A Sputtering Process

An Overview of the Platinum Group Metals Supply Chain

Tim Steinweg

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Contents

1 Introduction

Platinum Group Metals (PGMs) are some of the most valuable elements in the world. They not only serve a purpose as investments, but are also used on a large scale to produce a variety of products for high-tech industries such as the automotive and electronics sectors. In the automotive industry, PGMs are mostly used to produce catalysts, which reduce CO2 emissions of cars. The electronics sector, which uses PGMs for hard disks and motherboards, has traditionally been regarded as a high-tech 'clean' industry.

However, a closer look into the supply chain of PGMs, and in particular the mining of the metals, shows that the story is not as overall positive as it might seem at first sight. The two major producing countries of PGMs, South Africa and Russia, both face serious sustainability challenges. The Russian town of Norilsk is among the most polluted places in the world, due to smelting operations of nickel and palladium. The limited information that is available about this secluded place draws up an image of an almost uninhabitable place, where the snow is yellow and no living trees can be found.

In South Africa, PGM mining has a legacy that is deeply rooted in the country's history of apartheid. The extraction of precious metals such as PGMs has been controlled by large multinationals, while the profits and costs of the mining operations seem to be unevenly distributed. Local communities, who often had already felt the biggest burden of apartheid, are relocated to make way for PGM mining operations. The communities have little say in the matter, are not compensated for the profits made off their traditional lands, and many times are worse off than before. A recently published report by the South African Human Rights Commission (SAHRC) on the rights of communities around an Anglo Platinum mine, confirmed many of the findings from earlier NGO research reports.[1] On top of that, the PGM mining industry makes use of contract labour on a large scale, using temporary migrant workers to perform the most dangerous tasks, often without proper safety measures or training.

Several stakeholders have addressed the damage caused by PGM mining and have spoken out against some of the injustices. Local community representatives, lawyers, NGOs, government officials and responsible investors have all, in one form or the other, expressed concerns regarding South African PGM mining. The report of the SAHRC has given extra weight to the discussion, and shows the commitment of the South African government to human rights issues in relation to large extraction projects. Reporters and environmental NGOs have attempted to create increased attention and awareness about the conditions of Russia's PGM operations as well.

An important stakeholder that could play a significant role in addressing the sustainability issues in the mining phase of the PGM supply chain are the mining companies'

[1] The report is available on the SAHRC website, www.sahrc.co.za.

customers. The companies that use PGMs to fabricate industrial products, as well as the brand companies that sell products containing these metals, are all potential agents of change, and bear a responsibility in addressing these issues. Actively addressing sustainability issues, for example by pushing for adherence to the recommendations made by the SAHRC, can make a world of change.

This paper approaches the actors within the supply chain from a *force field analysis* perspective. It is based on the premise that these actors can be driving forces for change towards more inclusion of social and environmental considerations during the mining of PGMs. This paper therefore intends to map the PGM supply chain and its actors, and to discuss the current strategies of supply chain responsibility and possibilities for the future.

Within this context, a major recent development is the change in approach by the electronics industry, which has recently given increased attention to the sourcing of their metals. Among other factors, this change is caused by NGO activities, such as those of the makeITfair campaign, which stressed the role of electronics companies regarding sustainability in the mining sector. The electronics industry has been in dialogue with NGOs, and a research commissioned by the industry's sustainability initiatives EICC and GeSI has confirmed the findings of makeITfair's research. A process is currently underway to define follow-up steps in the form of concrete measures.

This report will follow the PGM supply chain downstream and draw a picture of what the chain looks like. The first chapter will discuss the mining and production of PGMs, looking at the regions where the metals come from, and the most important players active and issues identified. The second chapter will give a more in depth look into the fabrication of PGMs into various industrial products, as well the refining and trading of PGMs. This chapter includes three overviews of major companies active in this phase of the supply chain. The third chapter gives an overview of PGM containing products in the end sectors.

The purpose of the report is three-fold;

- To increase transparency in the PGM supply chain. This will provide stakeholders in the mining phase with a better understanding where the metals go to once they have been extracted. It also gives end user industries, such as electronics, more insight in the route of the PGMs that end up in their products.
- To identify the actors and strategies from a *force field analysis* perspective. The analysis of the driving forces towards change, and the hindering forces blocking change will provide a starting point for strategies of all relevant stakeholders. Opportunities will be identified which can be used by northern and southern NGOs, labour unions, responsible investors, and end user industries.
- To provide the necessary insight for a multi-pressure point strategy. Opportunities will be identified how companies within the supply chain can contribute to the ongoing efforts of other stakeholders that call for more sustainable mining activities.

2 Mining and Production

When discussing the downstream production chain of PGMs that end up in consumer products, the first link is the extraction and refining of the raw material. PGMs are precious metals and are among the least abundant of the Earth's elements.[2] The metals occur both in association with other metals, such as nickel and copper, and with each other.

The production of Platinum Group Metals (PGMs) occurs in a very limited number of countries. The large majority of raw materials are sourced from South Africa and Russia, where large reserves of PGMs are known, and a blooming industry has developed that deals with the prospecting, exploration and extraction of these metals. In 2006, total global platinum and palladium mine output was estimated at 6.9 million and 7.3 million troy ounces respectively.[3] South Africa is the largest producer of PGMs, accounting for 81% of the world's platinum output and 39% of the world's palladium. Russia produces 11% and 45% respectively. Worldwide, there are currently fewer than ten PGM mining companies.

2.1 South Africa

South Africa has the largest known reserves of PGMs, estimated at 88% of the world's known reserves, and dominates the world's production. There are several large PGM mining companies active, and the critical issues here relate to hazardous and bad working conditions, and the maltreatment of local communities. Almost all the PGM mining occurs at the Bushveld Igneous Complex (BIC), a large area with a number of PGM-containing reefs that are possible to mine. A more extensive analysis of the PGM mining sector in South Africa, and the CSR issues at hand, is discussed in a report by makeITfair.[4]

Over the last five years, the country's production of platinum has risen from 4.28 million troy ounces in 2002, to 5.55 million troy ounces in 2006.[5] This corresponds to an increase of almost 30%. The country is the second largest producer of palladium, accounting for 2.85 million troy ounces. The production has increased with almost 35% over the last 5 years, although recent news reports have indicated that the overall production of PGMs might have slowed down in 2007. Causes for a possible decline

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2 Platinum today website, "Production", no date, http://platinum.matthey.com/production/production.html (08-09-08).

3 This report uses troy ounces rather than kilograms, as all the available data is given in these units.

4 T. Steinweg & E. de Haan, *Capacitating Electronics: The corrosive effects of platinum and palladium mining on labour rights and communities*, makeITfair, November 2007, http://makeitfair.org/the-facts/reports/Capacitating-Electronics-november-2007.pdf (08-09-08).

5 CPM Group, *The CPM Platinum Group Metals Yearbook 2007,* (2007: John Wiley & Sons Inc. Hoboken, New Jersey).

include '*mine accidents, weather problems, labor disruptions, and, as of early 2008, power shortages and outages'*.[6]

2.1.1 Companies involved

There are three mining companies that control more than a 10% in the country's PGM production; Anglo Platinum, Impala Platinum and Lonmin. In addition Northam, Aquarius Platinum and Barplats play a minor role, while there are several junior exploration companies attempting to establish themselves in the mining industry.

→ Anglo Platinum

Anglo Platinum is the largest global producer of platinum and other PGMs, such as palladium, rhodium, ruthenium, iridium and osmium, accounting for about 40% of world production. Anglo Platinum Group comprises of a number of operating subsidiaries; the group mines, processes, refines and markets platinum and other platinum group metals (PGMs) and base metals.

Anglo Platinum is a subsidiary of Anglo American plc, which holds 74.75% shares in the company. In 2006, the company produced 2.82 million troy ounces of platinum, and 1.54 million troy ounces of palladium. Its total earnings combined to €1.28 billion (R11.993 billion). Additionally, it produced over 300 thousand troy ounces of ruthenium, accounting for a 38.2% share of the global ruthenium production.[7] In February 2008, the company announced that its platinum output in 2007 had decreased to 2.47 million oz.[8]

Table 1: Anglo Platinum's mining operations

	Platinum (Thousand troy ounces)	Palladium (thousand troy ounces)
Rustenburg Platinum Mines	2,158	1,011
Rustenburg	*942*	*466*
Amandelbult	*648*	*298*
Union	*327*	*148*
Bafokeng Rasimone	*241*	*100*
Potgietersrust	186	208
Lebowa	109	75
Modikwa	146	143
Kroondal R&S*	170	83
Western Limb Tailings	49	19

* In a sharing agreement with Aquarius platinum

[6] Mineweb website, "South African PGM production woes brighten life for North American PGM mining, exploration", 20-02-08, http://www.mineweb.co.za/mineweb/view/mineweb/en/page43?oid=47752&sn=Detail (08-09-08).

[7] Figures are based on figures made available by Anglo Platinum to the Commission of the South African Competition Tribunal in 2005.

[8] http://www.angloplatinum.com/investor_media/im_prelim/im_prelim_2007/prelim_feb08/default.htm

→ Impala Platinum

Impala Platinum is South Africa's second largest PGM producer.[9] Impala produced approximately 1.16 million and 535 thousand oz. of platinum and palladium respectively. The company is active in various regions of the BIC, and has mining, refining, investment and marketing operations. Impala Platinum operates one large mine, named Impala, and has a stake in the Two Rivers and the Marula mines. The Impala mined accounted fro 1.08 million oz. of platinum, and 469 thousand oz. of palladium.

→ Lonmin Platinum

Lonmin Platinum is the smallest of the three major platinum producers, but still produced 985 thousand oz. of platinum and 460 thousand oz. of palladium in 2006. Lonmin's mining operations are divided into the Marikana division, constituting of various mines, and the Limpopo mine.

Table 2: Lonmin's mining operations

	Platinum (thousand oz.)	Palladium (thousand oz.)
Marikana Division	936	424
Limpopo	49	36

2.1.2 Issues

The mining of PGMs, both in South Africa and elsewhere, has had a number of negative impacts at and around the mining sites. These issues include environmental damage, negative consequences for local communities, and hardships faced by workers in the mines.

One of the negative consequences of mining activities is the high impact on the environment, as the sector consumes vast resources such as water and power, and has immense effects on land degradation and pollution. In South Africa the study conducted by the Benchmarks Foundation revealed the impact of PGM mining on the groundwater. The effects included direction changes in underground water flows, the release of heavy metals into the groundwater, air pollution leading to respitory illnesses, as well as having negative effects on farming lands and the environment as a whole.[10]

Mining also affects communities, most significantly those located within the vicinity of the mine. Some of the negative effects include the encroachment of mining activities on residential and farming land, loss of livelihoods and health risks from exposure to pollutants. Several NGO's have addressed the community issues at Anglo Platinum's Potgietersrust mine, where 17,000 local people have been removed from their lands or

[9] Mbendi website, "South Africa, Mining: Platinum Group Metals mining," no date, http://www.mbendi.co.za/indy/ming/plat/af/sa/p0005.htm#10 (20-09-07).

[10] Bench Marks Foundation (2007), Review of the CSR programmes of the Platinum mining Industry in the Platinum Producing region of the North West Province.

are in threat thereof.[11] On top of the issues related to these relocations, reports have also come up regarding the contamination of water sources used by local communities as drinking water.[12] As a follow up on the reports issued by the international NGO Action Aid, the SAHRC commissioned its own research, in which many of the findings were confirmed. The report makes a number of recommendations that apply both specifically for Anglo Platinum at its Potgietersrust facility, as for large mining projects in general.

Those working at the mines often face dangerous working conditions and at times do not receive adequate safety training. One of the main issues identified is the use of contract labour, hired to do the most dangerous work, but who do not receive the same wages or benefits. In an interview with contract workers that had worked in different platinum mines, it was reported that with the high price of platinum in recent years, shafts are re-mined and rock pillars that were left in place as support are now being mined as well. Permanent mine workers are told that the work is dangerous and needs to be done by the contracting company that specialize in this type of work. Contract workers are hired to do this type of hazardous work for lower wages and with less rigorous safety instructions, while they are often not able to create or join unions. Many of the contract labourers are brought in from other areas, causing a number of additional social problems for the nearby communities.

2.2 Russia

Russia is the second largest producer of PGMs. Its reserves occur as by-products of nickel, and the large majority of PGM reserves are found in Northern Siberia. Russia produced approximately 11% of the world's platinum in 2006. The country's production has steadily declined over the last five years, from 1 million troy ounces in 2002, to 780 thousand troy ounces in 2006. The country produces approximately three times as much palladium as it produces platinum. In 2006, it produced 3.22 million troy ounces, which comprised 45% of world production. Over the last five years production has grown from 2.9 million troy ounces (2002) to 3.22 million troy ounces in 2006. It is expected that the relative share of Russia's production is likely to have increased in 2007, due to production woes in South Africa, caused by temporary shutdowns of PGM mines and production facilities.

2.2.1 Companies involved

Norilsk Nickel is the only major company active in Russia's production of PGMs. This company accounts for over 96% of the country's PGM production, and its mining activities primarily take place in and around the town of Norilsk, in Northern Siberia. Here, PGMs are mined as a by-product of nickel. Norilsk Nickel also owns the Stillwater

[11] For an extensive overview of the case, see T. Steinweg & E. de Haan, *Capacitating Electronics: The corrosive effects of platinum and palladium mining on labour rights and communities*, makeITfair, November 2007, http://makeitfair.org/the-facts/reports/Capacitating-Electronics-november-2007.pdf (08-09-08).

[12] M. Curtis, *Precious Metal: The impact of Anglo Platinum on poor communities in Limpopo, South Africa,* Action Aid, March 2008, http://www.actionaid.org/assets/pdf%5CActionAid.AngloPlats.45dpi.pdf (08-09-08).

mine, the only source of PGMs in the United States, and LionOre, a Canadian nickel mining company.

The Krastvetmet Metal Company owns and operates a large precious metals refinery, where PGM ores and concentrates are refined and sold on. Not much information was found on this company, except that it has close ties with PGM fabrication company Johnson Matthey, who have announced plans to build a autocatalyst factory on the site of Krastvetmet in the province of Krasnoyarsk.[13]

Norilsk Nickel's history

Mining operations started in the town of Norilsk in the 1930s, when Stalin founded a prisoner camp there. Between 1935 and 1950, approximately 500 thousand prisoners were sent to work here. Due to bad working conditions, and extreme climate, many did not survive. Many of these were political prisoners, who were forced to work for no salaries, and who were deprived of any rights.[14]

In 1953, when the system of Gulags was abandoned, the town had expanded to a population of 77 thousand, of which 68 thousand had forcibly been moved there as prisoners. Between 1953 and 1994, the mining activities were operated by the Soviet government. While there is only limited information available about working conditions during this period, it is known that this era witnessed one of the longest strikes in history, with workings calling for greater economic rights.

In 1989, several mining operations were combined to create the state-run Norilsk Nickel company. While the mining sector was excluded from the initial wave of privatisation in Russia in 1992-1994, Norilsk Nickel and many other extractive companies did become part of the so-called 'loans for shares' scheme from 1995 onwards. In this radical move to privatise many of the state owned enterprises, auctions were held to appoint the parties that would provide the state with bank loans, using these state owned enterprises as collateral. The auctioning was often such an in-transparent and exclusive process that those setting up these auctions, usually banks and other financial institutions, often ended up being assigned to provide these loans themselves. A condition to these loans was that the enterprises would be auctioned off if the government would be unable to repay these loans in the allotted time frame, something that was likely anticipated to happen from the beginning.[15]

When the government did indeed fail to repay most of these loans, the auctioning process was again limited to the same parties who were initially involved in the loans. This created a context where those that initiated the privatisation were the ones benefiting the most and consequently creating the oligarch class that controlled many of the most important industries of Russia. Norilsk Nickel was one of the companies that were auctioned off through this process. It fell into the hands of Vladimir Potanin, who owned the Oneximbank, the bank involved in the auctioning process.

[13] Johnson Matthey website, "Johnson Matthey to build Autocatalyst facility in Russia", 22-02-06, http://www.matthey.com/media/news/autocatrussia_20060222.html (27-09-08).

[14] R. de Man, *Options for Optimising the Catalytic Converter Chain; from Russian mining to metal recycling: a discussion document,* Milieukontakt Oost-Europa, RdM, (Leiden, September 2005) p.14.

[15] Interview with J. de Kort, Department of Russian Studies, University of Leiden, 13-06-08.

2.2.2 Issues

The known critical issues surrounding the mining and production of PGMs in Russia are all related to the immense amounts of pollution that are generated at the mines and production facilities in Norilsk. It is estimated that the town emits approximately 2 million tons of sulphur dioxide annually.[16] The reliability of Norilsk Nickel's commitments to reducing these emissions is difficult to evaluate, as no independent monitoring systems are in place. This is due to the ban for foreigners visiting the city, creating a secrecy and obscurity surrounding the city.[17]

The mine and adjacent facilities originally served as a Gulag for political prisoners, and was later converted into a state operation (see box on page 10). After the fall of the Soviet regime, Norilsk Nickel became the private owner of the mine and facilities. Due to the mining and heavy metal smelting operations, the town was listed as one of the ten worst polluted places in 2007 by the Blacksmith Institute.[18]

There are a limited number of Western news reports that give some indication of the conditions in Norilsk. In a slightly outdated news report, Nick Walsh, a Guardian reporter, states:

> *"This is the most polluted place in Russia - where the snow is black, the air tastes of sulphur and the life expectancy for factory workers is 10 years below the Russian average."*[19]

Several other news reports also make mention of the devastating effects of the acid rains produced. For example, a BBC news report mentions that there is a 'dead zone' with a 30km radius, where no living tree survives due to these acid rains.[20] Another report mentions that there is so much heavy metal emitted into the air, that it is commercially viable to mine the pollution.[21]

Logical consequences of the environmental pollution created by the mining and smelting operations of Norilsk Nickel are the devastating effects on the workers and local population. The Blacksmith Institute states:

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16 R. de Man, *Options for Optimising the Catalytic Converter Chain; from Russian mining to metal recycling: a discussion document,* Milieukontakt Oost-Europa, RdM, (Leiden, September 2005), p.24.

17 Video on BBC News website, World, "Siberian city's deadly rain", no date, http://www.bbc.co.uk/mediaselector/check/player/nol/newsid_6520000/newsid_6524700?redirect=6524795.stm&news=1&nbwm=1&bbwm=1&nbram=1&bbram=1 (28-09-08).

18 Worst Polluted website, Top 10 Most Polluted Places 2007, "Norilsk, Russia", no date, http://www.worstpolluted.org/projects_reports/display/43 (28-09-08).

19 Mines and Communities website, "Hell on Earth - Norilsk in Russia", 18-04-03, http://www.minesandcommunities.org/Action/press139.htm (28-09-08).

20 BBC news website, Europe, "Toxic truth of secretive Siberian city", 05-04-07, http://news.bbc.co.uk/2/hi/europe/6528853.stm (28-09-08).

21 The New York Times website, Europe, "For One Business, Polluted Clouds Have Silvery Linings", 12-07-07, http://www.nytimes.com/2007/07/12/world/europe/12norilsk.html (29-09-08).

> *The local population is severely affected by the air quality where air samples exceed the maximum allowable concentrations for both copper and nickel. Children suffer from numerous respiratory diseases. Investigations evaluating the presence of ear, nose and throat diseases among schoolchildren revealed that children living near the copper plant were twice as likely to become ill than those living in further districts. Similarly, children living near the nickel plant were shown to become ill at a rate 1.5 times higher than children from further districts. Mortality from respiratory diseases is considerably higher than the average in Russia, accounting for 15.8% of all deaths among children. Premature births and late-term pregnancy complications are also frequent. Sulphur dioxide emissions contribute to chronic diseases of the lungs, respiratory tracts, and digestive systems - and can result in lung cancer.*[22]

Terms such as 'exploitation' and 'slavery' have been used to describe the working conditions, while the life expectancy of the local population of Norilsk in ten years lower than in the rest of Russia.[23] The Arctic Monitoring and Assessment Program, based in Oslo, reported findings of several environmental diseases in the local population of Norilsk. These included lung cancer, allergies and so-called "nickel eczema".[24]

2.3 Other Countries

In Canada, most PGMs are produced as by-products of Nickel. Most mines are located at the Sudbury Basin in central Ontario, while PGMs are also extracted at the Raglan nickel mine in northern Quebec and from a nickel complex in Manitoba.[25] The country's production amounted to 239,000 oz. of platinum and 505,000 oz. of palladium in 2006. Active companies include North American Palladium Ltd., which operates the country's only primary PGM reserve, Vale Inco, a subsidiary of Brazilian Companhia Vale do Rio Doce (CVRD), and Falconbridge, which is ultimately owned by Swiss Xstrata.

The only PGM mine in the United States is the Stillwater mine, located west of Nye, Montana. Here the Stillwater Mining Company extracted a total of 143,000 oz. of platinum and 473,000 oz. of palladium in 2006. In 2003, Russian Norilsk Nickel acquired approximately 55% of the Stillwater mining Company.[26] No indications were found of any issues at the North American mines as stressing as those in South Africa and Russia, although by its very nature mining is bound to create some negative consequences.

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[22] Blacksmith Institute, *The World's Worst Polluted Places,* September 2007, http://www.blacksmithinstitute.org/wwpp2007/finalReport2007.pdf (29-09-08).

[23] R. de Man, *Options for Optimising the Catalytic Converter Chain; from Russian mining to metal recycling: a discussion document,* Milieukontakt Oost-Europa, RdM, (Leiden, September 2005).

[24] The New York Times website, Europe, "For One Business, Polluted Clouds Have Silvery Linings", 12-07-07, http://www.nytimes.com/2007/07/12/world/europe/12norilsk.html (29-09-08).

[25] Platinum Today website, Production, "North America", no date, http://www.platinum.matthey.com/production/nthamerica.html (29-09-08).

[26] S.M. Levit, "Sourcing Responsible Platinum Group Metals – Regulation in the United States and International Recommendations", Comments for presentation, Centre for Science in Public Participation (December 2007).

2.4 Scrap

Another source of PGMs is the secondary recovery of the metals from scrap. In 2006, 860 thousand oz. of platinum was recovered, while 1,407 thousand oz. of palladium was recovered. This accounts to 11% and 17% of total world supply respectively. Most of the PGMs are recovered from spent auto catalysts, while a smaller amount comes from electronic devices. Most of the recycling of spent catalysts and used consumer goods is performed by the same PGM processing and fabrication companies that source their raw materials from PGM mining companies, and that are described in further detail in the next chapter.

3 Fabrication and Refining

Once the metals are extracted, refined and traded, PGM is processed, and industrial products are fabricated that either contain PGMs, or for which PGMs are used during production. Both the ores and concentrates sourced from the mines, as well as recycled scrap are used to produce a variety of products for various end user industries. While a portion of the world's PGMs are purchased and traded for investment purchases, this chapter will focus particularly on the use of PGMs in the fabrication of industrial products.

The first part of this chapter will give a brief overview of the fabrication industry as a whole, its role in the PGM chain and its approach to CSR issues. The second part will focus on three European companies in more detail, with an analysis of both 1) their business approach, 2) their approach towards addressing issues at the mining phase, and 3) their recycling efforts.

3.1 Overview of the industry

Three major channels were identified through which mining and processing companies sell their products to customers further down the supply chain. Companies have direct supply contracts with fabricating companies, such as those described in this chapter, as well as with large end user companies, mostly car manufacturers.[27] An unknown portion of the supply is sold through spot markets, such as the London Platinum and Palladium Market and the Exchange Traded Funds of the Zurich Kantonal Bank in Switzerland.

However, there seems to be a high level of concentration in both the mining and fabrication phase of the PGM supply chain. Only a limited number of active global players can be identified, all of whom seem to be large multinational companies.

The members' list of the International Platinum Association, the business association of the PGM industry, gives an indication of the large players in the fabrication link. Apart from the largest mining companies such as Anglo Platinum, Norilsk Nickel and Impala, its members include the following fabrication companies;

- BASF Catalysts LCC[28] (USA/Germany)
- Ishifuku Metal Industry Co. Ltd. (Japan)
- Johnson Matthey Plc. (UK)
- Tanaka Kikinzoku Kogyo K.K. (Japan)
- Umicore SA (Belgium)
- W.C. Heraeus GmbH (Germany)

[27] International Platinum Association response to SOMO questionnaire, received 19-06-08.
[28] Formerly Engelhard

There is a large overlap of this list with the list of customers that Anglo Platinum, the largest PGM mining company in the world, provides on its website. Because of the limited number of members of the sector's business association, and the dominant position of Anglo Platinum in the South African PGM market, this gives a good indication of the trade flow of PGMs.

Company	Country
Johnson Matthey	UK
BASF	Germany/US
Tanaka Kikinzoku Kogyo KK	Japan
Umicore SA	Belgium
Heraeus	Germany
Toyota Motor Company	Japan
Honda Motor Company	Japan

In Russia, Norilsk Nickel does not give the same amount of transparency about its customers. They seem to focus more on end user customers[29], particularly in the United States and Japan, both major car manufacturing countries. Norilsk also exports large quantities of platinum and palladium to Switzerland, where these metals are stockpiled and sold on spot markets.[30]

Overall, only limited and indicative information is available about these trade flows to fabricating companies. Most of the specific information about supply contracts, volumes being sold, duration and other specific are considered confidential and sensitive information, and are dependant on a company's individual and confidential business approach. On top of this, the volume of metals sourced from spot markets increase the difficulties of tracing back metals to specific regions or mines, as these metals are likely to be co-mingled with metals from other sources.[31]

This chapter gives a more detailed overview of the structure, operations and CSR approach of three of these companies; Heraeus, Umicore and Johnson Matthey.

Fabrication companies' activities

The fabrication companies that this chapter mostly looks at, have three major activities that involve PGMs; Production, refining and trade.

Production

The above mentioned companies all produce a number of PGM containing products, for various end-user sectors. The most significant amounts of PGMs are used for various sorts of catalysts, mostly for the automotive industry. A number of these companies, for example BASF Catalysts, are specialized in producing catalytic converters. Many of

[29] Norilsk Nickel, Annual Report 2007, p.71.
[30] Orsa Maggiore, “Russian Palladium stockpiles”, Palladium-bar weblog, 13-09-07, http://palladium-bar.blogspot.com/2007/09/russian-palladium-stockpiles.html (09-09-08).
[31] International Platinum Association response to SOMO questionnaire, received 19-06-08.

these companies also produce products that are used in the electronics industry, mostly for hard disk drives and multi-layer ceramic capacitators (MLCC)

Refining
A number of these companies have also specialized in refining PGMs. Often this takes the form of recycling, where end-of-life products such as spent car catalysts and electronic products are used to extract precious metals from. Companies such as Umicore, that focuses all its refining activities on recycling consumer products and secondary materials, also offer their refining abilities as services, recovering precious metals for their customers for a set price.

Trade
All these companies are also active in trading these precious metals, while some are more active on the trading market than others. Johnson Matthey, the large PGM fabrication company in the UK, is a large trader and provider of market statistics. Often, these companies have trading desks at the major PGM markets, such as in London, New York and Hong Kong.

Industry wide CSR approach

As the general notion of supply chain responsibility is increasingly accepted, companies further down supply chains, such as the PGM chain, can play increasingly more important roles addressing sustainability issues. Within the PGM supply chain, the fabrication companies are the players with direct commercial contacts with the large mining companies, and bear some responsibility to use its buying power in various ways to ensure that the negative effects of PGM mining on the environment, labourers and communities are minimized.

In response to a questionnaire sent by SOMO, the International Platinum Association indicates that the industry is aware of its supply chain responsibility. It states that "*To our knowledge, the members of the IPA are focusing more and more on supply chain management as this concept becomes more clearly defined. They embrace the need for a socially responsible approach to selection of suppliers and customers expecting their partners to act in ethically, socially and environmentally responsible ways."*

The IPA also indicated that it has started a process of developing an industry position regarding Corporate Social Responsibility, in which issues such as supply chain responsibility. In November 2007, the IPA set up a Sustainability Working Group. However, at this moment it is unclear what activities have taken place. The IPA communicated that a face-to-face meeting was to take place in July 2008, of which the outcomes would be communicated through its website. At the moment of writing, no information was available. It therefore remains to be seen what the sustainability ambitions of the IPA and its corporate members will result in.

3.2 Heraeus Holding GmbH

Heraeus is a family-owned precious metals and technology group with its roots in Germany. Its headquarters are located in Hanau near Frankfurt. The company focuses on precious metals, sensors, dental and medical products, quartz glass, and specialty lighting sources.

More than 76% of its revenues in 2007 were generated with trading activities. It is the only one of the companies described in this section that is not listed on the stock market.

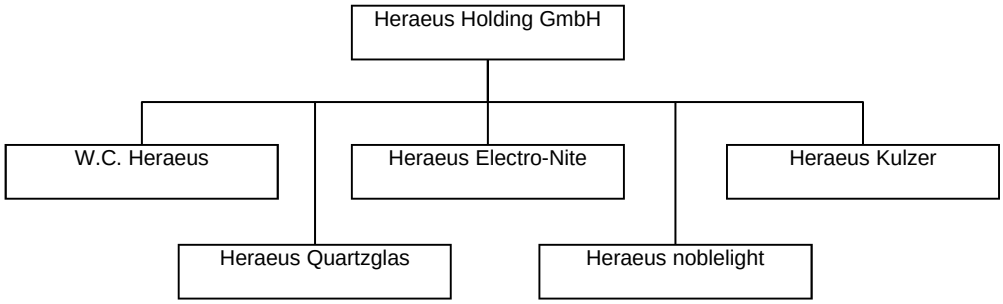
Heraeus	
Headquarters	**Heraeus Holding GmbH** Heraeusstrasse 12-14 D-63450 Hanau Germany
Websites	www.heraeus.com
Chairman of the Board of Management	Dr. Frank Heinricht
Chairman of the Supervisory Board	Dr. Jürgen Heraeus
2007 Statement of income (€ million)	
Revenues	12,190 (product revenue: 2,909; precious metal trading revenue: 9,281)
Relative to 2006	+0.9% (product revenue: +8.2%; precious metal trading revenue: -1.2%)
EBIT	321
Relative to 2006	+8.6%
Net profit	210
Relative to 2006	+19.2%
Balance sheet (€ million)	
Total assets	**2,637**
Current assets	1,814
Non-current assets	823
Total equity and liabilities	**2,637**
Total equity	1,444
Current liabilities	684
Non-current liabilities	509

Source: Annual report 2007

The Heraeus Group is made up of a holding company and five business segments; W.C. Heraeus, which produces industrial products and trades precious metals; Heraeus Electro-Nite, producing various sensors; Heraeus Kulzer, the company's dental and medical products division; Heraeus Quartzglass, producing various types of specialty

glasses; and Heraeus Noblelight, which produces specialty lighting products, such as infrared and ultraviolet lights.

Figure 1: Heraeus' five managing companies



Source: Heraeus website[32]

Heraeus is active throughout the world. Its headquarters are in Germany, but the company has major activities in various European countries, the Americas and Asia and some in Africa. 24% of the company's workforce is located in Asia.[33] Fourteen of the company's 31 sites in Asia are based in China.[34]

Segment	Number of employees
Workforce per region (in %)	
Germany	38%
Rest of Europe	17%
Americas	20%
Asia	24%
Africa/Australia	1%
Workforce per managing company	
W.C. Heraeus	4,270
Heraeus Electro-Nite	3,274
Heraeus Kulzer	1,577
Heraeus Quarzglas	1,563
Heraeus Noblelight	666
Total	11,350

Source: Heraeus website[35]

[32] Heraeus website, The Group, "Portrait", no date, http://corporate.heraeus.com/en/berheraeus/AboutHeraeus.aspx (07-10-08).
[33] Heraeus Annual report 2007, p.44
[34] Ibid., p.24.
[35] Heraeus website, The Group, "Key Figures 1998-2007", no date, http://corporate.heraeus.com/en/berheraeus/zahlendatenfakten_1/finanzpublikationen_1/Finanzpublikationen.aspx (07-10-08).

PGM activities

Production

Several of Heraeus' business segments fabricate products that contain PGMs. These products range from industrial products for the electronics industry, various catalysers used in the automotive industry and pharmaceutical and medical products. The largest business segment processes the precious metals gold, silver, platinum, and other platinum group metals, primarily to produce industrial products for the automotive, chemical, semiconductor, electronics, and medical industries.

W.C. Heraeus' Thin Films division uses PGMs in its sputtering targets, the raw materials for coating hard disks.[36] These sputtering targets consist of a mixture of cobalt alloy and platinum, and are only a few tens of nanometres thick. Sometimes, the layer is so thin that it consists of single atoms. However, as M. Welgert of Heraeus' Thin Film Materials Division states: *"Although the actual consumption of platinum is not very high, the sputter target technology requires quite remarkable amounts of platinum, which are permanently bound in the loop of target and rigid disc production."* As this technology greatly increases the storage density of hard disks, demand for platinum in hard disks has increased over the last years.[37]

The Engineered Materials Division, another subdivision of W.C. Heraeus, produces a range of platinum-based products for automotive electronics, laboratory equipment, components for manufacturing glass, catalysts for the production of nitric acid, and other industrial purposes.[38] These products include catalyst gauzes.

The Chemicals Division of W.C. Heraeus produces catalytic converters for small motors, such as those used in chain saws and lawn mowers, platinum-based pharmaceutical agents, and homogenous catalysts for a number of substances. W.C. Heraeus' Medical Component Division produces electrodes for nerve and muscle stimulation made of platinum-alloys.

Heraeus Electro-Nite produces platinum temperature sensors for the automotive industry. These temperature sensors are key components for particular filters used in diesel vehicles, which have seen a sharp rise after stricter governmental environmental regulations in 2006, and continued to grow in 2007.[39] Heraeus Sensor Technology also includes platinum thin film elements in its product portfolio for temperature sensors in household appliances and for the semiconductor, electronics, and automotive industries.[40] Heraeus claims to be the world leader in the sensor technology industry.

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[36] W. Wrezsniok-Rossbach, "$1,000 for 31 grams of platinum: no panic, but raised eyebrows," The London Bullion Market Association, no date, http://www.lbma.org.uk/publications/alchemist/alch41_pgms.pdf (20-09-07).

[37] Tim Steinweg & Esther de Haan, *Capacitating electronics*: *The Corrosive Effects of Platinum Mining on communities*, makeITfair, November 2007, p.31-32.

[38] Heraeus, Annual report 2007, p.50.

[39] Ibid, p.58.

[40] Written input to this report, Dr. Michael Schreck, W.C. Heraeus GmbH, 17-10-08.

Refining
The company's recycling activities fall under the W. C. Heraeus' Chemical division. Heraeus has four refining sites; In Hanau (Germany), Hong Kong, Santa Fe Springs (USA), and Port Elizabeth (South Africa). The Santa Fe Springs recycling facility reported an increase of throughput of precious metals.

Although Heraeus emphasizes the increase in recycling capacity as a result of the newly built plant in South Africa, South African news reports primarily focus on the new plant's ability to refine ores and concentrates from Northam's mines and other junior projects.[41] According to this report, the refinery will be able to process 400,000 oz. of PGMs once it is in full operation. The news report describes that concentrates from Northam's mines are first shipped to Germany to be treated, then returned to South Africa for processing and use in the automotive industry.

Trade
Heraeus trades precious metals, including platinum and palladium, from three trading desks around the world, in Hanau, Hong Kong and New York.[42] This is where most of the company's revenues are generated. This division benefited from the rise in demand for vehicles, electronic products and luxury goods. Heraeus' annual report specifically mentions the rise in demand for ruthenium, which is almost exclusively used in electronic data storage devises.[43]

CSR policies

Heraeus publishes an annual report and has a section on corporate responsibility on its website. The annual report offers very little information about hard policies related to CSR, although it does make mention of the company's efforts in the field of employee training and health measures. The corporate responsibility section of the website lists the company's principles, without further details on implementation of these principles into its business practices.[44] These principles include;

- Human welfare
- Health
- Occupational safety
- Innovation
- Lifelong learning
- Social involvement

In communication between Heraeus and the German NGO Germanwatch, Dr. Juergen Heraeus, Chairman of the Supervisory Board, states that: *"We [Heraeus] have an*

[41] Miningmx website, "Heraeus builds SA platinum refinery", 01-02-07, http://www.miningmx.com/platinum/604639.htm (29-09-08).
[42] Heraeus, Annual report 2007, p.52.
[43] Ibid.
[44] Heraeus website, "Corporate responsibility", no date, http://corporate.heraeus.com/en/verantwortung/VerantwortungbeiHeraeus.aspx (22-10-08).

intensive compliance programme in our company and thus we are taking care of the [CSR] issues that you are referring to."[45]

International initiatives and standards
Heraeus has been a member of UN Global compact since 2007. It also provides the Chairman of the International Platinum Group Metals Association (IPA), the PGM business association. The IPA has recently set up a working group on sustainability. However, no further information about this working group's goals or activities was available.

Supply chain responsibility
Dr. Roland Gerner, Managing Director of W. C. Heraeus and Chairman of the IPA, has stated in a letter to Germanwatch, a German NGO, that he raised the issues or worker security and wages in South Africa's platinum mines during a broadcast interview, in the role of IPA director. However, no information was found about policies related to supply chain responsibility, or any ongoing structural activities.

Recycling
Although Heraeus does recycle spent catalysts at some of its refineries, the company does not provide any information about its sourcing mix and relative share of recycled goods.

3.3 Johnson Matthey

General information

Johnson Matthey is a British chemicals company that finds its origins in the 19th century as a gold analysing company. These days, the company focuses on speciality chemicals and precious metals trading. It is a business-to-business operation that sources its raw materials from mining companies, in particular from Anglo Platinum with whom it has an exclusive marketing agreement.

[45] Letter from Dr. Jürgen Heraeus, Chairman of the Supervisory Board of Heraeus Holding GmbH to Germanwatch, 10-12-07.

Table 3: General facts and figures

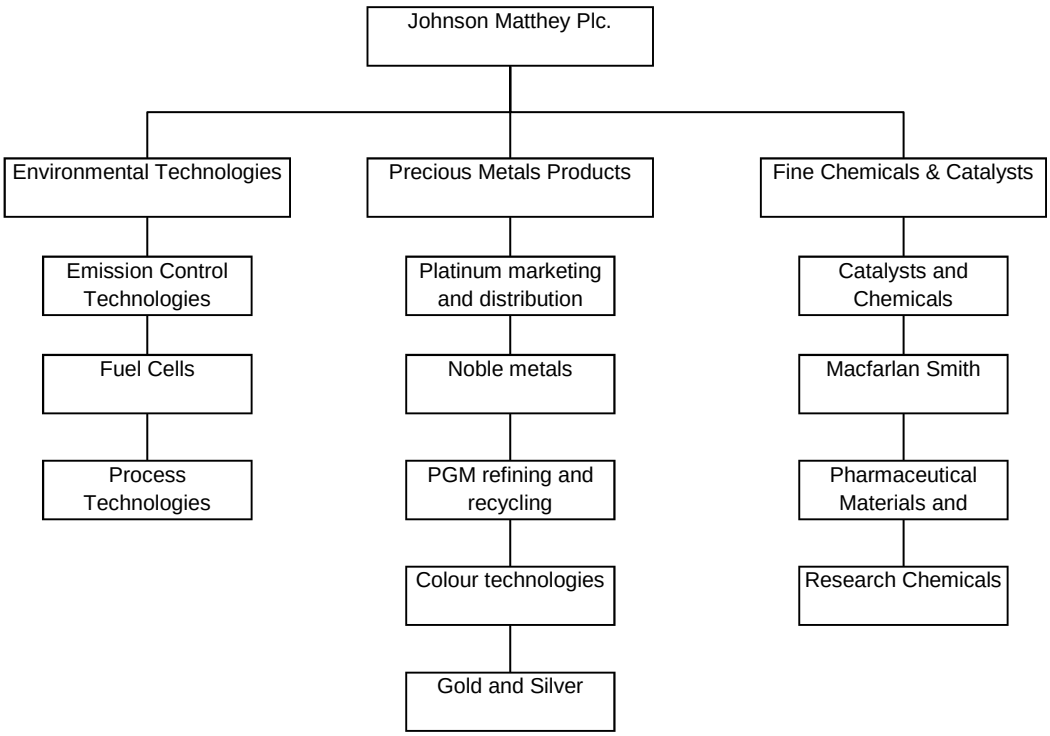
Headquarters	Johnson Matthey Plc 40-42 Hatton Garden London EC1N 8EE United Kingdom
Websites	www.matthey.com
Chairman	Sir John Banham
CEO	Neil Carson
2008 Statement of income (£ million)*	
Revenues	7,499 (1,750 excluding precious metals)
Relative to 2007	+22% (+20% excluding precious metals)
Profit	185.4
Relative to 2007	-10%
Balance sheet (£ million)	
Total assets	2,606.3
Current assets	1,194.2
Non-current assets	1,412.1
Total equity and liabilities	2,606.3
Total equity	1,160.3
Current liabilities	725.9
Non-current liabilities	720.1

Source: Johnson Matthey Annual report 2008
* Figures are for the year to 31st March

Johnson Matthey's operations are based around three divisions. The current structure has only been in place since April 1st, 2007.[46] Firstly, Environmental Technologies focuses on fuel cells, car and petroleum catalysts and other emission controlling products. The Precious Metals Products division entails all platinum trading and fabrication activities, as well as colour technologies and gold and silver operations. Finally, the Fine Chemicals and Catalysts division produces chemicals for research and the fine chemicals and pharmaceutical industries.

[46] Johnson Matthey, Annual report 2007, p.8.

Figure 2: Johnson Matthey's operational structure



Source: Johnson Matthey Annual Report 2008

Johnson Matthey is active in 33 different countries, in six different continents, and employs almost 8,000 people worldwide. Most employees are based in Europe and the United States, and the company fabricates most PGM products in the UK and United States.[47] However, the company's autocatalyst division has actively expanded to Asia in the wake of the growing car manufacturing sectors in Korea and Japan. Johnson Matthey employs most people in the Catalysts division, which is now within the Environmental Technologies division.

[47] Johnson Matthey website, Divisions, “Precious Metal Products Division”, no date, http://www.matthey.com/about/preciousmetals.htm (29-09-08).

Table 4: Johnson Matthey employees

Segment	Number of employees
Per region	
Europe	4,048
North America	2,519
Asia	765
Rest of the World	681
Per Division	
Corporate	310
Environmental technologies	4,094
Precious Metals Products	1,934
Fine chemicals and ceramics	1,675
Total	8,013

Source: Annual Report

PGM related activities

Johnson Matthey is one of the largest players with regards to fabrication and trading of PGMs. It fabricates a large number of different PGM containing products, mostly for the automotive industry. It also markets and trades PGMs and provides market research and data on its website. Although the company also has refining and recycling activities, these are much smaller than its fabrication and trading.

Fabrication

A large part of the Precious Metals Products division deals with the fabrication of products that contain PGMs. According to its own website, Johnson Matthey fabricates the following PGM products;

- Glass industry products
- Laboratory apparatus
- Crucibles
- Wire, tube and sheet products
- Catalyst gauze
- Jewellery alloys
- Brazing alloys

It also fabricates the following PGM catalysts and chemical products;

- PGM salts and precursors
- Emission control catalysts
- Process/petroleum catalysts
- Passive component materials[48]
- Fuel cell components

[48] These products are used in the electronics industry, including electrode materials for the capacitor industry. However, Johnson Matthey seems to specialize in products using silver.

- Gas purification
- Plating salts

In addition, the company also produces a range of products for the pharmaceutical industry, as well as precious metals inks. The company did have a subsidiary specializing in producing products for the electronics industry, the Johnson Matthey Electronic Materials Division, but it has sold off this branch to Allied Signal Inc., based in the USA, in 1999.[49] AlliedSignal has since merged with Honeywell International, who produces sputtering targets for hard drives. However, this company does not list PGMs as one of the metals it uses for this.[50]

The company has a number of fabrication facilities and refineries around the world, although it is not specified how many or where these are located. For certain, the company has the following plants and refineries;

- Autocatalyst plant in Krasnoyarsk, Siberia.
- Catalyst manufacturing plant in South Korea.
- Plant in South Africa
- Plant in Japan
- PGM refining facilities in the UK and USA[51]
- Refinery in Royston, UK
- Refinery in Brimsdown, Canada

Refining

The company also has a PGM Refining branch, which deals with the recovery of precious metals from a range of products, including from the automotive and electronics sector. The company has introduced new refining processes at its facilities, due to, among other things, the increased demand of ruthenium from the electronics sector.[52] Its main focus is the extraction of PGMs, although other metals are extracted as well.

Trading and marketing

Johnson Matthey also acts as a trader of PGMs in pure form. It has trading desks in the UK, the US and Hong Kong. It is the sole marketing agent for Anglo Platinum, the world's largest producer of platinum, based in South Africa. The company does not provide any disclosure regarding its client base.

CSR Policies

International initiatives and standards

Johnson Matthey commits to the following two international standards;

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[49] Johnson Matthey website, "Johnson Matthey Sells Electronic Materials Division", 09-07-99, http://www.matthey.com/media/news/sell_elec_0799.html (29-09-08).

[50] Honeywell website, Honeywell Electronics Materials, "Sputtering Targets", no date, https://www51.honeywell.com/sm/em/products-applications/metals/sputtering-targets.html?c=23 (29-09-08).

[51] Johnson Matthey, Annual report 2007, p.11.

[52] Johnson Matthey, Annual report 2007, p.12.

- UN Declaration on Human Rights[53]
- ILO Core Labour Conventions

It does not mention any membership of CSR initiatives, but it is a member of the FTSE4GOOD index.

CSR Report
Johnson Matthey publishes an annual CSR report, in which is formulates its policies shot-term and long-term goals related to five identified elements of CSR; Social; Environment; Health and Safety; Governance; and Financial.

The social element is manifested in the company's relationships with the community, and the development of its employees. The company reports on employee turnover, trade union representation and gender balance. It perceives its charitable operations as part of the community engagement activities. The environmental reporting of Johnson Matthey includes information about the company's energy use, emissions, waste generation and water consumption. The main target that the company has set itself is related to emissions control measures. Health and safety policies are formulated in the company's Corporate Health Management Strategy.[54] In its CSR report, the company reports about annual accident rates and days lost for its employees.

Recycling
Johnson Matthey has two precious metals refineries, where it processes spent catalysts and other primary and secondary sources. The refineries are located in Royston, UK and Brimsdown, Canada.[55]

No information was found about the absolute or relative volumes of recycled materials the company uses. It also does not give breakdowns related to the raw materials that go into its refineries.

Supply chain responsibility
Johnson Matthey makes mention of supply chain issues in its CSR report, although it is in rather general terms. It states:

> *"Whilst we are confident of the performance of our own operations, we recognize that business practices in the supply chain are not always transparent and represent a risk that must be managed. Every effort is made to ensure that issues are managed efficiently."*[56]

[53] Johnson Matthey website, Corporate Social Responsibility, "Business Integrity and Ethics Policy Statement", no date, http://www.matthey.com/cr/biepolicy.htm (29-09-08).
[54] Johnson Matthey CSR Report 2007/2008, p.34.
[55] Johnson Matthey PGM Refining website, "Home", no date, http://www.jmrefining.com/page-view.php?page_id=1&parent_page_id=0 (20-03-08).
[56] Johnson Matthey, CSR Report 2007/2008, p.46.

Supply chain management is also mentioned in the context of the company's ISO 9000 and ISO 14000 certification, and with regards to the company's goal to reduce its global greenhouse footprint.

The company's CSR report lists a number of case studies, which are used to illustrate the company's approach to CSR. One of the case studies is a project that with environmental issues in the supply chain of Shanghai General Motors. The overall aims of the project are to reduce energy use and improve resource utilisation.[57]

No specific information was found about the company's approach to the specific issues in the PGM supply chains or in what manner the company engages in dialogue with other players in the supply chain on these issues.

3.4 Umicore

General information

Umicore is a Belgian public company that originated from a number of predecessor companies, including "Société Anonyme des Mines et Fonderies de Zinc de la Vieille-Montagne", established in Belgium in 1805, and Union Minière du Haut Katanga (UMHK).[58] UMHK was the company that extracted the natural resource of the Congolese province of Katanga under Belgian rule. This company played a controversial role during the last years of Belgian occupation, as well as in the beginning years of Congolese independence. Not only was the uranium mined by UMHK used in the Manhattan Project that lead to the development of the atomic bomb[59,] but the company was also actively involved in the turbulent local politics through hiring mercenaries[60], and was actively involved in the political elimination of local nationalist politician Patrice Lumumba in September 1960.[61]

Today, Umicore has no direct activities in Congo anymore, and has been transparent about its controversial past. For example, it emphasizes its African heritage in its current communications about the company's sustainability approach.[62] It does still source some

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57 Johnson Matthey CSR Report 2007/2008, p.66

58 Umicore website, About Us, History, "Short History", no date, http://www.umicore.com/en/aboutUs/history/, (04-03-08).

59 Umicore website, Sustainable Development, "Umicore and its African heritage and activities", no date, http://www.sustainabledevelopment.umicore.com/mainIssues/africanHeritage/ (04-03-08).

60 R. van Doorslaer, De moord op Patrice Lumumba en de parlementaire onderzoekscommissie, Kroniek Congo, 2001, http://www.cegesoma.be/%5Cmedia%5Cchtp_beg%5Cchtp11/009_chron_rvd_lumumba_chtp11.pdf (04-03-08).

61 "Het lastige verleden van Umicore", De Standaard, Economie, June 14th, 2006.

62 Umicore website, Sustainability, "Umicore and its African heritage and activities", no date, http://www.sustainabledevelopment.umicore.com/mainIssues/africanHeritage/ (26-09-08).

cobalt from the DRC, but has a specific Code of Conduct, which stresses the ban on child labour.[63]

Table 35 shows some general facts and figures about the company today.

Table 5: General facts and figures

Headquarters	**Umicore Société Anonyme/Naamloze Vennootschap** Broekstraat 31 rue du Marais B-1000 Brussels, Belgium
Websites	www.umicore.com
Chairman	Karel Vinck
CEO	Thomas Leysen
Statement of income (€ million)	
Operating Income	8,439 (revenues 1,910)*
Relative to 2006	+1.6% (revenues +13%)
Profit before income tax	294
Relative to 2005	+8.9%
Profit from continuing operations	237
Relative to 2005	+7.4%
Balance sheet (€ million)	
Total assets	3.285
Current assets	2.081
Non-current assets	1.140
Total equity and liabilities	3.285
Total equity	1.533
Current liabilities	1.198
Non-current liabilities	519

Source: Umicore Annual report 2007

* The revenues comprises of the turnover minus the pass-through element of the metals processed

Umicore's organisational structure is based on the following four divisions; Advanced Materials; Precious Metals and Catalysts; Precious Metals Services; and Zinc Specialties. The company operates worldwide in a total of 37 different countries, and

[63] Swedwatch, Powering the Mobile World, MakeITfair, November 2007, http://makeitfair.org/the-facts/reports/Powering-the-Mobile-World-Swedwatch-November-2007.pdf (04-03-08).

employs 14,844 people.[64] Figure 3 and Table 5 show Umicore's structure and workforce respectively.

Figure 3: Umicore's structure

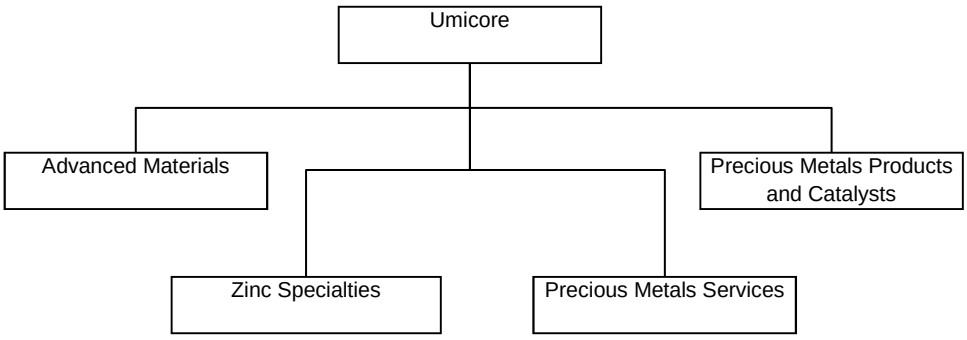

Table 5: Umicore's workforce

Segment	Number of employees
Per region	
Europe	8.137
North America	835
South America	1.130
Africa	1.512
Asia	3.164
Pacific	66
Per Division	
Advanced Materials	5.624
Precious Metals Products and Catalysts	4.508
Precious Metals Services	1.452
Zinc Specialties	2.172

Source: Umicore Annual Report 2007

PGM related activities

Umicore's activities related to PGMs are mostly based on production of industrial products and refining operations, which mostly deal with recycling services for spent car catalysts, used electronic consumer goods and other (by-) products. Production of PGM containing products accounts for approximately 70% of PGM related operations, while 25% consist of the company's refining operations, and the remaining 5% are trading activities.[65]

[64] Umicore Annual Report 2007, p.4.
[65] Umicore's response to SOMO's questionnaire, received 15-05-08.

Production

The company's Precious Metals Products and Catalysts division has a total of six subdivisions, all but one have operations that use PGMs; Automotive Catalysts; Catalyst Technologies; Thin Film Products; Jewellery & Electroplating; and Platinum Engineered Materials.

On the website of the Automotive Catalysts subdivision, mention is made of platinum, palladium and rhodium as ingredients for the active material that chemically transforms car exhaust gases.[66] The company's Catalyst Technologies division develops catalysts for the 'life science and chemical industries', as well as fuel cell technologies.[67]

Among other purposes, Thin Film Products produce products that are used in microelectronics. For example, the thin film technology is used in the development of sputtering targets, used in the production of hard disks. The sputtering targets developed by Umicore that are used for microelectronics and semiconductors, use PGMs.[68] Umicore has thin film production sites in Europe, the United States and Taiwan.

The Jewellery & Electroplating division produces platinum and palladium based electrolytes and high end products and services for electrical and electronic applications. Although PGMs are used in some of the jewellery, the total amounts of PGMs used are negligible in relation to overall PGM use.[69]

The Platinum Engineered Materials division markets a variety of platinum based products. These include manufacturing equipment for high-end glass applications such as LCD glass, but also catalysts for various industries, such as the fertiliser industry.[70]

According to the company's Annual Report, roughly 50% of the metals it uses comes from recycled sources.[71] For PGMs, the company compares the volumes it recycles internally to the volumes of PGMs that end up in products. The recycling rates amount to 29% for platinum, 34% for palladium and 54% for rhodium.[72] Umicore is mentioned by Anglo Platinum as one of its major customers, indicating that the company does source a significant amount of PGMs directly from mining companies.[73]

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66 Umicore website, Automotive Catalysts, "Products", no date, http://www.automotivecatalysts.umicore.com/en/product/ (04-03-08).

67 Umicore website, Our Business, "Precious Metals Products & Catalysts", no date, http://www.umicore.com/en/businessGroups/pmpc/pmpc.htm (26-09-08).

68 Umicore, Precious Metals for Semiconductor Applications, no date, http://www.thinfilmproducts.umicore.com/pdf/precious_metals.pdf (04-03-08), p.3.

69 Umicore's response to SOMO's questionnaire, received 15-05-08.

70 Umicore website, "Platinum Engineered Materials", no date, http://www.pem.umicore.com/en/ (04-03-08).

71 Umicore annual report, p.19.

72 Written input to this report, Mr. Geoffroy Raskin, Investor Relations Manager, Umicore, 17-10-08.

73 Anglo Platinum website, Our Operations, "INVESTMENTS AND STAKEHOLDINGS", no date, http://www.angloplatinum.com/ (04-03-08).

Refining

The company's Precious Metals Services division provides refining and recycling services to its costumers, as well as the management of precious metals, including leasing, hedging and physical delivery of metals.
Umicore operates a large refining factory in Hoboken (Belgium), where it refines and recycles by-products from other industries and end-of-life materials from consumer and industrial products.[74] 17 different metals are processed in this plant, including the platinum group metals, gold, silver, copper, lead and other minor metals.[75] The company's CEO has stated:

> *"[W]e take very little purely primary metal in the primary raw materials, meaning minded ores and concentrates, that's only very occasionally that we take real primary material into Hoboken. We have more or less a segment between autocats, electronics, industrial bi-products and residues or side streams. We don't give the full breakdown of that; that's commercially sensitive."*[76]

Clarification given by a Umicore representative indicates that the primary materials that the CEO mentions are mostly copper and lead concentrates, but never precious metal ores.[77]

Trade

The Precious Metals Services division also operates as a provider of precious metal bars, including platinum and palladium bars. These are sold to investors, external and internal customers.[78] However, the company's trading activities are minor in comparison with its production and refining operations.

CSR Policy

Umicore has a number of documents relating to the company's CSR policies; The Umicore Way, a brochure for employees; The Umicore Code of Conduct, which also includes the Human Rights Policy; the Umicore Procurement Policy; and the Corporate Governance Charter. It reports on its CSR performance in its Report to Stakeholders and Society, which includes an environmental and social report. Additionally, Umicore responded to SOMO's questionnaire, through which it provided additional information regarding the company's CSR approach.

International initiatives and standards

The company is a member of the following sustainability initiatives and is listed on the following sustainability indices;

- World Business Council for Sustainable Development

[74] Umicore website, Precious Metals Services, "EXCELLENCE IN RECYCLING", no date, http://www.preciousmetals.umicore.com/home/ (04-03-08).
[75] Email contact with G. Raskin, Investor Relations Mgr., 19-03-08.
[76] "Q4 2007 Umicore Earnings Conference Call – Final", FD (Fair Disclosure) Wire, February 14, 2008.
[77] Written input to this report, Mr. Geoffroy Raskin, Investor Relations Manager, Umicore, 17-10-08.
[78] Umicore website, Precious Metals Management, "Security of supply and price hedging", no date, http://www.metalsmanagement.umicore.com/en/ (04-03-08).

- Business and Society[79]
- United Nations Partnership Against Corruption Initiative (PACI)
- FTSE4GOOD
- "Best in class" rating by Storebrand Socially Responsible Investments
- Kempen/SNS Smaller Europe SRI Index

The company has signed a Framework Agreement with the International Metalworkers Federation (IMF) and the International Federation of Chemical, Energy, Mine and General Workers' Unions (ICEM).[80] Through this framework, the company has committed itself to the core ILO Conventions, as well as the principles of living wage, working hours and occupational health and safety.

CSR policies

In its Report to Stakeholders and Society, the company describes policies and efforts on the following themes;

Environmental

- Energy Use
- Water use
- Emissions
- Waste production
- Regulatory compliance

Social

- Labour Practices
- Health and Safety
- Human Rights
- Society
- Product Responsibility (this deals with the physical, chemical, toxicological and eco-toxicological qualities of Umicore's products).

Umicore has set itself five *social targets*;

- Accountability to the local community
- Be a preferred employer
- Constructive internal dialogue and open communication
- Encourage learning and development
- Equal opportunities and respect for human rights

Recycling

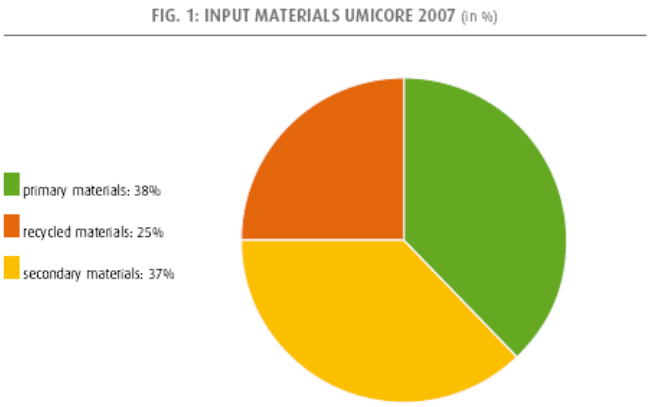
In its annual report, Umicore gives the breakdown of the raw materials that it sources (see Figure 4). 38% of the raw materials are from primary sources, while 25% comes

[79] A Belgian alliance of business and civil society groups.

[80] ICEM website, Key issues, Global Framework Agreements, Umicore, "Text of the Global Framework Agreement between Umicore and ICEM/IMF", 28-09-07, http://www.icem.org/index.php?id=187&doc=2411&la=EN (26-09-08).

from recycled materials. The remaining 37% comes from secondary materials, such as production scrap and waste streams. It should be noted that these figures relate to all of Umicore's activities combined.

Figure 4: Umicore's use of raw materials



For its product manufacturing activities, Umicore indicates that the ratio of recycled materials in its refining activities versus the overall PGM use in its materials products are 29% for Platinum, 34% for Palladium, and 54% for Rhodium.[81] It uses more PGMs in its manufacturing activities than it generates with its refining and recycling activities, and the company indicates that it sources these PGMs either from its costumers in consignment, or it purchases them from the spot market. It also indicates that it is not aware of any customer specifically requesting a certain percentage of recycled PGMs in any of the products.[82]

Umicore's refining and recycling activities, as part of its Precious Metals Services division, is focused on end-of-life materials, such as spent catalysers and electronic products, and secondary sources. 83% of all its refining activities use these sources of precious metals.[83] For PGMs, the full 100% of its refined materials come from end-of-life or secondary sources, and Umicore does not make use of raw PGM ores or concentrates in its refining activities.[84]

Umicore claims to be the world's leader in recycling complex materials that contain precious metals.[85] The Hoboken plant is the largest precious metals recycling plant in the world. Spent catalysts, electronic and computer waste and industrial by-products are all refined in Umicore's facilities to produce PGM sponge, among a variety of other metals. Umicore provides recycling services to external customers, and also uses the facilities to produce precious metals to be used or sold by the company itself.

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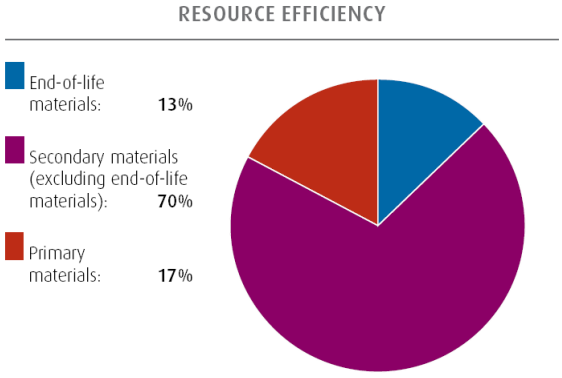
81 Umicore response to SOMO questionnaire, received 15-05-08.
82 Ibid.
83 Umicore annual report 2007, p. 33.
84 Umicore response to SOMO questionnaire, received received 15-05-08.
85 Umicorre, Precious Metals Refining, no date, http://www.preciousmetals.umicore.com/publications/brochures/ExploringUPMR.pdf *18-03-08).

Figure 5 shows the source of the raw materials of the Precious Metals Services division of the company. It should be noted that the same graph in Umicore's 2006 report was in terms of 'treatment charges', which relate to the revenue generated from different supply streams. As explained by a Umicore representative through email:

> "*The refining charges only represent part of the picture as revenues are also generated on any metal we extract on top of what we have contractually arranged to give back to the customer. Moreover, revenues are also generated on metal (quality) premiums and various services. We do however not give the split*".[86]

Umicore's Precious Metals Refining division does not specifically target ores and concentrates, but only uses these to '*[adjust] the production flowsheet'.* No PGM ores or concentrates are ever used, according to a Umicore spokesperson.

Figure 5: Precious Metals Refining division's use of raw materials



Supply Chain Responsibility

Umicore's CSR policy primarily relates to the company's own operations and employees. No mention is made about Umicore's role in the supply chain of PGMs or other metals. In one particular field, Umicore does express its position regarding issues within the company's supply chain; it has published an official position on the purchase of cobalt from the Democratic Republic Congo.[87] Here, the company commits to sourcing cobalt from suppliers who take labour conditions into consideration and pay export taxes, and to rejecting cobalt sourced from the closed Shinkolobwe mine.

In the above-mentioned International Framework Agreement, Umicore commits itself to:

> *[seek] business partners whose policies regarding ethical, social and environmental issues are consistent with our own Code of Conduct, which is*

[86] Email contact with G. Raskin, Investor Relations Mgr., (19-03-08).

[87] Umicore, Umicore position on the purchasing of cobalt raw materials in Katanga, Democratic Republic of Congo (DRC), no date, http://www.communityrelations.umicore.com/en/group/show_CobaltPositionPaper.pdf (18-03-08).

> *complementary to this agreement. Umicore supports and expressly encourages its business partners (subcontractors and suppliers) to take into account and apply the ILO core labour standards in their own corporate policy. Umicore takes the view that in doing so it lays the basis for promising future business relations*[88]

Umicore does not currently have a CSR policy that deals specifically with the issues regarding the sourcing of PGMs. The company has indicated that it is aware of the relocation issues surrounding one of Anglo Platinum's mines in South Africa, and stated that it is "*following the case".*[89]

[88] ICEM website, Key issues, Global Framework Agreements, Umicore, "Text of the Global Framework Agreement between Umicore and ICEM/IMF", 28-09-07, http://www.icem.org/index.php?id=187&doc=2411&la=EN (26-09-08).

[89] Umicore response to SOMO questionnaire, received 15-05-08.

4 End Use

This chapter gives a broad overview of the use of PGMs in end users sectors. An overview of the products and the global demand for PGMs per product is given, to map the relative importance of the various end user sectors. This serves as background information when identifying corporate players in the PGM supply chain, which might be involved in possible combined supply chain approaches.

Most of the demand for PGMs is accounted for by four end-use industries; Most of the PGMs are used in the automotive industry, while the raw materials also end up in jewellery, electronics, dental and medical applications, and petro- and chemical processing. The basis of most of the information given here is the annual PGM overview by the CPM Group.[90]

4.1 China

The figures for end use of PGMs are rather difficult to interpret. This is mostly due to the gap of knowledge about the end use of PGMs that are imported into China. As no estimates are available about the end use of PGMs in China, the CPM Group in its report lists China as a separate category. China's demand was estimated to comprise 7.7% of global demand for platinum, and 10.4% for palladium.[91] Consequently, the figures given below need to be interpreted with caution, as this gap in the available information might skew the figures about end use given below.

One of the main drivers for demand from China is the booming automotive industry, in combination with more stringent environmental laws.[92] However, estimates of demand from electronics, dental and chemical end uses range to up to 30% of Chinese PGMs demand, which is significantly higher than the combined share of these industries in other regions of the world.[93]

4.2 Automotive

Core figures

The automotive industry is by far the largest PGM consuming industry globally. According to CPM, the industry currently accounts for 56.7% of global platinum demand, 51.2% of palladium demand and 86.8% of rhodium demand. The demand from the

[90] CPM Group, The CPM Platinum Group Metals Yearbook 2007 (Hoboken, NJ, John Wiley & Sons Inc., 2007).
[91] Ibid., p.41 & p. 119.
[92] Orsa Maggiore, "China and Palladium", Palladium-bar weblog, 06-09-07, http://valuearea.blogspot.com/2007/09/china-and-palladium.html (09-09-08).
[93] Ibid.

automotive industry has steadily grown over the last three decades and there are two main uses for PGMs in the automotive industry; Catalytic converters and fuel cells.

Catalytic converters

Catalytic converters are devices that reduce the toxicity of exhaust gases from cars and other engine-driven vehicles and machines. In such a converter, a chemical process reduces the toxic by-products of combustion by converting these substances into less toxic ones. Platinum and palladium are increasingly used in catalytic converters, as the elements have specific traits that transform carbon monoxide, nitrogen oxide and hydrocarbons into less harmful carbon dioxide, nitrogen and water vapour.[94] There are two types of catalytic converters; the three-way and the two-way converter. The difference lies in the fact that three-way converters also convert nitrogen oxides into nitrogen and oxygen, whereas the two-way converter does not.

In 2006, 4.0 million oz. of platinum and 3.96 million oz. of palladium was used in automotive catalysts. These figures have been steadily rising over the last ten years, as demand was 2.0 million oz. of platinum in 1997. The CPM report makes mention of three causes for these figures to rise so significantly; Firstly, the production and sale of cars have steadily increased globally over the last thirty years. Secondly, due to more stringent environmental laws, more cars are now equipped with catalytic converters to reduce their toxic exhaust. And thirdly, these environmental laws have also affected in a higher amount of PGMs used per catalyst, to further reduce the toxicity of car exhausts. Another recent trend is the shift away from more expensive platinum and rhodium towards the cheaper palladium, although it is unlikely that palladium will completely substitute platinum use in catalytic converters.[95]

Fuel Cells

A fuel cell is a device that generates electric power through an electrochemical reaction of fuel and air.[96] Hydrogen is often used as fuel and mixes with oxygen to form water. In this process, electricity is generated that is used to power a car. A fuel cell is made up of two electrodes, an electrolyte, and a catalyst. This catalyst, which is used to speed up the process, is usually made out of PGMs. At this point fuel cells are still hardly used in commercial cars, and it is widely debated whether it ever will.[97]

Only platinum is used in fuel cells, while palladium, rhodium and other PGMs are not. No exact figures were found about the total use of PGMs in fuel cells, but it is likely to be insignificant in comparison to automotive catalysts. However, it should be noted that fuel

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[94] Platinum Today website, Applications, “Autocatalysts”, no date, http://platinum.matthey.com/applications/autocatalyst.html (29-09-08).

[95] CPM Group, The CPM Platinum Group Metals Yearbook 2007 (Hoboken, NJ, John Wiley & Sons Inc., 2007), p.44.

[96] http://www.fuelcelltoday.com/media/pdf/education-kit/The-Basics.pdf

[97] CPM Group, The CPM Platinum Group Metals Yearbook 2007 (Hoboken, NJ, John Wiley & Sons Inc., 2007), p.46-47.

cells are not only used in the automotive industry, but can also serve the purpose of providing electricity and heat for buildings and stationary products.[98]

The environmental downside to fuel cells seems to lie in the production process of hydrogen, the fuel used in fuel cells. Especially the production of hydrogen from hydrocarbons is an expensive and environmentally unfriendly process.[99]

4.3 Electronics

The use of PGMs in electronic equipment has risen significantly over the last three years. Platinum use in the electronics sector went from 214 thousand oz. in 2004 to 241 thousand oz. in 2006, an increase of 13%. Palladium use rose from 648 thousand oz. in 2002 to 1.056 million oz. in 2006, an increase of 63%. It should be noted that palladium use was almost three times higher in the mid-90s than it is currently, mostly due to a decrease in palladium use in semiconductors around the change of the century. In addition, the electronics industry is the only industry that uses significant amounts of ruthenium, one of the minor PGMs and is largely responsible for the price hike of this metal over the last years.

For the most part, PGMs used in the electronics industry end up in hard disks, electronic components and LCD screens.

Hard disks

The hard disk is the data storage facility of electronics products, which, through a cobalt alloy coating with magnetic properties, can store and retrieve information. The more magnetic qualities this coating has, the more data can be stored on a smaller surface. Platinum is used to increase the magnetic qualities of the coating, and improve the performance of the hard disk. Hence, the use of platinum in hard drives has increased greatly over the last years. The increase can be explained by three factors; Firstly, every hard disk now contains platinum, while this was only 50% in 1997; secondly, because the amount of platinum used in the cobalt alloy has also steadily increased; and thirdly because of the increase in hard disks sold.[100]

Hard disks using perpendicular magnetic recording technology have started to gain market share - these use similar recording media as conventional hard disks, maintaining the platinum content per disk. This new type of hard disk also accounts for the immense increase of 78% of ruthenium use in the electronics industry in 2006. The overall

[98] Fuel Cell Today website, “The Basics”, Education Kit 1, no date http://www.fuelcelltoday.com/media/pdf/education-kit/The-Applications.pdf (29-09-08).
[99] Fuel Cell Today website, “Advantages-Disadvantages”, Education Kit 9, no date, http://www.fuelcelltoday.com/media/pdf/education-kit/Advantage-Disadvantages.pdf (29-09-08).
[100] Johnson Matthey, *Platinum 2007*, May 2007, http://www.platinum.matthey.com/uploaded_files/Int2007/full_int_07.pdf (29-09-08).

demand for ruthenium fell in 2007 compared to 2006, mostly because of an increase in recycling rates.[101]

As the number of hard disks per device is rising, the platinum content of an average consumer electronics product is increasing. On the other hand, flash memory seems to be gaining in the portable device market, replacing the small one inch hard disks. As no platinum is used in flash memory, this development could potentially limit net growth rates. In 2007, this development only had a very minor effect on platinum demand.[102]

Electronic components

Most of the palladium in the electronics industry is used in multilayer ceramic capacitors (MLCCs). MLCCs are passive components used in computers and other consumer electronics devices. While the average size of MLCCs continues to shrink, the amount of MLCCs used per product still increase significantly. This causes the continuing increase in demand for palladium from the electronics sector.[103]

Palladium replaces other more expensive or environmentally hazardous metals in electronic products, such as gold, lead, and platinum.[104] Palladium-containing components are used in virtually every type of electronic device, from basic consumer products to complex military hardware. Although each component contains only a fraction of a gram of metal, the sheer volume of units produced results in significant consumption figures.

For example, it has been estimated that the amount of palladium in a single mobile telephone handset is 0.015 g. Mobile phone sales reached a total of 1 billion units in 2006, accounting for approximately 15,000kg (6% of total demand and almost half of the palladium consumption of the electronics industry) of palladium.

The connectors linking various components of personal computers are plated with a conductive layer of precious metal, such as gold and palladium. Palladium is used as an alternative plating material to gold for connectors as it has a lower density and therefore a coating of similar thickness requires less weight of the metal.[105]

Although an increase in palladium demand is expected, this be somewhat offset by a combination of miniaturization and the substitution of palladium by nickel and silver in multilayer ceramic capacitors.[106] Nickel has substituted palladium in many types of MLCC in recent years. However, with plant utilisation rates high, few manufacturers had the opportunity to switch to nickel-using technology in their production. Some producers

[101] Johnson Matthey, *Platinum 2008*, May 2008, http://www.platinum.matthey.com/uploaded_files/Pt2008/08_complete_publication.pdf (29-09-08), p.9.
[102] Ibid., p.30.
[103] Ibid., p.37-38.
[104] George, M. (2007) Platinum Group Metals. U.S. Geological Survey Minerals Yearbook 2006.
[105] Platinum Today website, Applications, "Electronic Components, no date http://platinum.matthey.com/applications/1049453350.html (29-09-08).
[106] George, M. (2007) Platinum Group Metals. U.S. Geological Survey Minerals Yearbook 2006.

have even added palladium MLCC capacity, increasing overall palladium consumption in this sub-sector for the first time in six years. Palladium usage in the plating of electronic components also fared well in 2006.

Environmental factors also had a significant effect on the uptake of palladium by the electronics industry in 2006. The pressure to move to cleaner manufacturing processes and to recycle a greater proportion of electronic products continues to grow all round the globe. In Europe, the WEEE directive came into force in 2006. Other countries are also considering implementing similar rules in the near to medium-term. Palladium has found some use as an alternative plating material on lead frames for this reason.[107]

LCD Screens

Liquid Crystal Display (LCD) is a display that works through applying an electric voltage through a layer of liquid crystal. LCDs are used in computer screens, laptops, game consoles, photo cameras, mobile phones and other applications.

Platinum and platinum-rhodium alloys are used during the manufacture of LCD glass. According to Johnson Matthey, this is the most intensive user of platinum per unit of glass produced.[108] No figures were found on the amounts of rhodium and platinum used, but according to the USGS, LCDs are the second largest use for rhodium.[109]

4.4 Jewellery

Most PGM containing jewellery does not contain pure platinum or palladium, but is typically producing using an alloy of 85-95% PGM. This is due to the fact that platinum, the most widely used PGM in jewellery, is too soft for daily use in its pure form. Platinum is usually alloyed with a combination of palladium, iridium, ruthenium, cobalt or copper.[110]

Jewellery is the second largest platinum using and the sixth largest palladium using industry. In 2006, the industry accounted for 615,000 oz. of platinum, or 8.6% of total demand, and 318,000 oz. of palladium, or 4.1% of total demand. The demand for platinum has decreased over the last years, while the gap is partially filled by the cheaper palladium. This decrease has been a steady and long-lasting process, as demand has gone down every year since 1998, except once in 2002. CPM Group ascribes this trend to the rise of platinum prices, reduced marketing efforts and increased consumer interest in other forms of jewellery.[111]

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[107] Johnson Matthey, *Platinum 2007*, May 2007, http://www.platinum.matthey.com/uploaded_files/Int2007/full_int_07.pdf (29-09-08).

[108] Platinum Today website, Applications, “Glass”, no date, http://platinum.matthey.com/applications/1046279130.html (29-09-08).

[109] George, M. (2007) Platinum Group Metals. U.S. Geological Survey Minerals Yearbook 2006.

[110] Platinum Today website, Applications, Jewellery, “Platinum Jewellery Alloys”, Platinum 2002, http://platinum.matthey.com/uploaded_files/publications/pdf2002/jewellery.pdf (29-09-08).

[111] CPM Group, The CPM Platinum Group Metals Yearbook 2007 (Hoboken, NJ, John Wiley & Sons Inc., 2007), p.49.

Historically, PGM jewellery saw its popularity rise in the United States during art deco era, only to diminish during and after WW2. In the 1960s, demand rose in Japan, which is still a major end use country. In the 1970s and 1980s a 'renaissance' occurred in Western Europe as well, while Chinese demand started rising during the last decade.

In 2006, Japan accounted for 470,000 oz. of platinum, or 76% of PGMs used for jewellery, excluding China.[112] For China there were no reliable figures available. Palladium jewellery seems to be more evenly spread across regions, with both the United States and Western Europe demanding 60,000 oz. in 2006. Japan used 148,000 oz. of palladium in jewellery in 2006, or 47% of global demand excluding China.[113] Another source estimates that a Chinese jewellery demand was 760,000 oz. in 2006, significantly higher than Japan or any other country.[114] However, there is a lot of uncertainty about the end use of PGMs in China, so it is unclear how reliable these estimates are.

4.5 Other

According to CPM, "*one in five manufactured products involves platinum, typically not in the product itself, but in its manufacture*". Mostly this is due to the use of platinum during the manufacture of glass and plastics, which means that any product that includes glass or plastics has been touched by platinum. In addition, PGMs are also used in petroleum and chemical refining catalysts and various dental and medical applications. When added together, the 'other' categories had a combined demand of more than 1 million oz. of platinum and 1.6 million oz. of palladium in 2006.

Chemical/petroleum processing

The most significant use of platinum in chemical processing is the use in chemical catalysts that are used in the manufacture of nitric acid.[115] Platinum is also used in the manufacture of specialty silicones.[116] The platinum is used in a catalyst during the manufacturing of this silicon, which is used in Post-It Notes and re-sealable bags, among other things. In petroleum refining, platinum is used in the production of high octane fuel for consumer cars and the production of plastics, synthetic rubber and polyester fibres.[117] Combined, chemical and petroleum refining accounted for 4.4% of global platinum demand in 2006, totalling 316.000.

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[112] Ibid., p.41.
[113] Ibid. p. 119.
[114] Orsa Maggiore, "China and Palladium", Palladium-bar weblog, 06-09-07, http://valuearea.blogspot.com/2007/09/china-and-palladium.html (09-09-08).
[115] Platinum Today website, Applications, "Nitric Acid", no date, http://platinum.matthey.com/applications/chemical.html (29-09-08).
[116] Platinum Today website, Applications, "Sillicones", no date, http://platinum.matthey.com/applications/1047662159.html
[117] Platinum Today website, Applications, "Petroleum", no date, http://platinum.matthey.com/applications/1095163486.html

Palladium is also used in both chemical and petroleum refining. In chemical process catalysts, the element is used in the production of bulk industrial chemicals, pharmaceuticals and other projections.[118] In petroleum refining, palladium is mostly used in a process called 'hydrocracking', which is used to upgrade certain refinery feeds. In total, 390.000 oz. of palladium was used in chemical and petroleum refining in 2006.

Dental applications

Relatively, only a very small amount of platinum is used for dental and medical applications. Platinum is used for dental braces, chemotherapy drugs for the treatment of various tumours, catheders and other medical implants.[119] In total, the dental and medical applications account for 59,000 oz. of platinum, or 0.8% of global demand.

Palladium is used in much higher quantities in dental applications. Palladium is used in alloys, mixed with gold, silver, copper and zinc, for dental fillings, crowns and bridges. Crowns are the most common application, where palladium is used as the core onto which porcelain is bonded to form an artificial tooth. Since 2003, the use of palladium in dental amalgams has increased quite rapidly, up to a demand of just over 1 million oz. in 2006. This made it the third largest end user sectors for palladium, accounting for 13% of global demand.

Glass production

PGMs, and platinum in particular, are used during the manufacture of glass. Glass is produced through a process that requires very high temperatures, up to 1700℃, and platinum is used in the machines due to its high melting point.[120] Even at these high temperatures, the element does not corrode, nor does it oxidise or melt with the glass. Rhodium is added to the platinum alloy to increase its strength and durability.

In addition to LCD screens, described above, platinum and rhodium are also used in so-called 'reinforcement glass fibres', which are used to strengthen materials such as plastics. In this process, platinum is used during the manufacture of the glass itself, but also during the fiberisation process, where fibres are produced in a platinum alloy container. Platinum is also used is various types of container and ceramic glasses.

4.6 Investment

In addition to gold and silver, PGMs are traded on various precious metals markets. Very limited data is available about quantities of PGMs traded, and the data that is available is difficult to interpret, as it is unknown whether PGMs used as an investment eventually

[118] CPM Group, The CPM Platinum Group Metals Yearbook 2007 (Hoboken, NJ, John Wiley & Sons Inc., 2007), p.125.
[119] CPM Group, The CPM Platinum Group Metals Yearbook 2007 (Hoboken, NJ, John Wiley & Sons Inc., 2007), p.53.
[120] Platinum Today website, Applications, "Glass", no date, http://platinum.matthey.com/applications/1046279130.html (29-09-08).

end up in industrial products or not. It is therefore beyond the scope of this report to give a thorough analysis of this market.

One obviously aspect that is import to note is that investors have a heavy influence in the prices of PGMs. Through simple supply and demand mechanisms, PGM prices can fluctuate due to these investors to such an extent that this has an effect on industrial end use demand. Often, the PGMs used in industrial fabrication can be replaced by other metals, or cheaper PGMs. Price would be the most likely incentive to change metals in the production process.

5 Analysis and Recommendations

This report provides a first overview of the supply chain of PGMs and identifies some of the actors and their approaches towards supply chain responsibility. This final chapter will analyse the force fields in the PGM supply chain, and discusses the possibilities and difficulties to use the characteristics of the supply chain to push for a more sustainable use of this precious metal. The issues that are known to occur during the mining of PGMs include community displacements and hazardous working conditions in South Africa and environmental pollution in Russia.

Highly concentrated force field

The PGM supply chain can be characterized by a number of phases where the concentration is very high. This has large effects on the force fields within the chain. Most of the metals are mined in either South Africa or Russia, where there are a very limited number of large mining companies active. In Russia, Norilsk Nickel is the only significant miner of PGMs, while Anglo Platinum controls such an enormous amount of resources in South Africa that it accounts for 40% of the global platinum production.

The next phase of the supply chain can also be regarded as highly concentrated, as there are only five or six major fabrication companies worldwide, including Heraeus, Johnson Matthey and Umicore. Although no exact figures are available, these fabrication companies likely account for a large part of the sales of the mining companies. Most of these companies are based in Europe or Japan, although they do control production sites worldwide.

Looking further into PGMs that end up in electronic products, another highly concentrated phase can be identified. Almost certainly, all PGM containing hard disk drives are produced by one of six different hard disk producers worldwide. Again, these are large multinationals, based mostly in the Asia and the United States, which operate worldwide. Most of the production of these hard drives occurs in Thailand, China, the Philippines and Mexico. Finally, the number of large brand companies in the end user sectors is also limited. Both in the electronics and the automotive industries there are only a few large multinationals active worldwide.

The emphasis of this report has been on the fabrication of industrial products containing PGMs. The concentration that is present in this link of the chain offers a number of opportunities. These few fabricating companies have large buying power, both in their sourcing of raw materials upstream, as in the supply of industrial products downstream. This buying power can be an important tool to use when pushing for more sustainability. End user companies, such as the electronics and automotive industries, could engage with players in this phase on the following three issues; transparency, supply chain responsibility and recycling.

Limited opportunities for traceability

Several sources have indicated that a large portion of the PGMs used by the fabrication companies are bought on spot markets. This makes direct traceability of metals difficult, as metals from different sources are mixed. This is a challenge for all companies within the supply chain who intend to increase sustainability in the mining phase.

However, this report gives a general idea of the routes of PGMs ending up in cars or computers, by using only public sources. It can be assumed that companies themselves have a more detailed understanding of the supply chain, as they have access to a lot of information that is not publicly available. Additionally, the limited number of possible sources of PGMs makes the tracing problem less relevant. It is very likely that any company that uses significant amounts of PGMs sources most of its materials from Russia or South Africa.

Regardless of potential difficulties, all companies do have a responsibility in creating a more transparent supply chain. While trading houses have a crucial role to play in indicating where metals originate from, companies should also play their part. The electronics industry has come to the same conclusion, and is currently taking first steps in their effort to trace back the metals they use to the mines where they come from.[121] The fabrication companies mentioned in this report could play a crucial role in this process.

Supply chain responsibility

It is promising that the notion of supply chain responsibility is becoming more widely accepted by national and international institutions. The OECD Guidelines for Multinational Enterprises states that companies should *""[e]ncourage, where practicable, business partners, including suppliers and subcontractors, to apply principles of corporate conduct compatible with the Guidelines*."[122] Recently, a British trader in coltan and cassiterite, two metals used extensively in the electronics industry, was found guilty of violating this principle of the OECD Guidelines by the National Contact Point of the UK Government.

Supply chain responsibility is also becoming an increasingly important criterion for socially responsible investors. Using the OECD Guidelines as a reference, the OECD Watch network developed a series of fact sheets for responsible investors. One of these fact sheets was particularly on the issue of supply chain responsibility. Here, OECD Watch formulates a number of key questions that investors should raise to "*assess whether a company is engaged in a process to apply standards of good practice throughout its supply chain*". [123] One of the major sustainable investment indices, the

[121] GHGm, *Social and Environmental Responsibility in Metals Supply to the Electronic Industry*, joint study of the Electronics Industry Citizenship Coalition and Global E-Sustainability Initiative, June 2008, http://www.eicc.info/downloads/EICC%20and%20GeSI%20Joint%20Study%20on%20Metal%20Extraction%20-%20Final%20Report.pdf (22-10-08).

[122] OECD 2000: The OECD Guidelines for Multinational Enterprises, pp.19.

[123] OECD Watch and Eurosif, "Assessing Adherence to the OECD Guidelines' Supply Chain Provision", The OECD Guidelines and Socially Responsible Investment, Factsheet 4, 2007, http://www.oecdwatch.org/docs/OW_SRI_Factsheet4.pdf (26-09-08), p.4.

FTSE4GOOD, also developed specific criteria for labour standards in the supply chain.[124]

Finally, it is promising that a number of companies within the supply chain have taken up some of key issues in the sector by their own initiative. While such initiatives might vary in concreteness and levels of ambition, it does indicate a willingness to address issues that go beyond a company's own business activities. Companies that source directly from mining companies have the responsibility to ensure that they do not purchase materials that have been extracted under damaging conditions for workers, communities or the environment.

Looking at the PGM supply chain from a CSR perspective, it can be concluded that efforts towards supply chain responsibility are relatively recent and not yet fully developed. First steps have been taken by both the automotive and the electronics sector to expand their supply chain responsibility to the mining phase. The International Roundtable on Sustainable Platinum has taken some initiative to bring car manufacturers, mining companies and other stakeholders together.[125] The electronics industry has taken initiatives to address issues in the mining sector, partially because of the makeITfair report on PGMs. Both initiatives are yet to develop into structural approaches that address these issues on a continued basis. Industry-wide and company specific approaches in the middle of the chain are also still in infantile stages. The notion seems to gain importance in the CSR policies of the individual companies, while the International Platinum Association is also taking first steps of a sustainability initiative that will include the notion of supply chain responsibility.

Fabrication companies could use their position in the supply chain to directly address some of the environmental, social and labour issues known upstream, in the PGM mining phases. The CSR policies that some of these companies have, and that apply to these companies' own operations, could be extended to also apply throughout the supply chain. Responsible sourcing of metals, with considerations for environmental management, fair and safe working conditions, and ample considerations for the interests of local communities, should be part of daily business activities. The notion of supply chain responsibility implies that a company should make all efforts to ensure that the standards that apply for one's own business operations are also met by the business partners within the supply chain.

Companies in the middle of the supply chain, who operate on a business-to-business model, also have a supply chain responsibility downstream, towards their customers. Fabrication companies can play an active role to support the efforts by electronic and automotive companies for more sustainable use of PGMs. A large part of this responsibility can be translated into efforts to increase transparency. They are in an ideal position to offer the necessary information to end users to trace back where their metals

[124] FTSE4GOOD, "FTSE4Good Index Criteria; Supply Chain Labour Standards", Criteria documents, no date, http://www.ftse.com/Indices/FTSE4Good_Index_Series/Downloads/FTSE4Good_Supply_Chain_Criteria.pdf (26-09-08).

[125] For more information, see http://www.sustainable-platinum.org/.

come from. Another part of such responsibility is the active participation in recycling efforts.

Recycling

Recycling is a crucial aspect of supply chain responsibility in the PGM supply chain. This is one of the major opportunities that is already part of the business approach of some of the fabrication companies. Being precious metals, PGMs have very high recovery rates, and recycled consumer and industrial products can be a large source of PGMs. The benefits of recycling are twofold; it reduces waste at the end of the chain, while they also reduce the pressure to mine more PGMs. It is promising that some companies focus parts of their business operations on these activities. However, recycling of cars and electronic products is far from optimal, and the brand companies can play a more prominent role in promoting sustainable recycling.

Electronics companies have expressed their difficulties in setting up effective programs. Many of the electronic consumer products are still not recycled. There is an important role for companies that refine metals from used consumer goods to team up with end user industries to enhance such programs. If electronic brand companies can combine their recycling efforts with companies who own and operate refining facilities, this could have immense effects. Re-entry of metals from used consumer goods into the supply chain is beneficial to all parties. A crucial condition is that recycling is done in a sustainable manner, without creating hazardous environmental and labour conditions by itself.

An added benefit is that metals that re-enter the supply chain through recycling old materials can be seen as sustainable. As the demand for products such as sustainable computers and mobile phones is increasing, there are benefits to ensuring that PGMs processed into hard disks and MLCCs are recycled. This is where recycling and transparency meet each other. If it can be assured that PGMs used in ‘green’ electronics are indeed green, this enhances the credibility of these sustainability efforts. The major condition for this is that recycled PGMs are not mixed with non-recycled PGMs during the processing phase.