Polish side O/ZWR KGHM PM and ZGH Bolesław, respectively), as well as manufacturers of flotation reagents. The expected result is final decrease of irrecoverable loss by about 1%, which —when considering current volume of production of metals in concentrates — means about 5,000 t Cu/year and about 1,000 t Zn/year.

The project shall cover laboratory basic research in the area of mineralogical studies, physico-chemical properties of minerals and reagents, mechanism of surface phenomena, mechanism of operation of selected flotation collectors and modifiers. The next stage is related to conducting investigations on model and large laboratory scale and in pilot installations. The selected flotation collectors and modifiers will be then verified in industrial applications.

5.5 Innovative methods for making value of tailings

Innovative methods in the processes of non-ferrous ores enrichment are implemented for two basic reasons:

- To increase efficiency by way of intensification of processes, implementation of new equipment, which brings decrease of energy consumption and maintenance and repair costs;
- Improvement of technological parameters, especially complete utilisation of ore material, decrease of irrecoverable loss and improvement of recovery rate.

The basic technological directions are as follows:

- Introduction of new flow-sheets using innovative constructions of machines and equipment;
- Recycling of the material which is now considered waste, e.g. dumped flotation tailings, where after application of the modern technologies it is possible to recover efficiently about 50% of the contained in them usable metals;
- Optimisation of concentrates quality, decrease of costs and better utilisation of metals in the whole technological cycle, from ore excavation to metallic products winning.

The project presents economic aspect, as it brings increase in efficiency of non-ferrous metals production, as well as environmental one, by recycling waste material and protection of existing mineral resources.

The project is expected to run for 5 years, and costs of research work as well as pilot tests should be about 4 M€.

The main performer from the Polish side would be Institute of Non-Ferrous Metals.

The main beneficiaries are ore enrichment plants (from the Polish side O/ZWR KGHM PM and ZGH Bolesław).

The results can also be used in the processes of enrichment of coal and rock materials.

The expected results are mainly related to costs decrease, especially energy consumption reduction, utilisation of waste material — such as dumped flotation tailings — for winning of non-ferrous metals.

The project will cover laboratory studies, model testing and experimental tests as well as verification in industrial conditions.

5.6 New technological processes for treatment of polymetallic materials with recovery of usable metals

The subject covers two main issues:

- Implementation of new technologies for recovery of metals, such as Co, Te from copper metallurgy semi-products, or In from lead refining semi-products, which today are not recovered, as well as new technologies to improve efficiency of already recovered accompanying metals;
- Implementation of new technologies for winning metals from waste materials, e.g. from lead metallurgy slag, at the same time transforming those slag from hazardous into non-hazardous waste.

There is an economic aspect to the subject (increase in efficiency of metallurgical production), as well as an environmental one (production of lead metallurgy waste slag which can be economically utilised either as road aggregate or in engineering works or dumped in environmental friendly way).

The time span for the project is 10 years. The costs of research work and testing will amount to about 20 M€.

The main performers are IMN together with universities working on basic research and physico-chemical properties of materials.

Among the beneficiaries will be copper smelters at KGHM PM, HC Miasteczko Śląskie, lead smelters (Orzeł Biały S.A., Baterpol S.A., HM Głogów).

Expected results are recovery of new commercial products (accompanying metals) from non-ferrous metals metallurgy, reduction in production of hazardous waste (slag) from lead metallurgy and decrease of environmental impact.

Scope of the project is basic research, studies into physico-chemical properties, laboratory tests, large scale and pilot testing and verification in industrial conditions.

5.7 Complete utilisation of materials from secondary materials and scrap treatment

The subject covers development of methods for utilisation of secondary materials or scrap which currently are not recycled or used in any other way.

The considered materials are scraps and multimetallic and multimaterial waste which contain non-ferrous metals, as well as scrap and waste from electric and electronic industry, which contain non-ferrous and precious metals.

The objective of the project is to develop technologies for recovery of non-ferrous and precious metals from those materials and adaptation of non-metallic waste into a form which can be used economically or dumped in environmental friendly way.

The solution to the problem will provide possibilities for recovery of non-ferrous and precious metals, which has very important influence on environment because complex and multimaterial scrap in large part are considered hazardous waste, the category which also include waste and scrap from electronic industry.

The expected results are utilisation of hazardous waste and improvement of environmental protection conditions (both with respect to production waste as well as scrap of used equipment and machines). The additional advantage is recovery of usable metals in a form of commercial semi-products.

Scope of the project covers laboratory investigations, testing in pilot installations as well as development of concepts and process designs for industrial installations.

The main beneficiaries of the project will be small and medium enterprises operating in the area of scrap and waste treatment.

Project timeframe will be about 10 years. The budget necessary for research work, testing and preparation of typical concepts and process designs for SMEs will be around 20 M€.

5.8 Helping cities in mining regions secure their strategic land, water and biodiversity resources by the use of modelling and economic tools

Why this initiative?

Economic, social and environmental questions have to be addressed in the cities of mining regions which see increases in urban expansion: with a great variability of minerals prices, climate and social uncertainties abound, particularly in Africa; the need for predictive resources assessment before opening a mine and after closure is compelling.

The presence of mining operations opens a series of issues for the local authorities, the central government and the operators:

- Rapid increase of migration looking for employment opportunities into neighbouring towns; mining cities is where urban growth is the faster;
- Cities have underfed budgets as the redistribution of mining rents at local levels does not necessarily cover the additional charges brought by these movements of population;
- Heavy pressures, besides those from the mine itself, are impacting local resources (land, water, air, ecosystems, wet zones, biodiversity...); long term safeguards imply immediate protection against short term risks.

Then, new initiatives are needed. Mines operators are often willing to help fund social or employment programs in particular to inspire day to day measures on societal and environmental concerns. But, looking further, the potential for voluntary cooperation is broad. Some questions should no be bypassed as they should prove that the designed cooperation can serve the public interest:

- When activity subsides or after mine closure, the labour force is leaving. Will the city be sustainable and use the interim period for diversification?
- In a context of climate change and rapid urban sprawl, how local economic development can be safeguarded, indeed enhanced.

What is suggested below is an approach that could help both cities and mines: tools for assessing and simulating future environmental risks and the ecological assets needed now and in the future to remain capable of facing these risks should be made available to civilian authorities. Managing complex ecosystems is easier when the expertise from the mine's qualified technicians is present nearby.

Important interdependencies between the mining and minerals industries and society: improve environmental care and communicate these improvements. The minerals industry has made a considerable work of participation in the EU environmental regulation and on adaptation to climate change; the present research projects will help in providing references on the way it could be implemented at the local level (Water and Waste framework directive, thematic strategy on soil...). There are yet few studies on the impacts of the "*acquits communautaire*" in a typology of local situations.

Scope of the proposed action:

It is suggested to focus on enhancing operating and anticipatory planning capabilities in a choice of typical situations of cities close to mines sites or in mining regions. In these places, the project would integrate fragmented areas in time and scale into a comprehensive biosphere and ecosystems monitoring. Modern ICT tools (remote and near field sensing technologies, integrated monitoring, modelling and simulating tools…) have made continuous progress for community *knowledge and communication* on their own resources (air, soil, water, vegetation, biodiversity, energy…) and their evolution. Thus a double benefit would be obtained:

- Illustrate by practical examples the link between environment protection, adaptation to climate change and economic benefits derived (including energy savings) in urban management;
- Facilitate stetting up norms and training for environmental urban governance. In these actions, the role of mining would be to facilitate understanding how local actors may practice the simple use of complex scientific models.

In parallel, there is a need to encourage the funding institutions (EIB, WB African development bank…) make it as a priority the support for aid decision tools as well as integrated urban environment planning and management.

The intention is to have a two years program depending on the number of volunteer sites interested in potential networking and the mining companies interested by this aspect of community's relations.

Outline of the action

Stage one: Heterogeneous data gathering, transmission and aggregation on urban watersheds limit; indicators for typical situations

- Choice of data to access and assemble about the way local resources will be needed, used and renewed in the short and long term, determining potential development options. An update of the basic information on the resources and the impacts is necessary. This supposes to set-up networks of observation tools (sensors, remote sensing…) at the representative places, in particular the extensions of the communities and the agricultural areas. This inventory includes the hydraulic surface and groundwater models and also the variations of the greenhouse gas emissions and the *albedo* amplified or reduced by urban extensions, agriculture and deforestation.
- Selection of indicators and models

Stage two: Development and calibration of decision support tools and economic models.

- Technical models must provide simulations: land use, climate variations, new technologies, change in biodiversity:
    - A geomodeler, to be adapted to the condition of continental surfaces and interfaces, to take into account data of the whole critical zone, canopy, soils, surface formations, aquifers, their heterogeneities and limiting conditions;

- A geochemical model for soil-rocks/water interactions, to be improved for saline and low quality waters used for irrigation in limiting water resources conditions;
- A crop model to be adapted to the conditions of climatic and land uses changes;

- Economical models to compute discounted costs/benefits for environmental assets and services provided by ecosystems and anthropogenic systems.
  These models will use data collected in the cities data banks, in the field and in the mine exploitation with sensors and assembled with new development of information and communications technologies.

Stage three: More flexible financing strategies: assess risks and show the costs and benefits of different strategies to manage these risks.

Who are the beneficiaries?

Local authorities and stakeholders.

While the metropolises and big cities are receiving a large share of the benefits of economic growth, the smaller cities of mining regions have often depressing finance. They need to show the value of their ecological assets and possible jobs creation for populations in search of employment outside of jobs directly provided by the mines. At least, the local mayors should get the tools needed to better understand *how to preserve their basic resources which are the long term life line of the cities after mining is closed*. The considerable progress achieved recently in ICT for monitoring and visualising local ecological assets should help cities management prevent environment degradation thus making local cities' resources more sustainable. They will benefit from what will result in a strengthening of their capacity to act.

The mining and minerals industries.

In places where ore and metal groups intend to have a long term presence, such a project will be an important signal for broad local acceptance. Local actors would be able to better face the risks to FDI, thus enhancing the competitiveness of industries located in adjoining cities or the State itself. In this case, the industry will be acting essentially as a facilitator in the setting up of scientific tools with an easy access for non professionals. Accessible information is an important part of local decentralisation and the contribution of mining should be part of its image. *This should facilitate the acceptability of the opening of new mines.*

Expected impacts

- New community water strategies and financing initiatives of PPP;
- Demonstrating managerial and financing capacity in complex dynamic situations.
- Promotion of public participation in local decisions;
- Demonstrate the benefits of e-governance which could help multiply positive initiatives replicable at a large scale.

In a global context, such an innovative project sharing modelling experience and technical progress by calculating how cities could improve on energy consumption and natural resource protection would be a *strong example of public/private convergence and participation, indeed one message of Corporate Social Responsibility.* This initiative could become a reference for the "cities of the future" and speed up global adaptation to climate change.

Promoters of the project:

Depending on the degree of engagement of the minerals industry and geological surveys on one or several projects should be proposed to countries and cities at the forefront of urban issues:

- The partners of the French project in the Marseille region;
- Companies or R&D participants from other EU countries.
- Development Funds

Available experience:

Project underway in France:

We will experiment in France a decision support system of urban growth impacts. It will be a typical site in the Mediterranean basin, the Crau/Camargue in the Rhône Delta and around Marseille. Expansions of Fos, first France's harbour and multimodal platforms, plus infrastructure intersections connecting Spain, Italy, France and northern Europe are *increasing pressures* on vulnerable land, air, and water resources. The competition between land used for the expanding infrastructure and space necessary for local agriculture and biodiversity is intense. It is also a risks prone region (flash floods, drought and coastal areas).

Sharing of competencies with mining

Among the priority research areas of the EU Technology Platform on Sustainable Minerals Resources, there are obvious possibilities of sharing competencies from minerals resources predictive assessments to other natural resources: for example, 4-D minerals belts models, geological data management and systems for resources endowment analysis….