Competitive Edge of the Finnish Mineral Cluster

Helsinki, November 2011

Recently opened mines and current projects in Finland (September 2011)

Jalometallit — *Precious Metals*

1. Iso-Kuotko gold - Agnico-Eagle Ltd
2. Hanhimaa gold - Dragon Mining Ltd
3. Kittilä gold - Agnico-Eagle Ltd
4. Kettukuusikko gold - Taranis Resources Inc.
5. Naakenavaara gold - Taranis Resources Inc.
6. Pahtavaara gold - Lappland Goldminers Ab
7. Kiekerömaa gold - Tertiary Minerals Plc
8. Suhanko-Konttijärvi PGE - Gold Fields Arctic Platinum Oy
9. Kuusamo gold - Dragon Mining Ltd
10. Laiva gold - Nordic Mines Ab
11. Hirsikangas gold - Belvedere Resources Finland Oy
12. Kopsa gold - Belvedere Mining Oy
13. Taivaljärvi silver - Sotkamo Silver AB
14. Seinäjoki gold, antimony - Nortec Minerals Corp.
15. Pampalo gold - Endomines AB
16. Osikonmäki gold - Belvedere Resources Finland Oy
17. Haveri gold - Lappland Goldminers Ab
18. Orivesi gold - Dragon Mining Ltd
19. Jokisivu gold - Dragon Mining Ltd
20. Kaapelinkulma gold - Dragon Mining Ltd

Perusmetallit — *Base Metals*

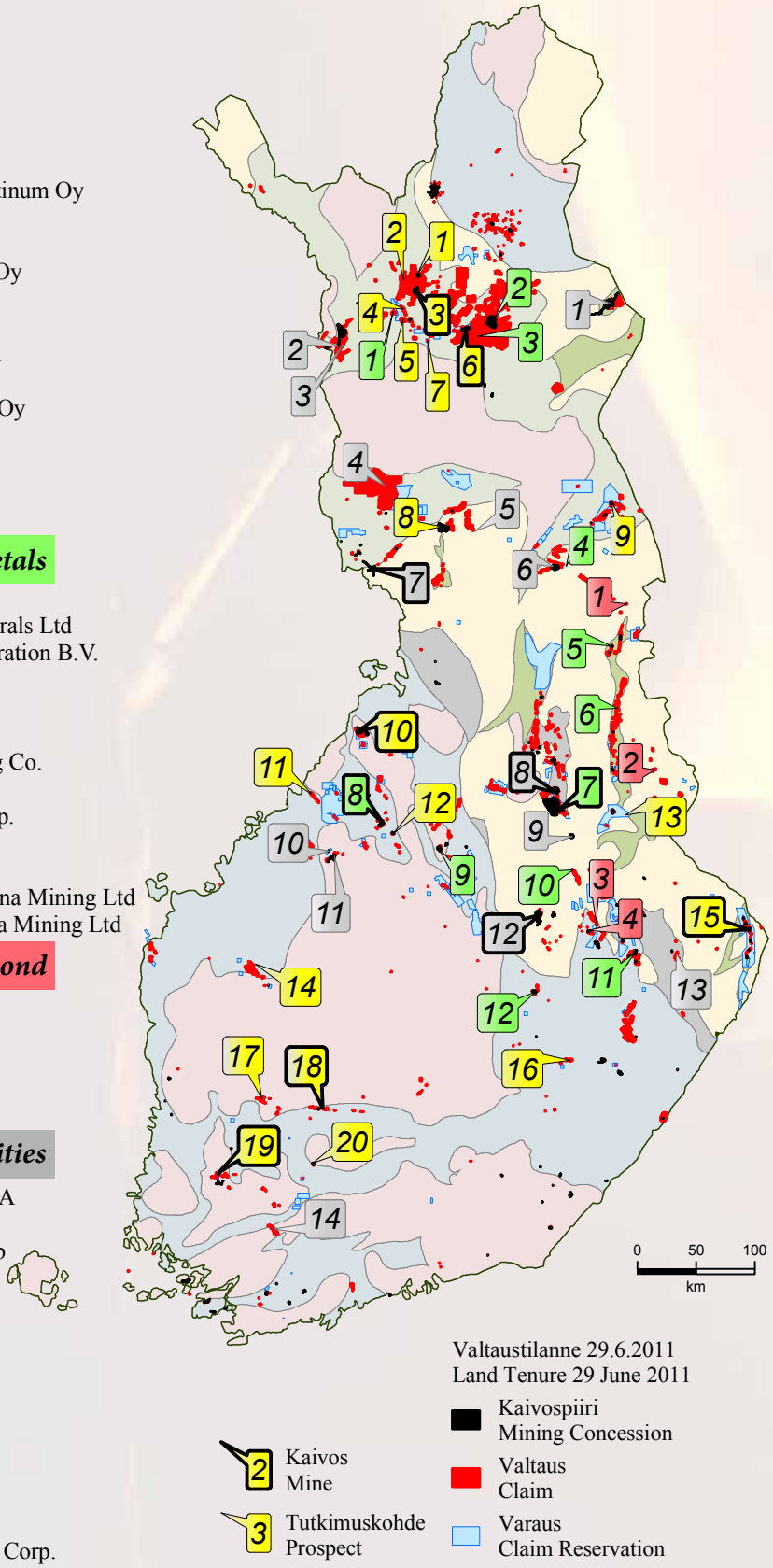
1. Riikonkoski copper, gold - Taranis Resources Inc.
2. Kevitsa nickel, copper, PGE - First Quantum Minerals Ltd
3. Sodankylä nickel, copper - Anglo American Exploration B.V.
4. Kaukua nickel, PGE - Nortec Minerals Corp.
5. Kuhmo nickel - Altona Mining Ltd
6. Kuhmo nickel - Anglo American Exploration B.V.
7. Talvivaara nickel, zinc, copper - Talvivaara Mining Co.
8. Hitura nickel - Belvedere Mining Oy
9. Pyhäsalmi zinc, copper, pyrite - Inmet Mining Corp.
10. Rautavaara nickel, zinc, copper - Western Areas NL & Magnus Minerals Oy JV
11. Kylylahti copper, gold, zinc, nickel, cobalt - Altona Mining Ltd
12. Valkeisenranta, Särkiniemi nickel, copper - Altona Mining Ltd

Timantti — *Diamond*

1. Kuusamo - Sunrise Resources Plc
2. Kuhmo - Karelian Diamond Resources Plc
3. Kaavi-Kuopio - Sunrise Resources Plc
4. Kaavi - Mantle Diamonds Ltd & Firestone Diamonds Developments JV

Muut — *Other Commodities*

1. Sokli phosphorus, niobium - Yara International ASA
2. Sivakkalehto iron - Tertiary Minerals Plc
3. Kolari iron, gold, copper - Northland Resources Ab
4. Rompas gold, uranium - Mawson Resources Ltd
5. Ranua uranium - Mawson Resources Ltd
6. Mustavaara vanadium - Mustavaaran Kaivos Oy
7. Kemi chromium - Outokumpu Chrome Oy
8. Punasuo talc, nickel - Mondo Minerals Oy
9. Alanen talc - Talc de Luzenac
10. Länttä lithium - Keliber Resources Ltd
11. Koivusaarenneva ilmenite - Kalvinit Oy
12. Siilinjärvi phosphorus - Yara International ASA
13. Eno uranium - Mawson Resources Ltd
14. Tammela lithium, tin, tantalum - Nortec Minerals Corp.



Source: GTK.

Competitive Edge of the Finnish Mineral Cluster

The competitiveness and economic impacts of the Finnish mineral cluster were evaluated in a research project conducted by ETLA, the Research Institute of the Finnish Economy, during 2010–2011. This is an English summary of the study. The study was published in Finnish by the name "Kalliosta kullaksi – kummusta klusteriksi, Suomen mineraaliklusterin vaikuttavuusselvitys" ETLA B 252, Helsinki 2011 http://www.etla.fi/julkaisuhaku.php?type=details&id=1827

The Finnish mineral cluster is comprised of three extractive sectors – the mining industry, aggregates industry and the natural stone industry. In addition, the cluster includes diverse fields of technology manufacturing – manufacture of mining machinery, rock crushing equipment and enrichment equipment – and process suppliers. The activities of the mining industry are based upon large-scale geological mapping and research. Their results are utilized by the so-called mining development companies, which are internationally called junior companies. They investigate promising deposits and develop them into mining sites that can attract investment. The same functions are also needed for development of deposits of aggregates and natural stones. Many new industries emerge from the cluster, such as exploration-stage drilling companies and assorted contractors that drill, explode and crush aggregates or shape rock slabs and provide transport services at mines, excavation sites and natural stone quarries.

Jobs for 50 000 people

The mineral cluster as a whole employs more than 16,200 people, and employment will increase by mid-decade to about 20,000 people in the wake of growth in mining activities. When the foreign staff of equipment manufacturers is taken into account, the cluster directly employs 32,500 people. Including the multiplier effect on employment in Finland, the cluster employs 25,000 people, and if foreign operations are included the number of jobs rises to 50,000 people.

Like the forest industry and telephone operator activities, the mining cluster has given rise to significant tech-

Bolting machine in Pyhäsalmi mine

Photo: Pyhäsalmi Mine Oy.

nology manufacturing. Finnish companies engaged in the manufacturing technology of mineral cluster have become very international. The companies have sales and service points as well as production located on all continents and in major mining countries.

The most significant impact on the Finnish economy has been the raw material base offered by the mineral cluster. The mines gave birth to metal processing and manufacturing of versatile chemical and mineral products. The most important raw materials used in construction are various sorts of aggregates: sand, gravel and crushed. Natural stone is processed further for construction purposes, fireplaces, monuments and the other stone products. Industry using minerals as a raw material employs over a quarter of a million people in Finland.

Safe and effective business environment

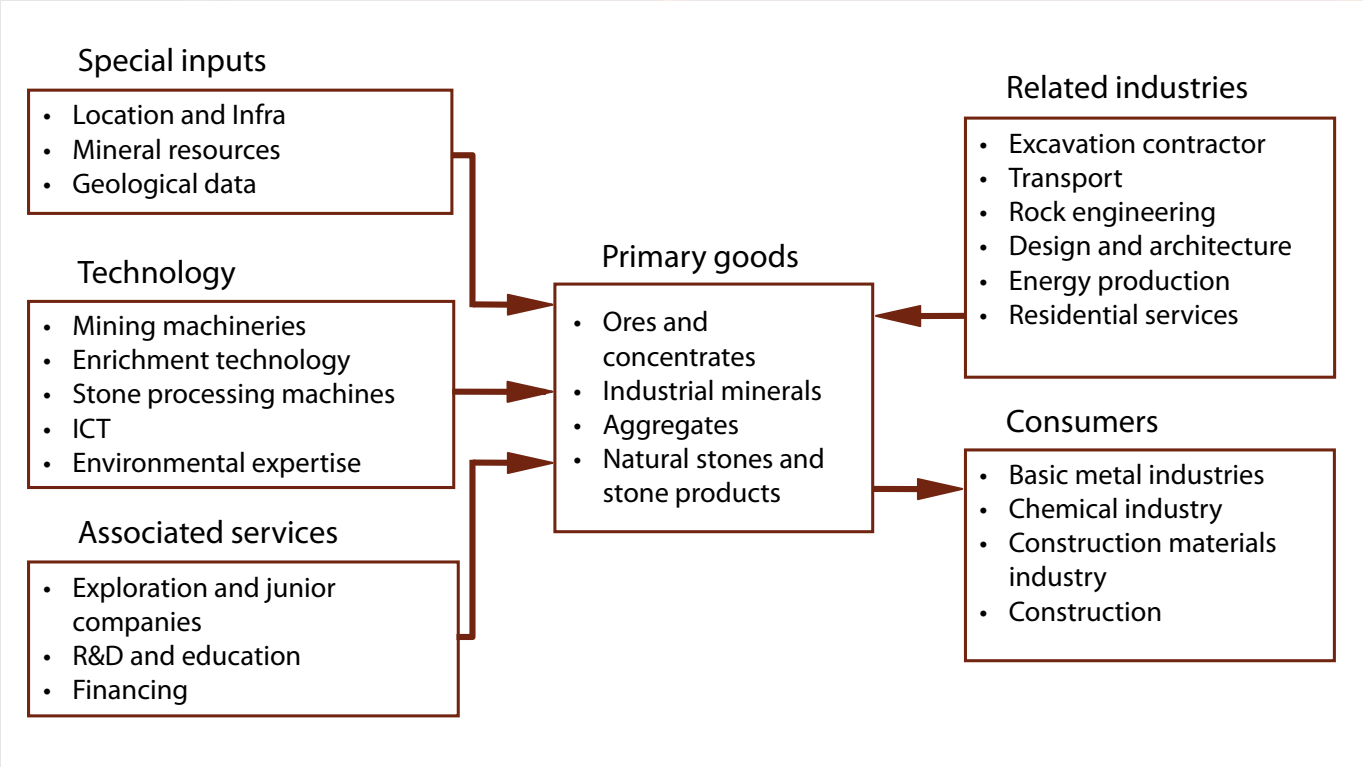
Compared to any other country, the mineral cluster in Finland can be regarded as very advanced for the following reasons:

- There are good mineral and stone resources that companies are able to utilize safely and sustainably. Developed infrastructure supports the operations.
- In addition to extraction activities, the cluster has developed versatile refinement processes. Only a fraction of the extractive industry's products are exported unprocessed.
- The extractive industry has given rise to diverse technology manufacturers dominating international markets as in other major clusters (forest cluster and ICT cluster).
- The extractive industry in Finland has been a pioneer in safety and environmental thinking.
- The next stage of development will be the emergence of a wide range of services and their globalization.
- In Finland, current trends include development of training in this field and investment in innovation activities.

Future – Over 40 new mines

In recent years, the biggest mining investments have been the Talvivaara multi-metal mine (production began in 2009) and the Kittilä gold mine (2009). The planning for expansion of both of these mines is already under way. These mines quickly grew right from the start of their production to be amongst the largest in Finland, alongside Pyhäsalmi, Kemi and Siilinjärvi. In addition, the Kevitsa multi-metal mine is currently under construction (2012) with expansions being planned. The expansion of the Kemi mine will double its production capacity. The Hitura nickel-copper mine has been re-opened. The Pampalo gold mine began production in the spring of 2011 and the Laiva gold mine will start up in late 2011. Big mines in terms of mining volume in the future will be the Kolari iron mine and the Sokli phosphorus mine. In addition, data is expected from Anglo American's promising research work in Sodankylä and from the Ranua palladium and platinum mines. All in all there are over 40 new mining projects and development sites in Finland.

Structure of Finnish mineral cluster



Mining revolution in Kittilä

The 8th Fennoscandian Exploration and Mining Conference was held at the Levi Summit Conference Centre located in the municipality of Kittila. Kittila has thrived on tourism. Levi is Finland's largest ski resort in terms of sales. Kittilä has 22,000 beds for tourists and an airport. Agnico-Eagle Finland's mine at Kittilä started production in 2008. It is Europe's largest mine exclusively focused on the excavation of gold. What has happened to the economy in the local municipality of Kittilä?

The economy is now strong, because the municipality has two pillars: tourism and mining. Tourism provides about 1,100 jobs. The mine employed 591 people at the end of 2010. The unemployment rate of in municipality has fallen below 10 per cent, to 6 per cent during the high tourist season. Unemployment was 21% in the year 2000 and nearly 14% in 2006 when construction of the mine began.

Multipler income effects of a mining job are greater than those of a person catering to tourists. When the multiplier effects are taken into account, Kittilä's tourism employs about 1,650 people while mining employs 1,350. Population of Kittilä has also begun to increase, it exceeded the limit of 6,000 inhabitants.

Kittilä's mine has an annual turnover of approximately EUR 150 million. Tourism generates income of 200 million euros. Kittilä's mine is planned to be expanded in the future. Mining operations should become a more important source of revenue than tourism.

Kittilä's mine accounted for about 3.5 million of municipal tax revenues in 2010, while the central government received the same amount of tax revenues. The mine paid 200,000 euros in real estate taxes to the municipality. The central government will also receive 2 million euros in royalties from mineral rights. The corporate income tax paid by the mine is expected to rise in the future to 10–15 million euros.

Sources: Agnigo Eagle Finland Oy and Kittilä municipality, www.kittila.fi

Investments 3 billion euros

Mining investments required over the next few years are projected to be at least 1.6 billion euros, calculated based on projects for which companies have announced the sums to be invested. This figure includes investments required by mine construction in construction, machinery and equipment as well as immediate mine-related infrastructure. In reality, we expect investments to rise to about 3 billion euros, taking into account earlier investments in the Talvivaara mines and the almost certain to be realized production expansion of the Kevitsa, Kittilä and Talvivaara mines. These investment costs do not include public investments in infrastructure, which can be very sizeable, for instance, if they require new tracks.

Real mining boom

According to a survey conducted by ETLA, the Research Institute of the Finnish Economy:

- Extraction volumes were 54 million tonnes in 2009. Extraction will increase by nearly three-fold to approximately 155 million tonnes by 2016. Ore mining will increase by 24 million tonnes to a maximum of 68 million tonnes. These figures include quarrying of both metal ores and non-metallic minerals. In the beginning of the millennium ore mining was only 4 million tonnes. At the end of this decade we expect that ore mining will rise up to 100 million tonnes.
- In 2010 mining companies reported they employed about 3,000 people, including their own personnel and subcontractors. According to a survey, mining will employ as many as 5,200 people in the next decade. In addition, construction of mines will create jobs.

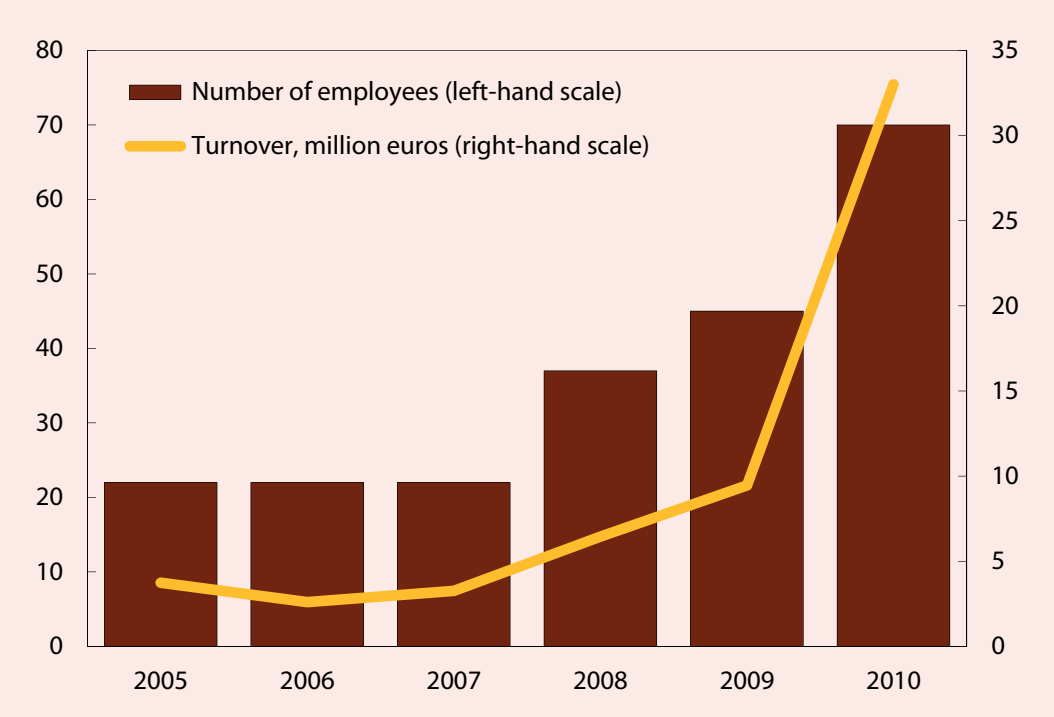
Fast growing Paakkola Conveyors

Paakkola Conveyors Ltd is a fast growing technology company supplying conveyor systems. The starting point for operations is to solve the objectives of a project in close collaboration with the client. The company has 30 years of experience in supplying conveyors for demanding Nordic conditions in Finnish, Swedish, Norwegian and Russian mines and industries. The mining boom has helped the company to achieve strong growth.

The company won the tender for the Talvivaara mine conveyor project. The firms in the running for the tender included top international competitors. The value of the project was some 24 million euros. It included 6 kilometres of overland conveyor tracks and a 420 metre long bridge stacker conveyor. The bridge stacker conveyor is mounted on 9 crawler units steered with a GPS positioning system. The equipment has a capacity of 4,500 tonnes per hour.

After the Talvivaara project, Paakkola Conveyors also won the tenders for Kevitsa and Kemi mine conveyors. The company delivered 11 conveyors to the Kevitsa mineral processing plant owned by First Quantum Minerals Ltd. The conveyors have a capacity of 200–2,000 tonnes per hour and a total length of 1.8 kilometres. Paakkola Conveyors is supplying a homogenization and conveyor system for intermediate stockpiling of crushed ore for the Outokumpu Chrome Oyj, Kemi mine. According to Managing Director Tommi Juntikka their automatic homogenization system is a considerable step towards becoming a specialized international supplier of demanding conveyor systems.

Paakkola Conveyors' turnover and number of employees



Sources: Juntikka Tommi, Paakkola Conveyors Oy.

- Turnover from mining activities, which describes the value of production, will increase from slightly less than 800 million euros in 2010 to an estimated 2.5 billion euros by the middle of the decade.

In reality, production volumes, turnover and number of employees will rise above these figures if the world market prices of ore and industrial minerals remain high as expected. Thus research on mineral deposits and their development into mines will continue to be brisk in the next decade.

Mineral cluster benefits all of Finland

Mining jobs are located mostly in northern and eastern Finland. Other major beneficiaries are the provinces of Northern Karelia and Northern Ostrobothnia. Mines are creating jobs in areas which currently have the highest unemployment. The employment effects of mining are felt throughout the country.

The manufacturing of equipment for mining technology employs mechanical industry cities like Tampere, Turku, Pori, Lappeenranta and Iisalmi. Through subcontracting the effects extend to the whole country. Metal processing is concentrated in the coastal towns of the Gulf of Bothnia and Gulf of Finland, where low-cost sea transportation may be utilized.

The aggregates industry is located all over the country, because all construction and maintenance of the built environment is based on the ready availability of different types of mineral products. Aggregates production volumes correspond regionally to infrastructural and residential construction. If aggregates excavation and processing activities are located far away from the construction sites, this significantly increases the total construction costs since about half the price of aggregates on site consists of transportation costs. The main aggregate processing areas are the greater Helsinki region and the regions of Pirkanmaa, Turku, Oulu and Jyväskylä.

The natural stone industry centres are Southern Karelia, and Kymenlaakso as well as Southwestern Finland, Häme and Uusimaa with its granite reserves, and Northern Karelia with its soapstone industry.

Extractive industries are enabling industries. Ores are further processed in Finland, and the vast majority of products will be exported. Aggregates are the most important raw material for the job-creating construction industry. The processing chains of the natural stone industry extend around the world.

New mines – Progress for Lapland's and Kainuu's economy

Input-output analysis was used to examine the effects of four mining investments in Lapland (Hannukainen, Kevitsa and Suurkuusikko mines as well as Outokumpu's mine and expansion of ferrochrome production) in addition to those of Talvivaara in Kainuu and the Taivalhopea mine to be opened in 2013.

- The direct output impact of growth in mining activities in Lapland at the end of the decade will be almost 600 million euros annually. Taking into account the indirect effects, the output of the Province of Lapland will increase by an estimated 1.2 billion euros. The impact on employment of growth in mining in Lapland will be highest in 2014, when the job increase is about 3,000. One third of the jobs will be created directly via quarrying of metal ore and mine construction while two-thirds of the jobs will be created in other industries of the regional economy.
- The direct impact of mines in Kainuu is about 600 million euros while the total impact is almost 800 million euros. The total employment impact is about 2,000 jobs and direct employment effect about 600 jobs.

According to input-output analysis, the GDP of Lapland would increase by 10 per cent thanks to the mines some of which have been decided upon and some of which are currently under construction. The GDP of Kainuu would increase by as much as 20 per cent because the total output of the province is otherwise relatively small.

New development phase

The mining boom has already brought about a new wave of mineral cluster development. Subcontracting has become a new industry where companies have already sold their services to other countries. A number of mining development companies founded by Finns are operating in Finland. After a domestic learning period, these companies will be able to operate in other mining countries. Also the technology has developed, as demonstrated e.g. by bioleaching, used in Talvivaara. New equipment manufacturers have emerged alongside old ones.

Talvivaara is the best example of new domestic mining companies. Normally however, mining development companies founded by Finns are sold to foreign mining companies due to lack of capital. The establishment of a mining investment company and an educational programme for mining finance can significantly promote the emergence of a new domestic mining industry.

Challenges

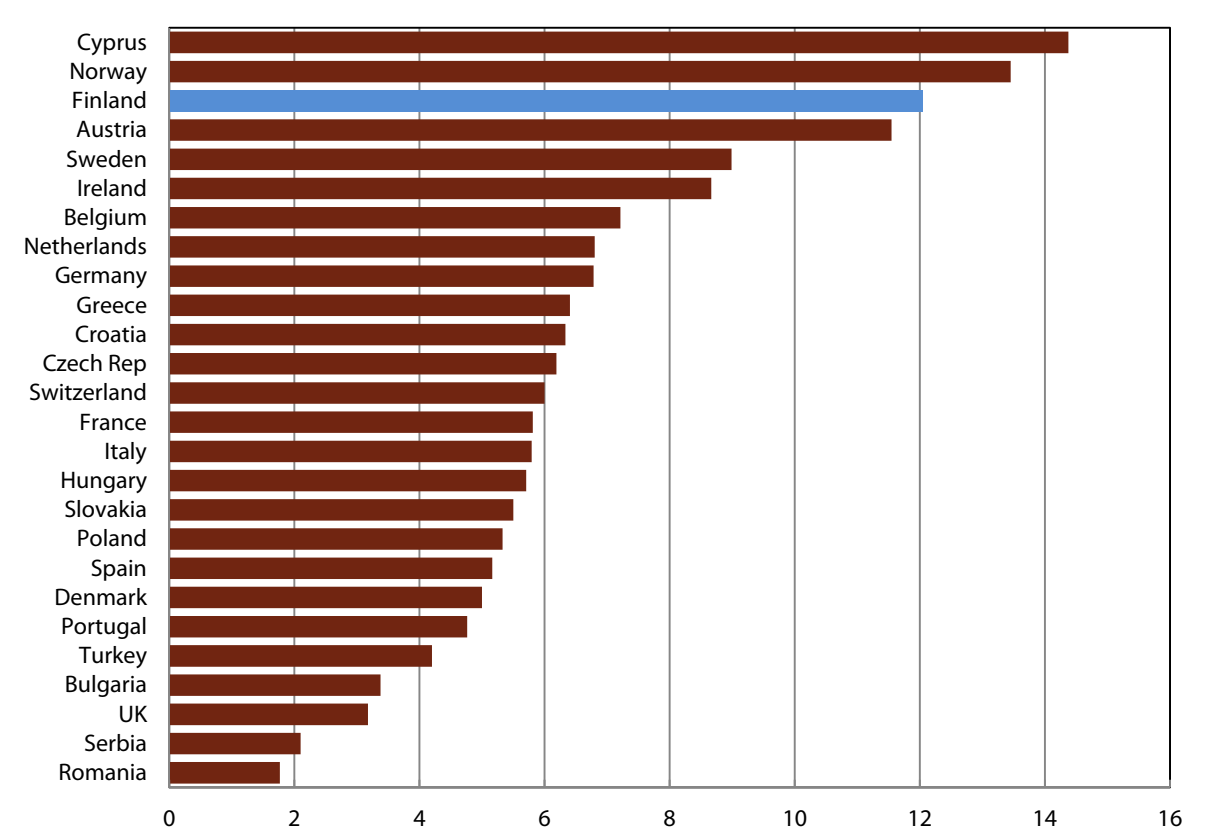
Mining industry

The operative framework for the mining industry was defined in the new Mining Act, which went into force in summer 2011. The final impact is still difficult to assess, but conclusions can be drawn on the basis of the new licensing practices that have been applied since 2006. The time it takes to process mining permits has stretched out to more than two years and there is little hope for a speedy improvement in the situation without changing the law. Companies believe that the exploration and mining compensation stipulated by the law is too high compared to neighbouring countries such as Sweden. In addition, the law increased rather than decreased the already heavy bureaucracy with respect to licensing. The Parliamentary Finance Committee said in its report that superfluous work could be eliminated by standardizing administrative licensing requirements, by reducing the number of individual permits and making better use of information already provided in other licensing processes. The mining industry lives in the hope that the changes proposed by numerous interest groups will be implemented by the current government.

Mining finance is underdeveloped in Finland, because previously the mines were opened by state-owned companies. They were able to obtain financing relatively easily. Today the mines are run by private companies and mining entrepreneurs. The new situation calls for more funding for mining operations. Nowadays, the financing for projects comes from various stock exchanges around the world and international investors. Efforts are nevertheless being undertaken to develop domestic financing channels. Funding is raised from institutional investors and also the government has decided to invest in mining activities. Some 30 million euros has been earmarked in the central government's budget for mining. The government also participates in the construction of infrastructure and supports technology development under the auspices of the Green Mining programme. Mining finance and mining project management should be developed in Finland in accordance with the best practices in use elsewhere. This will be a major development project aimed at safeguarding the implementation of economically viable mining projects in the future. An essential part of the work entails the development of teaching about mining finance and reporting of information to investors.

Aggregates production and use per capita is very high in Finland

Aggregates production per capita in tonnes, year 2009



Source: UEPG, The European Aggregates Association.

Transport costs are a critical factor in the extractive industries and processing of ores:

- New mines need tracks, roads and energy. The government has responded to these challenges very well. The principle is that the government and the mining company agree about the investments required. Investments are first financed by the mining company. If the agreed production and transport volumes are realized, the state buys the tracks and roads from the company.
- In 2015 stringent sulphur limits will be introduced on Baltic Sea shipping. Sulphur limits will increase the export costs of key client industries – metal processing and the chemical industry – which will threaten their competitiveness. Also part of the mines will need to find low-cost export routes. The mining industry proposes that a new railway should be built from Finnish Lapland to the Arctic Ocean. This would foster new investments in mining and processing companies and provide a deep harbour and low-cost export route to Asia via the Arctic Ocean. The Norwegian and Russian mining industries are already testing the shipping of cargo via the Arctic route.

Aggregates industry

The excavation sites of the aggregates industry should be located close to utilization points because of the transportation costs. Two-level zoning is proposed as a solution. Building areas would be zoned for rock material extraction first, paving the way for construction, and then the final purpose.

The excavation permits granted to the aggregate industry for sand, gravel and rock are valid for a maximum of 10 years. From the standpoint of the development of operations and a positive investment environment the new technology would instead require the granting of permits for several decades.

Natural stone industry

A key objective of the natural stone industry is to extend the time for extraction to at least the 20 years now allowed by law. It should also be useful to explore systematically for new rock quarries in order to obtain exportable production.

The potential export opportunities of the natural stone industry are great. Companies in this sector are nevertheless too small for launching vigorous export efforts, which is the industry's biggest development challenge. The companies will work together to produce marketing materials about the potential uses of natural stone, building life cycle costs as well as technical guidance to architects and building designers. Real breakthroughs in exports would apparently also require mergers into larger companies.

Mineral cluster protected by central government

As a whole, managing the natural resource policy and strategic planning of mineral supplies is a challenge for Finland. An objective was set out in the Mineral Strategy document compiled a year ago to strengthen the position of natural resource policy by charging a high-level body in the central government with responsibility for the overall development and coordination of the natural resource policy.

Environmental management is a very important aspect of managing natural resources. Society's sustainable development is based on three pillars – i.e. environmental, economic and social perspectives – so that all three are in balance.

Finland is a world market leader in soapstone fireplaces

Photo: Tulikivi Oyj.

Green Mining Programme 2011–2016

The main objective of the Green Mining Programme carried out by Tekes (the Finnish Funding Agency for Technology and Innovation) is to make Finland a global leader of the sustainable mineral industry by 2020. The programme creates new businesses that require new, specialised expertise alongside the growing field of traditional mining. A central goal is to increase the number of SMEs geared toward the export market in the mineral cluster. The programme aims to achieve global leader status for the research in selected sectors.

The programme consists of two main themes:
1) Intelligent and minimum-impact mines
2) New mineral resources

The goal is to invest 60 million euros in development projects.

The Finnish mineral industry is a world leader in many areas. Equipment and process suppliers in particular are on the leading edge of the sector globally. The aim of the Green Mining Programme is to make Finland a pioneering country of eco-efficiency in the mineral industry by 2020.

"We must capitalise on the current growth in the mineral industry without wasting time", stresses Programme Manager **Kari Keskinen** from Tekes.

The programme will be promoted through international networking drawing on best international practices. The scope of this cooperation is a signal of the actors' strong commitment to developing eco-efficiency.

"The Green Mining Programme offers great opportunities for stronger internationalisation through both concrete cooperation projects and exchanges of scientists. This programme will further raise Finland's profile as a country of cleantech expertise", stresses Chief Technology Officer **Kari Knuutila** from Outotec Oyj.

Source: Tekes, http://www.tekes.fi/programmes/GreenMining

Leading Finnish mining technology developers

Metso Materials Inc., http://www.metsomaterialstechnology.com/
Outotec Oyj, http://www.outotec.com
Sandvik Mining and Construction Oy, http://www.miningandconstruction.sandvik.com/
Kemira Oyj, Mining and Oil and Gas, www.kemira.com/
Normet Oy, http://www.normet.fi/
Forcit Oy, http://www.forcit.fi/en/

Mobile crushing machines are some of Finland's successful export products

Photo: Lemminkäinen Infra Oy.

Operating and future mines in Finland

Invest in Finland is the government agency promoting foreign investments into Finland. We assist international companies in finding business opportunities in Finland and provide all the relevant information and guidance required to establish a business in Finland. Finland offers significant opportunities in a favourable mining environment.

www.investinfinland.fi/industries/mining/en_GB/mining/

Tekes – the Finnish Funding Agency for Technology and Innovation – is the main public funding organisation for research, development and innovation in Finland. The two principal themes of the Green Mining programme are new mineral resources and intelligent, minimum-impact mining. The programme is intended not only for mineral sector actors but also for technology industry companies and service providers supporting them. Both companies and research institutesare eligible for funding under the programme.

www.tekes.fi/programmes/GreenMining

Geological Survey of Finland (GTK) is a state research institute under Finland´s Ministry of Employment and the Economy. The mining sector forms the most important customer group to which GTK provides expert services, geological data bases, identifies areas with mineral potential and finds new surficial deposits. Furthermore, GTK offers chemical- and mineral-processing services and ground-geophysical services to the sector.

http://en.gtk.fi/

FinnMin – Kaivannaisteollisuus ry was established in 1999 to improve the operational environment of the Finnish extractive resources industry. Especially the metal and industrial mineral mining industry is the part of industry which the association is serving. This sector is growing very fast today.

www.kaivannaisteollisuus.fi

Infra ry, founded in 1954, functions as the federation and employers' association for civil engineering and the asphalt and aggregates industries. The companies belonging to Infra's aggregates industry section produce all sorts of aggregates needed in construction, i.e. sand, gravel, and crushed rock. The members of the blasting industry section include rock and tunnel construction companies in addition to companies engaged in mine construction as well as those in the mining, aggregates and natural stone industries.

www.infra.fi

The Finnish Natural Stone Association was founded in 1938, and it is the only Finnish organization representing companies engaged in the field of stonework. Member companies are producers of natural stones or natural stone products, and the cooperation members are companies and communities, such as research and educational institutes, that provide the stone industry with machinery, equipment, supplies and services.

www.finstone.fi