

# *Finland's Minerals Strategy*



*Efficiently managed and sustainable utilisation of our mineral resources secures the long-term supply of raw materials at a national level, while creating the preconditions for stable regional development far into the future. Expertise in the minerals sector also enables Finland to effectively promote responsible and sustainable management of mineral resources within a global environment, as well as generating opportunities for new international business activities.*

## VISION 2050

*Finland is a global leader in the sustainable utilisation of mineral resources and the minerals sector is one of the key foundations of the Finnish national economy.*

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The availability of natural resources and resource-based industries production have become essential to prosperity and well-being in our rapidly changing world. However, the global distribution of mineral resources is rather uneven, with over 50% of the world's mineral production originating from politically unstable areas. At a time when the minerals industry is becoming more and more diversified, there is nevertheless an increased vulnerability to regulatory changes in access to resources, to obstacles in trade and commerce and to major fluctuations in commodity prices.

With regard to many critical metals and minerals, Europe is heavily or fully reliant on imports, so that disruptions in availability and supply can pose a significant risk. The EU has begun to address this issue by implementing the Raw Material Initiative in 2008. A number of related measures have been launched since then, including the attempt to formulate a uniform minerals policy for the EU. Finland has expressed its strong support for the initiative.

In addition to EU policy measures, national strategies are required to secure resources and to promote the minerals sector. Accordingly, the ministerial working group on climate and energy policy has commissioned the preparation of a Minerals Strategy for Finland. The key terms of reference have been to anticipate international and domestic development trends in the minerals sector over the next few decades, and to make recommendations concerning the formulation of a sustainable minerals policy and the development of the minerals sector in a way that satisfies the needs of both society and business.

The minerals sector covers the mining industry, which produces metallic ores and industrial minerals, as well as other extractive industries that refine rock material and natural stones. The minerals sector also includes companies who produce the machinery, equipment, technology and services required for extraction and mining.

Finland's diverse mineral resources represent a significant part of the Finnish national wealth. Finnish expertise and innovations in the minerals sector also have a significant global impact, through the provision of exploration and mining equipment and processing technologies and services. Effective utilisation of our mineral resources both secures the supply of raw materials and creates the prerequisites for balanced and sustainable regional development far into the future. Through our expertise in the minerals sector, we can also actively promote a global minerals economy that is both efficient and socially and environmentally responsible, as well as generate new international business opportunities.

Three strategic objectives and 12 action proposals related to four distinct themes have been defined to facilitate implementation of the minerals strategic vision.

### Strategic objectives:

- Promoting domestic growth and prosperity
- Solutions for global mineral chain challenges
- Mitigating environmental impact

### The themes of the action proposals:

- Strengthening minerals policy
- Securing the supply of raw materials
- Reducing the environmental impact of the minerals sector and increasing its productivity
- Strengthening R&D capabilities and expertise

## The significance of minerals

Mineral-based materials, products and structures are used either directly or indirectly in almost every area of our life. Modern society's dependence on minerals has grown over a long period of time, and no change to this trend can be seen. Prosperity, security and the opportunity for self-fulfilment, which are closely related to higher living standards and well-being, are likewise based on the utilisation of minerals in many ways. New technologies and environmental challenges have still further expanded our need for raw materials and mineral-based products.

Modern society requires the use of mineral-based products in the construction and maintenance of housing and other buildings, earthen structures, railroads, road networks, power lines, pipelines and other infrastructure. Industrial production and manufacture of machinery, equipment, vehicles and ICT technology are largely based on the utilisation of mineral-based materials. Mineral fertilisers, and agricultural machinery are also vital to food production.

In addition to an increased need for basic metals, we are becoming more and more dependent on so-called high-tech metals. These are relatively rare metals, yet essential in the manufacture of advanced technological products, including circuit boards, semiconductors, coatings, magnets, mobile phones, computers, home electronics, solar panels, wind power plants and electric cars. On the other hand new materials and new technologies can drive to innovation in the more efficient use of raw materials.

As well as direct wealth creation from mining and value-adding to mineral products, the minerals sector has a much broader impact on society through employment in services and infrastructure development. The mining sector has played an important role in industrial development in Finland, having begun with small scale processing of bog iron and grown through larger scale mining operations to become a globally acknowledged and diverse provider of mining equipment and processing technologies. This success in value-adding, from extraction through to high-quality metal products has also sustained commerce and employment, even in areas remote from mining activity. This current era of increased demand for minerals and changing global markets also presents new opportunities for expansion and diversification of mining operations, and for business growth based on innovative developments in refining and processing technologies.

Mineral-based products are essential in many areas that are important for the national economy. Although the direct contribution of mining to the overall European GDP is rather modest, the economic impact of value-added industries is considerably greater. The EU estimates for example, that together with met-

als manufacturing and the construction industry, the production based directly and indirectly on the minerals sector accounts for approximately 40% of gross domestic product.

The widespread distribution of mineral deposits, which may be located remote from urban centres, and the nature of extractive operations also provide opportunities for long-term, decentralised and regional economic development. In the current global economy, where production can be relocated and changed at an increasingly rapid pace, extractive operations can provide regional community stability and continuity – the concept of a quarter in the extractive sector effectively corresponds to 25 years.

**“Material well-being requires the use of minerals – anything you can't grow, you have to dig from the ground.”**



## Global challenges

An increase in population, more rapid urbanisation and higher material living standards have resulted in an unprecedented demand for metals, minerals and rock aggregates. It has been forecast that 60–80 million people will move annually to cities, and as many as 70% of the population will live in cities by 2030. At the same time, the middle class is becoming larger and more affluent. Urban expansion encroaches upon agriculture and the natural environment. As a consequence, to guarantee adequate food supply in the future requires that agriculture will become more efficient, which in practice means that mineral-based fertilisers, machinery and equipment will be used to a greater extent.

Despite the continual increase in demand for mineral resources, there is no risk of rapid depletion of raw materials - the Earth is made up entirely of minerals. In addition to identified ore resources, a large number of sub-economic mineral deposits are known, which may become economically viable in the future, depending on their geographic location, demand and fluctuations in commodity prices, and the introduction of new beneficiation technologies. Our knowledge of the mineral potential of many areas continues to be deficient, and our level of understanding in areas that have been extensively surveyed is usually limited to the near-surface environment. The success of a new mining operation requires both adequate mineable reserves, and the availability of an appropriate technology for ore processing.

Future mining operations will have to be increasingly based on underground operations and exploiting deposits having lower concentrations, or which are technically more difficult to process. Competition for available water and energy is becoming more intense, which may prevent mining activity in some areas. Responses to these challenges require innovative technological developments throughout the entire extraction and production chain. Permit procedures are also becoming more demanding, which can lead to delays in processing. These factors, when combined with a continuous increase in consumption

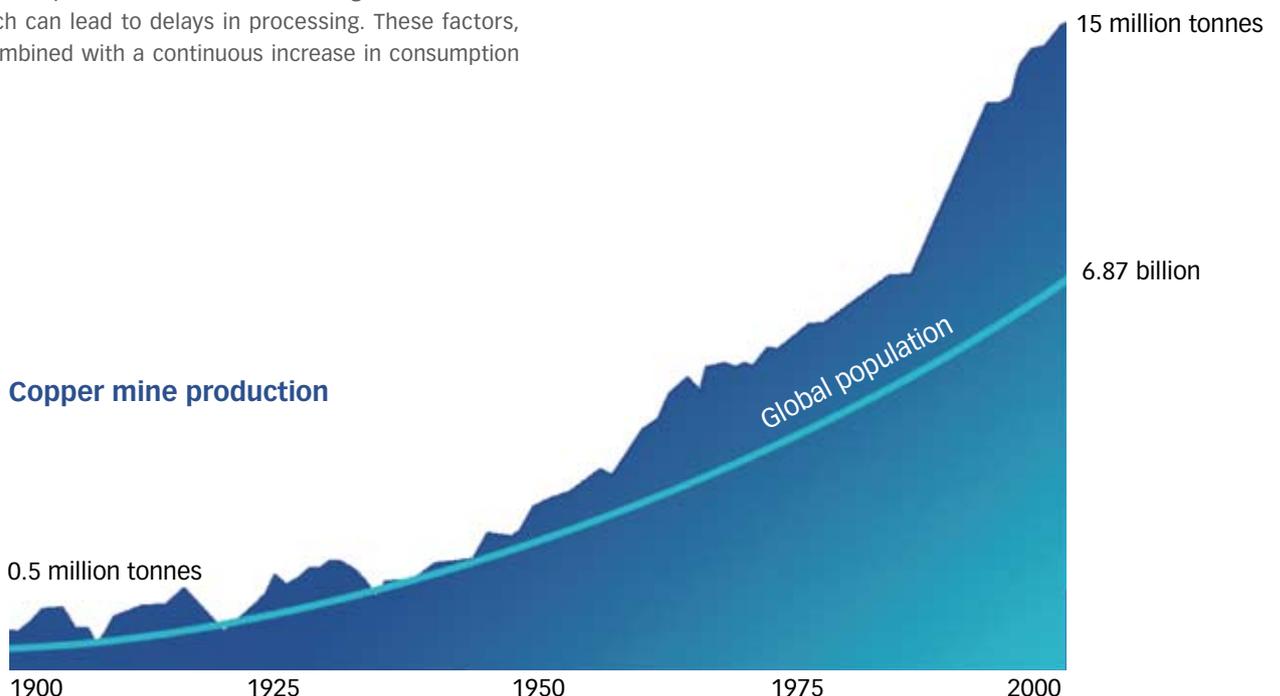
and demand, raise metal prices, which in turn provides incentives for seeking either alternative raw materials or improving recycling efficiency.

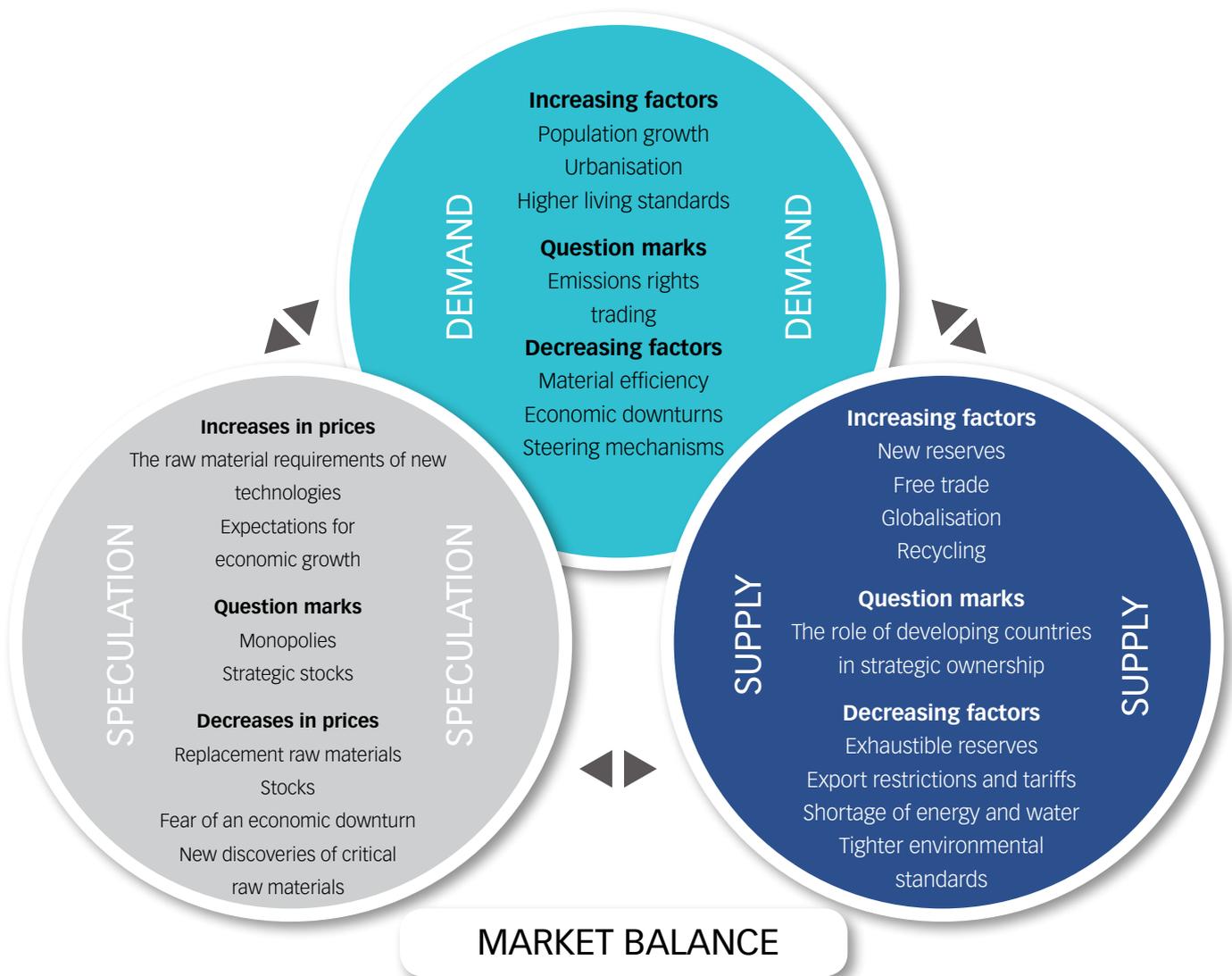
Metals and minerals are non-renewable natural resources. However, the lifespan for products derived from metals and minerals is typically long, of the order of decades, and they can be recycled effectively. However, recycling can only partially meet the current demand for minerals. For example, more

**“Population growth, higher living standards and technology development require more extensive and diverse mining activity.”**

than 80% of copper is recycled but due to rapidly increasing demand, and the fact that the average life of copper products is more than 30 years, recycling covers only one-third of current needs. The increased use of metals can be considerably slowed through careful product planning based on material efficiency and recycling. Price increases, as well as adoption of new and replacement materials, can also lower the demand for traditional raw materials.

The rapid expansion of information and communications technology, and developments in new energy technologies have created an entirely new demand for a range of metals, that were previously only used to a small extent. Accordingly, only a relatively small proportion of these metals can be sourced through recycling. To meet the growing demand for these metals, new mines are required, as well as more effective techniques for the recovery of high-tech metals as by-products of other mining activities.





The uneven distribution of global mineral deposits, due to underlying geological factors, is a key reason for production and consumption being focused in different countries. Risks relating to availability and supply are emphasised in analyses by the World Bank, according to which more than half of all mineral production originates from politically unstable areas, with the production of many critical raw materials being centralised in very few countries. For example, China is a major producer of critical metals, but increasing domestic demand has led to export restrictions and tariffs.

### Future scenarios

Global socioeconomic development and its potential impact on the minerals sector in the next few decades are difficult to forecast. The prosperous Asian superpowers have increased the demand for mineral resources in a way that has totally transformed the global market in the minerals sector. Governments are having an increasingly important role in mining activities and the resolution of problems relating to sustainable production and consumption will require closer political cooperation in the future.

In 2010, the World Economic Forum published three alternative scenarios for the mining sector, extending out to 2030. In one scenario, the world adopts a more environmentally aware approach, conserving natural resources. In this case, extractive industries operate according to high environmental standards

and sustainable development policies have a key role in society, alongside conventional economic performance indicators. However, according to this scenario, it is considered unlikely that such policies would be implemented in all developing countries endowed with mineral resources, especially those which are becoming increasingly significant to the world economy and for which current growth rates are expected to continue for a long time.

The initial assumption for the second scenario is that a new kind of globalisation emerges, in which developing countries, led by China, assume control. Free world trade continues, but the ownership of major mining companies and technology industries within the sector is transferred to the developing countries. Mining activity becomes more efficient, but commitment to environmental perspectives and legislative controls does not receive common approval, particularly in developing countries. The experts contributing to drafting Finland's minerals strategy consider this scenario to be the most likely during the next few decades.

In the third scenario, the individual ambitions of developing countries and their trading blocs or alliances dominate, with protectionism and bilateral agreements potentially forming impediments to free world trade. The availability of strategic mineral resources becomes a critical factor in the development of society. Commodity price fluctuations are rapid, and the global coordination of developments of the minerals sector becomes more difficult.

## Minerals policy in the EU

The availability of mineral raw materials is very important for the prosperity of Europe. The combined turnover of the construction, chemical, automobile, aeroplane, machinery and equipment manufacturing industries is about EUR 1,300 billion, and they provide employment for 30 million people. Since EU industries are generally heavily reliant on imported raw materials, measures by both the EU and individual member countries are needed to secure the supply of mineral resources.

Europe is largely self-sufficient in the production of industrial minerals and aggregates. However, the sustainable supply of aggregates faces major challenges because there are extensive regional differences in the availability of aggregate resources. In Finland, for example, the available resources near most population centres are only sufficient to meet short-term demand

EU member countries consume 25–30% of metals produced globally. In contrast, metal production within the EU is only about 3% of global production, and many important metals are not produced in Europe at all. The overall intensity of metal use



*Building a typical family home makes use of 250–400 tonnes of aggregates.*

in the EU is slowly decreasing and as in other developed countries, recycling is becoming more efficient, and new replacement materials are being found. Despite that, it is expected that European industries will, for a long time to come, remain vulnerable to disruptions in metal supply and to market volatility. An important issue with respect to material recycling is that an increasing volume of recyclable materials is being exported, legally and illegally, to developing countries.

The European Commission has taken measures to improve the long-term availability of raw materials through implementation of the Raw Material Initiative in 2008. According to the initiative, maintaining transparency in the world market for raw materials must be encouraged. Production and consumption must move towards improvements in reducing waste and conserving resources, and in promoting sustainable utilisation and recycling of raw materials. Measures must be taken by the EU and individual member countries to promote the utilisation of raw material resources within the EU, while enhancing expertise and developing new technology in the sector. A favourable operating environment must be secured by developing and integrating legislation, permit procedures and land use planning. The Raw Materials Initiative also aims to create a uniform minerals policy for the EU and member countries. This could also act as the basis for global minerals policy measures in the future.

The European Commission has already investigated best practice options for land use planning that balances extractive operations with other forms of land use, and for expediting permit-

ting processes. These measures would prevent the exclusion of large areas from mining purposes and also otherwise improve the operating environment for the sector.

The Commission has also listed so-called critical metals and minerals, for those commodities that are highly important to industry and society, and whose availability is subject to risk and uncertainty. The overall consumption of many critical metals may be rather insignificant, but their production is very centralised. China, for example, produces the majority of rare earth metals and in recent years has imposed export restrictions, at least partly in order to centralise component and product manufacturing in China.

Action proposals defined in the EU's Raw Material Initiative:

- 1) Define critical raw materials.
- 2) Launch of EU strategic raw materials diplomacy with major industrialised and resource rich countries.
- 3) Include provisions on access to and sustainable management of raw materials in all bilateral and multilateral trade agreements and regulatory dialogues as appropriate.
- 4) Identify and challenge trade distortion measures taken by third countries using all available mechanisms and instruments.
- 5) Promote the sustainable access to raw materials in the field of development policy through the use of budget support, cooperation strategies and other instruments.
- 6) Improve the regulatory framework related to access to land.
- 7) Encourage better networking between national geological surveys with the aim of increasing the EU's knowledge base.
- 8) Promote skills and focussed research on innovative exploration and extraction technologies, recycling, materials substitution and resource efficiency.
- 9) Increase resource efficiency and foster substitution of raw materials.
- 10) Promote recycling and facilitate the use of secondary raw materials in the EU.

According to the Europe 2020 plan, released by the European Commission, the EU must develop a knowledge-based economy, which also is resource-efficient, low-carbon and competitive. The Commission has defined five measurable goals aimed at sustainable growth, including improving employment rates, investing in research and development, reducing emissions, improving the education level of young people, and reducing poverty. Achieving these goals presents major challenges, but they also are clear opportunities for the minerals sector.

## Critical raw materials as specified by the EU

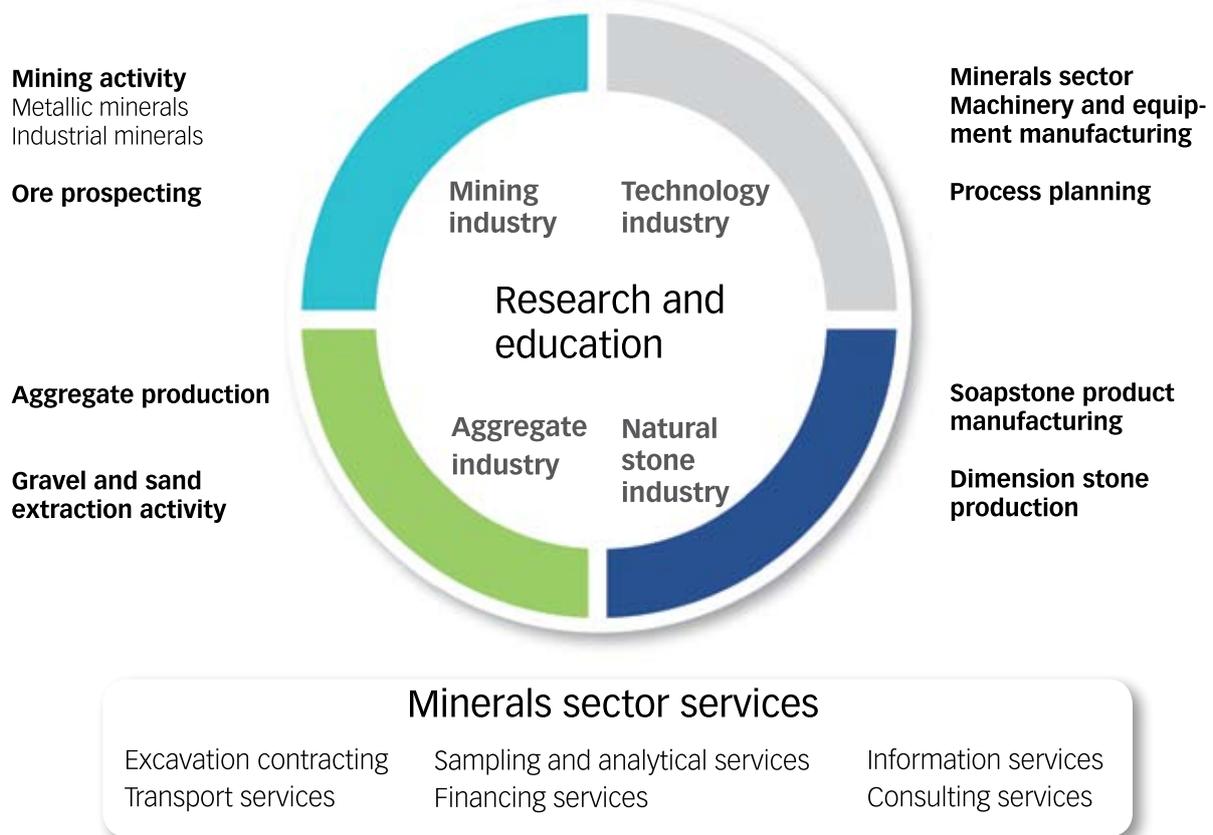
| Metal/mineral                       | Mining production in Finland | Discovery potential in Finland |
|-------------------------------------|------------------------------|--------------------------------|
| <b>Critical:</b>                    |                              |                                |
| Antimony                            | Deposits                     | Moderate discovery potential   |
| Beryllium                           | No deposits                  | Moderate discovery potential   |
| <b>Cobalt</b>                       | <b>Mining production</b>     | Good discovery potential       |
| Fluorspar                           | No deposits                  | Low discovery potential        |
| Gallium                             | No deposits                  | Low discovery potential        |
| Germanium                           | No deposits                  | Low discovery potential        |
| Graphite                            | Deposits                     | Moderate discovery potential   |
| Indium                              | No deposits                  | Moderate discovery potential   |
| Magnesium                           | No deposits                  | Low discovery potential        |
| <b>Niobium</b>                      | <b>Mining projects</b>       | Good discovery potential       |
| <b>Platinum group metals</b>        | <b>Mining projects</b>       | Good discovery potential       |
| Rare earth metals                   | Deposits                     | Good discovery potential       |
| Tantalum                            | Deposits                     | Moderate discovery potential   |
| Tungsten                            | Deposits                     | Moderate discovery potential   |
| <b>Economically very important:</b> |                              |                                |
| Aluminium                           | No deposits                  | Low discovery potential        |
| <b>Chromium</b>                     | <b>Mining production</b>     | Good discovery potential       |
| <b>Iron</b>                         | <b>Mining projects</b>       | Moderate discovery potential   |
| Magnesite                           | No deposits                  | Moderate discovery potential   |
| <b>Manganese</b>                    | <b>Mining projects</b>       | Moderate discovery potential   |
| Molybdenum                          | Deposits                     | Moderate discovery potential   |
| <b>Nickel</b>                       | <b>Mining production</b>     | Good discovery potential       |
| Rhenium                             | No deposits                  | Low discovery potential        |
| Tellurium                           | Deposits                     | Good discovery potential       |
| <b>Vanadium</b>                     | <b>Mining projects</b>       | Good discovery potential       |
| <b>Zinc</b>                         | <b>Mining production</b>     | Good discovery potential       |
| <b>Economically important:</b>      |                              |                                |
| Barite                              | No deposits                  | Moderate discovery potential   |
| Bentonite                           | No deposits                  | Low discovery potential        |
| Boron                               | No deposits                  | Low discovery potential        |
| Clay minerals                       | Deposits                     | Moderate discovery potential   |
| <b>Copper</b>                       | <b>Mining production</b>     | Good discovery potential       |
| Diatomite                           | No deposits                  | Low discovery potential        |
| <b>Feldspar</b>                     | <b>Mining production</b>     | Good discovery potential       |
| Gypsum                              | No deposits                  | Low discovery potential        |
| <b>Limestone</b>                    | <b>Mining production</b>     | Good discovery potential       |
| <b>Lithium</b>                      | <b>Mining projects</b>       | Good discovery potential       |
| Perlite                             | No deposits                  | Low discovery potential        |
| <b>Quartz</b>                       | <b>Mining production</b>     | Good discovery potential       |
| <b>Silver</b>                       | <b>Mining projects</b>       | Moderate discovery potential   |
| <b>Talc</b>                         | <b>Mining production</b>     | Good discovery potential       |
| <b>Titanium</b>                     | <b>Mining projects</b>       | Good discovery potential       |

# The Finnish minerals sector

The Finnish minerals sector covers a diverse range of activities, including the mining of metallic ores and industrial minerals, as well as other industries that extract and process aggregates and natural stones. The minerals sector is also considered to include industries that produce and supply machinery, equipment, technology and services for mining operations. In addition the minerals sector is supported by various institutions

process, as is ongoing exploration in order to define new ore resources. In Finland, exploration and mining activities fall under the jurisdiction of the Finnish Mining Act, and also the Environmental Protection Act, with respect to assessment of environmental impact.

The mining industry is global in nature and through acquisition



including research organizations and agencies, universities and technical and trade schools.

## Mining industry

Mining activity comprises the excavation of metallic ore deposits and industrial minerals. Mining of ore deposits and production of concentrate is the first step in a process that leads on to refining and ultimately to high-value industrial products. In the case of industrial minerals production of concentrates and marketable end products is typically a more direct process. It is important to appreciate that the discovery and delineation of mineable ore deposits, prior to economic feasibility assessments is an essential and integral part of the mining

and consolidation has become increasingly dominated by a small number of transnational mining houses. Nevertheless, a multitude of smaller mining companies and junior exploration companies still operate in the sector. The smaller exploration companies typically aim to discover deposits that can be sold to mining companies. In Finland at present, the majority of exploration and mining companies are small or medium-sized mining companies, most of which are listed on and funded through foreign stock exchanges in Toronto, London, Stockholm, Oslo and Sydney. In fact, the mining sector is one of the few industry sectors that is substantially targeted by, and dependent upon, foreign investment in Finland.

Outokumpu Oyj is the only traditional Finnish mining company that still mines metallic ore (the Elijärvi chromite ore deposits at

Kemi). The Talvivaara Mining Company Plc, which recently commenced exploitation of the very large, low-grade polymetallic Talvivaara nickel deposit has a majority of Finnish shareholders. In the industrial minerals sector, Nordkalk Corporation, which has limestone quarries in Parainen, Ihalainen and Lohja, is the only significant Finnish operator.

Mining activities undertaken by foreign-owned companies in Finland include the Kittilä gold mine (Agnico Eagle Mines Ltd),

**“Diversity in the minerals sector offers competitive advantage for Finland.”**

zinc and copper at Pyhäsalmi (Inmet Mining Corp) and phosphate from the Siilinjärvi carbonatite (Yara International ASA) In combination with the increased demand for raw materials, the recognition of the mineral potential of Finland has stimulated interest and growth in the minerals sector. As a result a number of new mines are being opened in previously unexplored terrain, while production in proximity to old mines is being increased.

The minerals sector differs from other industries in that the location of operations is dictated by geological factors, which effectively means that mining operations cannot be relocated to countries with lower expenses. Conversely, the mining industry has the potential to create long-term employment opportunities, as is currently evident in eastern and northern Finland.

**Aggregate industry**

Annual aggregate production in Finland is about 120 million tonnes, and the aggregates sector is the biggest extractive industry in Finland with respect to tonnage. Approximately 22 tonnes of aggregate materials per resident are used annually in Finland. The term aggregate is applied to either crushed rock or gravel and sand. Production of crushed rock has increased in recent years due to the limited availability of gravel and sand, particularly near population centres, where demand for aggregate materials is greater. Aggregate extraction is regulated by



*An average Finnish family owns thousands of items based on mineral products.*

the permitting procedures designated in the Land Extraction Act and the Environmental Protection Act, and in areas in proximity to water resources, is also subject to the Water Act.

Activities central to the aggregate industry operations comprises raw material procurement, administration, permit acquisition, production, logistics, sales and the landscape rehabilitation and monitoring. In Finland, a special characteristic of the sector is that production is usually assigned separately to companies

**Finnish minerals sector in numbers**

|                          | Mining industry <sup>3</sup> | Natural stone industry <sup>1</sup> | Aggregate industry <sup>1</sup> | Technology industry (minerals sector) <sup>1, 4</sup> | Total  |
|--------------------------|------------------------------|-------------------------------------|---------------------------------|---|--------|
| Number of enterprises    | 20                           | 311                                 | 315                             | 21  | 667    |
| Number of establishments | 41                           | 353                                 | 386                             | 41  | 821    |
| Turnover (€ million)     | 808                          | 251                                 | 563                             | 2, 012  | 3, 634 |
| Personnel                | 3,489                        | 1,848                               | 1,801                           | 4,868   | 12,006 |
| Exports (€ million)      | 85 <sup>2</sup>              | 83 <sup>2</sup>                     | 14 <sup>2</sup>                 | 1,520 <sup>5</sup>                                    | 1,702  |

<sup>1</sup> Statistics Finland (2008) <sup>2</sup> Customs Finland (2008) <sup>3</sup> Etla (preliminary data 2010) <sup>4</sup> Etla and Asiakastieto Oy <sup>5</sup> Customs Finland (2009)

Exploration companies are not included in mining industry in this table.

carrying out crushing and quarrying contracting. Rudus Oy, Lemminkäinen Infra Oy, Destia Oy, Morenia Oy and NCC Roads Oy are aggregate companies, which operate nationally and dominate production, with hundreds of smaller companies operating alongside them.

Transport of large volumes of aggregates can become prohibitively expensive over long distances, more than several tens of kilometers. Accordingly, the aggregates business is almost always local, meeting the needs of nearby construction and society. Aggregate extraction competes with other land use activities and priorities, so that availability of materials of the right quality near the point of use is a critical factor in production.



*Constructing one kilometre of motorway demands 50,000 tonnes of aggregates.*

### **Natural stone industry**

The Finnish natural stone industry has a long tradition, and Finland is well-known internationally as a producer and exporter of granite. Examples of the use of Finnish natural stone can be seen all over the world. The City of St. Petersburg, for example, was largely built with Finnish stones. Currently, China is the most important market for granite.

Natural stone production extracts large stone blocks for mechanically upgrading of finished or intermediate products in Finland. Soapstone ovens and other products represent the highest degree of upgrading in the industry. Tulikivi Oyj and Nunnauni Oy are the most important companies manufacturing soapstone products. The Finnish soapstone industry is the world market leader. The degree to which materials quarried as dimension

**“Regardless of the location of an underground mine, 70–90% of the technology required by the mine originates from Finland and Sweden.”**

stones, such as granite, are refined and dressed varies more extensively and intermediate products are exported, to China in particular. Many small companies are active in this sector, with Palin Granit Oy being the main operator.

In the case of soapstone and limestone, natural stone extraction is regulated by the Mining Act and the Environmental Protection Act. The excavation and utilisation of other natural stone

products are mainly subject to the Land Extraction Act and the Environmental Protection Act.

### **Minerals sector technologies and services**

The long tradition of mining in Finland has generated a manufacturing industry that is recognized internationally as a leading supplier of mining equipment and machinery and processing plants. Indeed it is claimed that when an underground mine is established anywhere in the world, 70–90% of the required technology comes from either Finland or Sweden.

Mining operations extract ore either underground or in an open-pit mine, and produce concentrates, by mechanical or chemical separation of ore metals and minerals from host rocks. The specific type of enrichment and refinement process required may vary considerably from mine to mine, so that a broad range of expertise and adaptability is needed. Processing technologies are also being increasingly driven by a need to be more energy-efficient and environmentally compliant.

The entire ore research, extraction and refining chain requires specialized skills and competence in using designing and using a variety of machinery, equipment and processing technologies. Mineral exploration relies heavily on the use of geophysical techniques and drilling equipment, while ore extraction requires expertise with drilling, crushing, blasting and rockbolting and shotcrete spraying, to ensure stability of underground rockfaces. Loading and transportation often requires highly automated machinery which operates in tight places in mines, as well as technology designed for ore hoisting and transfer. Ore enrichment involves crushing, grinding, flotation, dissolution, thickening and filtering systems. The entire mining and beneficiation process is increasingly automated, and water and waste treatment must be regulated and monitored. Finland enjoys a reputation as a global leader in mine systems and processing technologies, represented by such companies as Metso Corporation, Normet Oy, Outotec Oyj and Sandvik Mining and Construction Oy.

In terms of tonnes per kilometre, the large volumes and masses of mineral materials represent the largest product group in road transport. This can present logistic and financial challenges, if mines and quarries are remote from existing infrastructure and transport distances to smelters or ports are considerable. Accordingly, the need for additional investments in railway, road and sea transport connections must be balanced against the feasibility of optimising distance between production and end-use, so as to minimise expenses and the amount of emissions.

Key minerals sector services include mine planning, excavation and crushing contracting, sampling, geophysical surveys, laboratory analytical services, beneficiation and enrichment tests, information services, permitting matters, and other kinds of

consulting. The minerals sector is also very capital-intensive and therefore requires effective financing channels.

There are numerous globally operating companies that provide services to the industry, but also a large number of established local SMEs. Service provider companies include: Ahma Engineers Ltd, Astrock Oy, Destia Ltd, E. Hartikainen Oy, Kati

### “Raw materials extracted in Finland are also refined in Finland.”

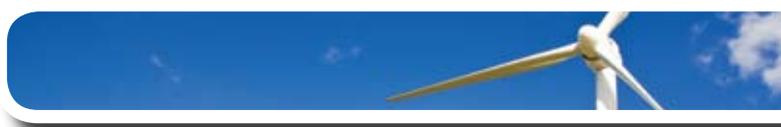
Oy, Labtium Oy, Outotec Oyj, Pöyry Plc, Ramboll Oy, Suomen Malmi Oy, YIT Corporation, and various financing sector organisations and lawyer’s offices. The Geological Survey of Finland also provides diverse consulting, information and processing technology services to the minerals sector, both within Finland and abroad.

#### Customer sectors

The chief demand for minerals sector products comes from the construction and metal refining industries, and in the manufacturing of pulp, paper, chemicals and other non-metallic products. At present, mining operations in Finland supply only 9% of the raw materials used in metal refining. However, this is changing with the opening of new mines, supplying a more diverse range of metals. In contrast, some 78% of the non-metallic materials required by industry, in wood and paper processing, construc-

tion, non-metallic products and chemicals, is already sourced from mines or quarries within Finland.

Mineral raw materials produced in Finland are only exported to a very small extent. Consequently, Finnish mineral raw materials primarily benefit downstream production within Finland. Moreover, it is expected that growth and diversification of the minerals sector will lead to a decline in the import of mineral raw materials.



*A wind turbine requires 250 tonnes of iron and over 20 different high-tech metals.*

As a whole, the total value of products from the most important Finnish customer sectors was EUR 66 billion in 2007 (Statistics Finland), with an export component of about EUR 23 billion. Regardless of the origin of the mineral raw materials, they clearly constitute a significant value-added production factor in the Finnish national economy.

### Downstream use of mineral raw materials by Finnish industry

| Raw materials                              | Total supply (imports + domestic) | Proportion of domestic supply | Export | Domestic consumption by customer sectors       | Proportion of total use | Value of main products of customer sectors | Export |
|--|-----------------------------------|-------------------------------|--------|--|-------------------------|--|--------|
| <b>Metal ores and concentrates</b>         | EUR 2.5 billion                   | 9%                            | 1%     | Metal refining                                 | 99%                     | EUR 12 billion                             | 68%    |
| <b>Other mining and quarrying products</b> | EUR 1.2 billion                   | 78%                           | 9%     | Construction                                   | 25%                     | EUR 30 billion                             | 0%     |
|  |                                   |                               |        | Manufacture of pulp, paper and paper products  | 15%                     | EUR 14 billion                             | 70%    |
|  |                                   |                               |        | Manufacture of non-metallic mineral products   | 14%                     | EUR 3 billion                              | 26%    |
|  |                                   |                               |        | Manufacture of chemicals and chemical products | 12%                     | EUR 7 billion                              | 63%    |

Statistics Finland, Customs Finland (2007)

## The minerals sector as an opportunity for Finland

Global changes in the minerals sector present many opportunities for Finland. Finnish bedrock contains significant known deposits of many critical metals and minerals, and has considerable potential for discovery of new resources. Finland also

**“Changes in the global raw material sector represent a major opportunity for Finland.”**

has a globally recognized position as a leading supplier of skills and equipment in the minerals sector. The question is: Are we able to make use of the opportunities provided by the increased global demand for minerals so as to bring further benefits to Finnish society?

The long-term goal of Finland’s minerals strategy is an active minerals sector which is globally competitive, secures Finland’s raw material supply, supports regional development and promotes responsible use of natural resources. The minerals sector has significant direct and indirect impacts on Finland’s national economy, employment and society as a whole. The minerals sector is already well-placed to serve as a platform for a sustainable and diverse export-oriented industry based on refinement and value-enhancement of mineral products and related technologies and services. However, this is only possible by providing an optimal legislative regime and business environment for the sector. This vision for the minerals strategy is therefore based on promoting knowledge and skills enhancement coupled with innovation research and development, as a basis for sustained and sustainable growth in the sector.

### VISION 2050

***Finland is a global leader in the sustainable utilisation of mineral resources and the minerals sector is one of the key foundations of the Finnish national economy.***

Global competitiveness

Secure supply of raw materials

Dynamic regional development

Life cycle thinking



**Minerals strategy objectives**

### **Promoting domestic growth and prosperity**

The minerals sector has significant potential to further enhance its position as a vital foundation of the national economy, particularly from the perspective of invigorating and sustaining regional development. However, continued development in the sector requires proactive support and commitment from both the Finnish Government and other relevant public authorities, to generate a business environment conducive to attracting ongoing, long-term investment. A positive attitude and approach is in general needed towards ecologically and socially sustainable utilisation of natural resources, as well as appropriate support for the education system, and for regulatory and administrative reform, and ensuring that logistic requirements are optimized. The expanding and rapidly diversifying Finnish minerals sector therefore has an important role to play in supplying raw material supply both in Finland and elsewhere in the EU.

The long-term utilisation of mineral resources should be included as a key aspect of nationally coordinated regional planning programmes, so that the relevance of the sector can be considered in land use planning and zonation at all levels of the decision-making process.

### **Solutions for global mineral chain challenges**

Sustained growth in the Finnish mining industry creates a favourable environment for maintaining technological leadership across the whole minerals sector. Awareness of both international and Finnish trends and product demand together constitute a strong, synergistic combination which stimulates innovation in refinement processes, and in product development and services, for both domestic and export markets. The global increase in consumption of mineral raw materials, together with growing environmental challenges, offers considerable potential for business activities promoting sustainable utilisation of mineral resources.

### **Mitigating environmental impact**

Finland should take a proactive role in implementing the principles of sustainable development throughout the extractive minerals sector, ensuring that mining and processing is compliant with established best-practice guidelines. Increasing the proportion of raw materials produced sustainably in Finland represents a significant step towards meeting these objectives, while at the same time gaining practical experience of implementation of sustainable mining strategies, which can then be applied elsewhere, for example in developing economies. Incentives for using environmentally benign raw materials, quality certification for materials and processes and the implementation of penalties through environmental taxes will be among the principal steering mechanisms for guiding reform in the sector.

### **Minerals sector challenges:**

- Greater volatility in the demand for mineral resources.
- Deposits are of lower grade, or are located at greater depth.
- Decline in availability of aggregates in proximity to locations of greatest use.
- Extractive operations are limited by competing forms of land use and access.
- Permitting procedures become more complex, and processes become longer.
- Increasingly difficult to recruit expert consultants and skilled labour.
- New exploration and beneficiation technologies must be developed.
- Water and energy consumption must be decreased.
- Emissions and waste need to be minimised.
- Utilisation of by-products and replacement materials must be enhanced.
- Automation in the mining industry must be encouraged.
- Health and safety issues and workplace atmosphere must be improved.
- Use of rehabilitated sites after mine closure needs to be promoted.
- The general acceptability and perception of the industry must be improved.
- Finnish ownership must be increased.



*Increasing food production leads to a 3% annual increase in global demand for mineral fertilisers.*

### **Mining industry**

In recent years, significant new mines have been opened in Finland, while existing mines have recorded increased production, and many more mining projects are in progress. It is anticipated that the total volume of metallic ore production will increase markedly by the end of the decade, with mining operations remaining strongly focused on the eastern and northern parts of the country.

Mining activities impact on regional economies directly through work income and the demand for locally based subcontractors and services. In addition, revenue from corporate taxes, municipal taxes paid by new residents and taxes related to higher consumption levels all increase. According to various estimates,

for each position generated directly by mining activity, three or four additional jobs are indirectly created. Mining activities will generally lead to a diversification of the regional business structure and may have a positive impact on other business areas through improved services and transport connections and other infrastructure developments.

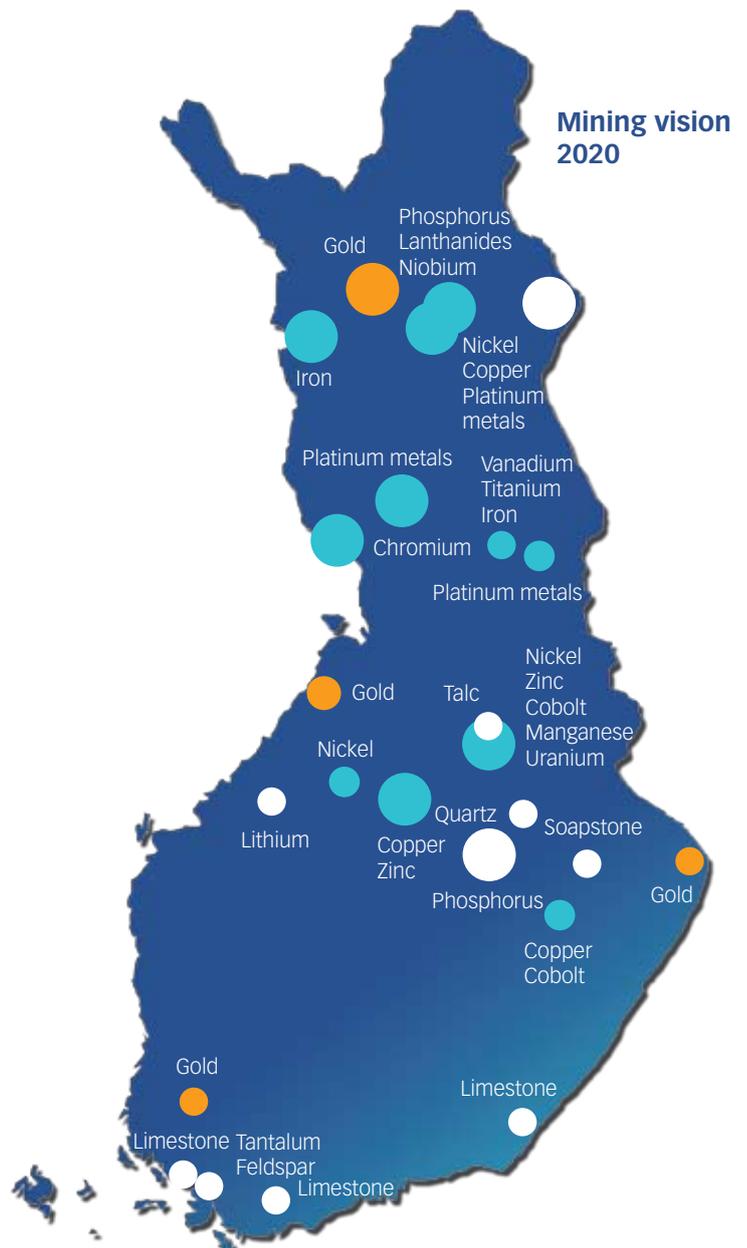
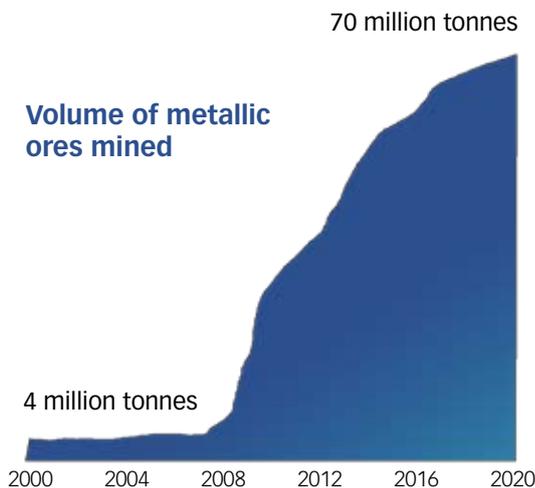
Over the long term, growth and diversification in the mining and minerals sector can only be sustained by discovery of new deposits. This in turn requires an ongoing commitment to exploration. Indeed, together with research into beneficiation technologies, exploration represents one of the key areas of mining industry research and development. On average, it can take 10-15 years from the commencement of an exploration program to the opening of a new mine. Moreover, exploration is a demanding, high-risk activity, such that for every thousand or so exploration targets evaluated, only a few will lead to discovery of an economically viable ore deposit.

The strategies of larger mining companies usually involve an international focus, seeking locations that offer the best opportunities for success on the basis of both geological potential and various socioeconomical factors. Recent international evaluations have placed Finland as one of the most favoured countries for targeting mining operations. Finland provides a good operating environment for exploration and mining activity - in addition to diverse mineral potential, Finland has well-developed infrastructure and legislation, as well as a stable operating environment. The Finnish Government actively promotes mining activity, and local communities generally tend to have a positive view of new mining projects. However, growing concerns in the sector include increased land use restrictions, more complex legislation and longer permitting processes. Efforts should continue to be made, through legislation and other means, to ensure that a competitive operating environment for exploration and mining investment is maintained.

The mining industry in Finland is one of the rare industrial sectors that is currently targeted by considerable foreign investment. Exploration is inherently a high-risk activity, and establishing a mine requires substantial capital investments. For maintaining

long-term growth, it is therefore necessary to further strengthening financing mechanisms that promote development of the sector. Contributions to high-risk investment by institutional investors and the government, either through direct ownership or as a creditor, are important because in this way mining and prospecting projects can be efficiently accelerated. An additional objective should also be to gradually increase Finnish ownership in the sector. In recent years, the government has begun providing support for infrastructure investment for mining projects; such support should be continued in the future.

Competition for land use, and related conflicts of interest, and restrictions on land access present increasing challenges to all forms of mining and extractive activities. Mines in certain areas may, for example, need to accommodate competing interests related to environmental protection and tourism. However, the area of land required by mining activities is commonly relatively small, and release of potentially harmful emissions from modern mines has been substantially minimised. Mining operations and



tourism, for example, can also offer mutual benefits through improved services and transport connections. It should also be emphasized that jobs in the mining industry are permanent in the long term.

Although mining operations may continue for decades, legislation now requires that applications for mining include a fully financed strategy for mine closure in an environmentally sound way and for post-closure monitoring. It is important to consult with and where possible, involve the local residents in mining projects at all stages, in order to develop appropriate procedures for compensation and to prepare for any problems caused to local communities by mine closures.

### **Aggregate industry**

The supply of appropriate aggregate materials – whether from sand and gravel, or crushed rock - is critical especially for urban community planning and construction. An adequate supply of aggregate resources must be assured at local government level through long-term planning, enabling large scale production areas and sound management practices, ensuring that extraction can also take place below groundwater aquifers. The introduction of extended permits, together with streamlining of the application process, should enable companies to invest in better and more environmentally sound production technology. Diverse options for using pits and quarries subsequent to cessation of aggregate extraction are being promoted, already in the initial stages of permitting, by drafting “cradle-to-cradle” plans.

In the future, gravel and sand will be even more difficult to obtain, and the proportion of crushed rock aggregates will accordingly increase, particularly in the vicinity of large population centres. The price of aggregate material at the site where needed will increase depending on availability, longer transport distances and requirements for higher quality materials. The total volume of material produced by the aggregate industry is directly proportional to growth of the national economy and construction volume.

The volume of alternative and recycled aggregate materials is expected to increase in the future. Such materials include recycled aggregates, demolition waste from the construction industry, and locally also waste rocks from mining activity or the excavation of natural stones. However, effective utilisation of these materials requires that any legislative obstacles to recycling are removed and that innovative research and development is promoted, with the additional aim of designing new products. Efficient material extraction and appropriately allocated use of materials require detailed and careful planning by communities and regulating authorities.

### **Natural stone industry**

The Finnish soapstone industry is centralised in the eastern parts of the country, at Juuka in Northern Karelia, and par-

tially in Kainuu, whereas the focus of granite production is in the Ylämaa area in southeastern Finland. However, there are numerous other natural stone deposits throughout the country that are yet to be exploited, and Finland has substantial building stone resources. Locally, the sector also has a significant employment impact.

Some 50% of the annual turnover of the Finnish natural stone industry derives from exports. The increase in the export of undressed stone is largely due to demand by the major buyers, China and India. Domestic and European markets are the most important for more extensively refined products. The emphasis on natural materials and high-quality construction work provides a solid basis for increasing uptake of natural stone products in future construction projects. The aim of increasing the use of bioenergy also serves to stimulate demand for fireplaces made of soapstone. In order to ensure that raw materials are accessible in the future, the requirements of the natural stone industry, including potential areas for quarrying, must be included within regional and local government land use planning activities.

An adequate and assured domestic supply of suitable raw materials is also an essential condition for the ongoing development of product refinement. The degree of refinement of building stones should in particular be increased, and related research and development should be carried out with structural designers, architects and industrial designers. Priority areas for development include production automation, improving the productivity and supply of quality materials and finding opportunities for using rock currently stockpiled as waste. The sector is also characterized by numerous small companies, which poses challenges for business management and the supply of skilled labour.

### **Minerals sector technologies and services**

The current strengthening of the mining and minerals industries in Finland presents new export opportunities for the sector as a whole. Refinements to existing production processes and further innovations in the sector provide a strong basis for future success. Some of the key challenges facing the entire sector are enhanced recycling of materials, more efficient use of resources, the search for alternative and new materials, and mitigation of adverse environmental impacts. Indeed, it is expected that advances in efficient use of resources, and implementation of intelligent systems, together with recycling initiatives that promote sustainable mining practices, will define the key future areas of growth within the sector.

Existing expertise across the breadth of the minerals sector in Finland can be integrated to develop new business opportunities and alliances, for example by combining skills and expertise in environmental and mining technologies with those in metals processing and machinery and equipment manufacturing. Without active intervention by the government, including contributing to R&D financing of the minerals sector, Finland will

not succeed as an innovative provider of technologies within the emerging green economy. A strong and sustained commitment to education, research, product development and commercialisation, integrated across sector boundaries will form the basis for new Finnish business models and activities in the minerals sector. The success of this approach will also require entrepreneur training and risk financing for both the SME sector and spinoff companies.

The European Raw Material Initiative places strong emphasis on efficient use of resources and the development of new technologies. A “resource-efficient Europe” is also one of the flagship projects of the Europe 2020 plan. This alignment between EU goals and national strategic objectives provides further opportunities for strengthening the minerals sector in Finland, by applying for EU assistance in developing new mining equipment and processing technologies.

Ensuring the stable supply of raw materials from sources outside Finland and the EU requires that the Finnish Government actively supports the EU in overcoming and eliminating barriers



*A mobile phone contains different chemical elements from over 20 different mines.*

to international trade, while at the same time promoting good governance and transparency in the mineral policies of developing countries. Indeed, the opportunity exists for a service-based consortium based on Finnish expertise, in developing regulatory regimes and administrative policies and institutions for the minerals sector in developing countries. At the same time, this could create export opportunities for Finnish industry and increase Finland’s international influence and support in expanding awareness of the impacts and responsibilities associated with the consumption of natural resources.

## **Education and research**

The Finnish minerals sector is facing a shortage of experts. The average age of specialists is high throughout the sector, but due to recent expansion and investments, demand for them is growing continuously. Training in Finland has also been poorly coordinated across the sector, while training programmes in the sector have been reduced and teachers have retired. In addition, the minerals sector does not appeal to young people, which is principally due to the characteristic cyclic nature of investment in exploration and mining and the general image of the sector. The mining industry also demands a skilled professional workforce trained in modern mining techniques, which in turn requires appropriate, comprehensive training programmes in universities of applied sciences, technical colleges and trade schools. There is no quick remedy in sight for the labour prob-

lem due to the low training volumes in the sector, and this is made worse by tighter global competition.

The concept of sustainability with respect to the use of natural resources must become an accepted and integral part of the educational system, in order to promote a wider understanding of the importance of raw materials and their geological context, alongside other teaching in the natural sciences. This is important not only to the general educational curriculum but also to economics and commercial studies in particular. Minerals sector training programmes must be further promoted over the medium and long term, with efforts to strengthen international connections. These objectives are aligned with those of the “young people on the move”, flagship projects of the Europe 2020 plan, which aims to improve education system results and facilitate young people’s access to the job market. Finland should accordingly actively promote the inclusion of minerals sector education objectives within the EU’s training programmes.

Attainment of the minerals strategy vision requires not only existing expertise but training and recruitment of a new generation of specialists to focus on priority areas. The business sector has an important contribution to make in this area, whereas public sector geoscience agencies should invest in minerals sector research programmes and international exchange programmes. The Finnish Funding Agency for Technology and Innovation (Tekes) should be implement a minerals sector research programme, aiming to develop new and innovative products, processes and services embracing all aspects of the mineral utilisation chain. Enhanced collaboration between research groups working in material sciences and metal refining can also open up new opportunities.

The visible inclusion of minerals sector proposals in the EU’s FP8 Framework Programme (2014–2020) is a key objective. Cooperation with Sweden in particular should be strengthened because Finland and Sweden are united through their very common mining histories, competence and challenges in the minerals sector.

### **Priority research areas:**

- Invisible and intelligent mining
- Innovative processes, automation and optimisation
- Efficient use of materials, energy and water
- Minimisation of emissions
- Chemical/biological beneficiation processes
- Geodata systems and multi-dimensional modeling
- Innovative exploration technologies
- High-tech metal exploration and beneficiation
- Recycling, new and alternative materials
- Environmental impact management and measurement

# Action proposals

## *Strengthening minerals policy*

1. The significance, growth potential and risks pertaining to the minerals sector should be recognized by the Finnish government and actively included within government policy programmes and parliamentary policy agenda. Minerals policy objectives are to be clearly defined and a stable, competitive operating environment is to be secured for the sector. The Ministry of Employment and the Economy strengthens its role as a key facilitator for the minerals sector. An expert working group is appointed to develop policy alternatives and to monitor implementation of the objectives. (TEM)

2. Finland assumes a visible role in implementing the objectives of the EU's Raw Material Initiative and in establishing a minerals policy in cooperation with Sweden and other mining countries in the EU area. Priority is placed on the utilisation of mineral resources within the EU area. An additional focus is on promoting good governance and infrastructure related to the utilisation of the mineral resources of developing countries. (TEM, UM, YM, GTK)

3. Improve the minerals sector's financing opportunities and increase Finnish ownership. Institutional investors and the government have a key role in this area by through continuing public support for infrastructure investments and through lending and loan guarantees for mine investments. (TEM, Finnvera plc, Finnish Industry Investment Ltd, investors, financing institutions)

4. Investigate the potential of using tax incentives to promote exploration for natural resources and for efficient use of resources. Establish whether state ownership is appropriate and beneficial with respect to sustainable and efficient utilisation of mineral resources. (VNK, VM, TEM)

## *Securing the supply of raw materials*

5. Compilation, interpretation and distribution of diverse geoscientific and environmental data are further enhanced, in order to promote sustainable utilisation of mineral resources and maintain their supply security. (TEM, YM, GTK)

6. Permit processing times are significantly reduced and permitting procedures are refined. This is to be achieved in part by improved cooperation between different authorities and by arranging joint hearings in the event of appeals being lodged against applications. (TEM, YM, Tukes, AVI, municipalities, businesses)

7. The supply and sustainable utilisation of mineral resources are regarded as integral to land use planning. Ensuring the adequate supply of aggregates to expanding urban centres

should be a priority area in regional and local government land use planning processes. Impediments to the recycling of aggregates are eliminated by developing incentives for recycling and re-use, and through logistic solutions relating to management of stockpiles, rates of consumption data and designation of intermediate storage sites serving multiple municipalities. (YM, regional councils, ELY, GTK, VTT, Syke)

## *Reducing the environment impact of the minerals sector and increasing its productivity*

8. The material and energy efficiency of machinery, equipment and processing technologies within the minerals sector are further improved. Incentives are created for the recycling and re-use of stockpiled waste materials, tailings, mineral products and earth materials associated with construction industries. Encourage the presentation of an annual award for excellence and achievement in resource efficiency. (YM, TEM, Tekes, companies, VTT, GTK, Motiva Oy)

9. Green economy business is promoted through cooperation between the SME sector and research institutes by combining expertise from throughout the entire minerals sector, with skills in risk management, land use planning and good governance. (TEM, YM, companies, universities, Tekes, VTT, GTK, Syke, Motiva Oy)

10. Establish mechanisms that promote cooperation between local residents, companies and the regulatory authorities to ensure sustainable well-being of individuals and communities throughout the entire life-cycle of mining activity. (TEM, YM, companies, ELY, AVI, municipalities, civic organisations)

## *Strengthening R&D operations and expertise*

11. Establish a research programme under the Finnish Funding Agency for Technology and Innovation (Tekes), aimed at developing innovative solutions, products and services in all areas of the mineral utilisation chain. (TEM, YM, Tekes, Finnish Minerals Cluster, GTK, VTT, universities)

12. Account for the minerals sector in the education administration's long-term planning, and the significance of metals, minerals and rock materials in everyday life is emphasised as part of environmental education at different educational levels. Teaching resources are reinforced in university training and research funding is ensured for leading research at the international level in selected fields. Specialized training programmes at universities of applied sciences, and technical trade schools are structured to meet future needs. (OKM, SA, universities, research institutes, schools, companies)

The organizations and agencies relevant to implementing recommendations are: AVI= Regional State Administrative Agencies, ELY= Centres for Economic Development, Transport and the Environment, GTK=Geological Survey of Finland, OKM= Ministry of Education and Culture, SA= Academy of Finland, Syke= Finnish Environment Institute, Tekes= Finnish Funding Agency for Technology and Innovation, TEM= Ministry of Employment and the Economy, Tukes= Safety Technology Authority, UM= Ministry for Foreign Affairs, VM= Ministry of Finance, VNK= Prime Minister's Office, VTT= Technical Research Centre of Finland, YM= Ministry of the Environment

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Other background material : [mineraalistrategia.fi](http://mineraalistrategia.fi)

# The minerals strategy preparation process

Finland's Minerals Strategy was drafted in response to a commission by the ministerial working group on climate and energy policy, as part of the Natural Resources Strategy of Finland. The Ministry of Employment and the Economy appointed the Geological Survey of Finland to coordinate the preparation process.

The strategy was drawn up over a six-month period during 2010, based on contributions from a team of more than 20 experts drawn from across the entire minerals sector. An additional 90 people were invited to support the process, representing various stakeholder groups in the minerals sector, from industry to nature conservation organisations. This larger group contributed to drafting the strategic document through online surveys and seminars.

HMV Public Partner Oy was assigned a consultancy role in the strategic process, being responsible for the technical implementation of the surveys and the workshops, while assisting in background reports related to the content of the strategy. A dedicated website was also launched for the minerals strategy, so that anyone who was interested could access an open survey at the site and submit their development proposals. For a more detailed description of the process, see [mineraalistrategia.fi](http://mineraalistrategia.fi).

## Specialists involved in drafting the minerals strategy:

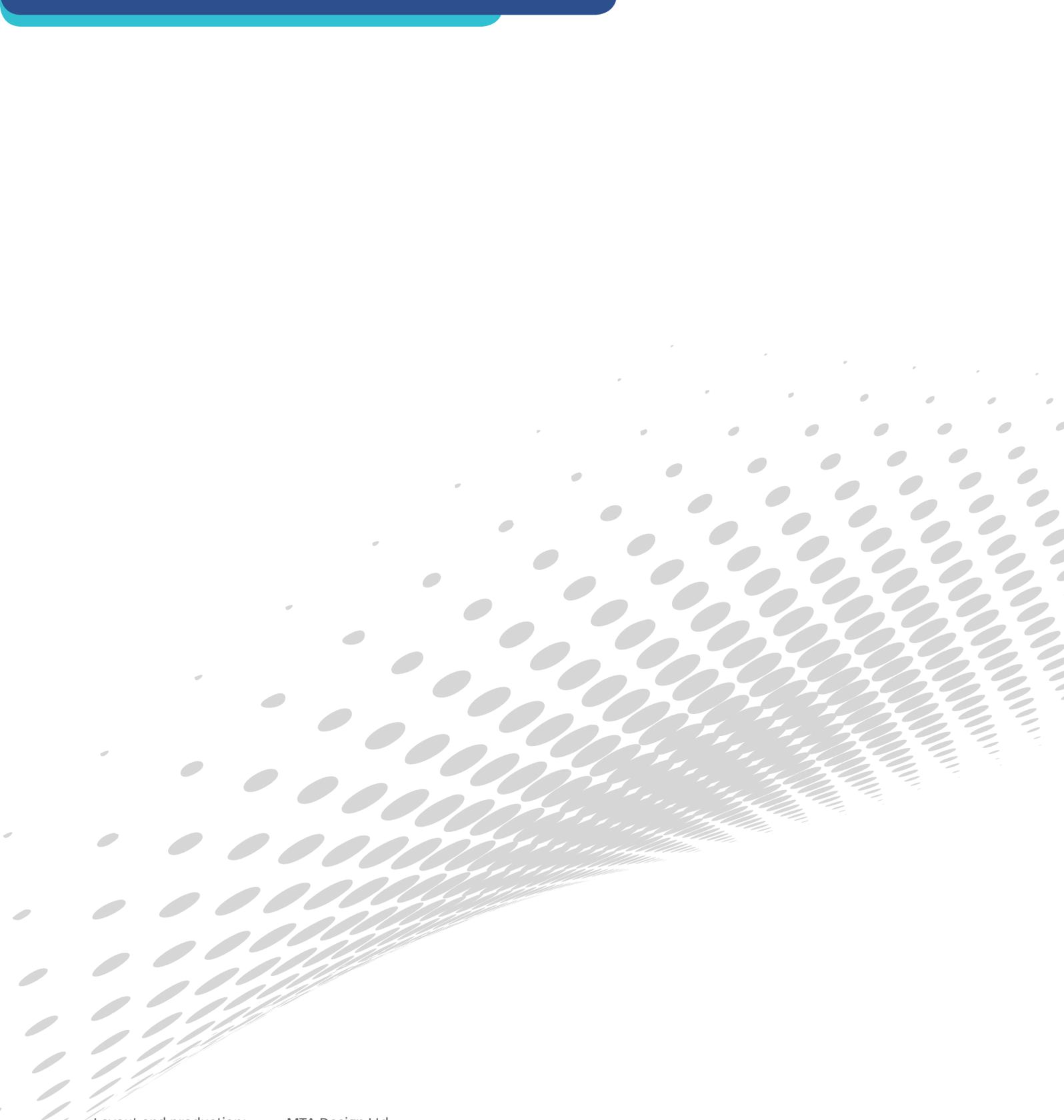
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This report is available for downloading online ([mineraalistrategia.fi](http://mineraalistrategia.fi)), or from the Geological Survey of Finland, telephone 020 550 2450 or email: [julkaisumyynti@gtk.fi](mailto:julkaisumyynti@gtk.fi)



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