ICMM
International Council on Mining & Metals

InBrief

The role of minerals and metals in a low carbon economy

Mining's contribution to sustainable development
June 2012

The role of minerals and metals in a low carbon economy

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Summary

This is one of a series of publications commissioned by ICMM to highlight the sector's role in modern society.

Many companies in the industry are measuring, managing and reducing their own greenhouse gas emissions. Many abatement options are being considered when looking to emissions management including reducing consumption, low carbon energy technologies and improvements in transportation systems and building infrastructure. Two key areas of mitigation potential are in energy efficiency improvements and low carbon power generation.

Energy efficiency initiatives in the industry are already driven by cost savings opportunities and security of supply considerations. Emissions management is another driver. Well-designed policies will encourage further energy efficiency improvements across all sectors of the economy in the transition to a low carbon economy. Multiple opportunities relating to energy efficiency are in the buildings and transport sectors.

A range of technologies exist to reduce the emissions-intensity of power generation, including energy systems based on renewables and carbon capture and storage (CCS) technologies. Both of these technologies need to be scaled up if they are to lower the carbon intensity of the global energy mix. The mineral and metal requirements for the physical structures of both wind turbines and solar panels are significant. Applying CCS technology would also increase metal requirements due to the additional infrastructure needed to capture, transport and store CO_2 emissions.

Although the exact pathway to a low carbon future is not yet known, a number of viable elements are well understood in the areas of energy efficiency and low carbon power generation. All of these low carbon technologies will require mineral and metal inputs. The widespread adoption of these technologies has the potential to change global metals demand compared with demand from current technologies. This change in demand will also affect the emissions associated with metals production.

Mining's contribution to sustainable development

ICMM has commissioned this series of publications to describe mining and metals' contribution to sustainable development. It seeks to set out some of the more important benefits, costs, risks and responsibilities related to mining and metals in today's world.

The first in the series – *Mining's contribution to sustainable development* – provides an overview of the series and introduces the concept of contribution analysis. *The role of mining in national economies* examines the contribution of mining activities in all countries with an overview of the contribution to the global economy. *Trends in the mining and metals industry* provides a forward looking discussion of trends likely to govern the evolution of the industry over the next decade.

In *Uses of minerals and metals*, a treatment of the current and future contribution of minerals- and metals-based products to sustainable development is offered. Building on this theme, *The role of minerals and metals in a low carbon economy* focuses on the materials needed for the technologies to address the climate change challenge.

The next two titles in the series focus on the contribution of mining to people and the environment. *Human rights, social development and the mining and metals industry* focuses on the role of business in contributing to the realization of human rights. Whilst *Mining and the environment* looks at how mining companies are tackling the challenge of achieving a net positive contribution from their activities.

Together these discussions are intended as a starting point for the industry and others to more fully examine the contribution of mining and metals to sustainable development, a conversation that will continue for years to come. They are intended to stimulate an exchange of ideas leading to the development of innovative ways forward. The series was launched at the Rio+20 summit in June 2012 and individual titles are being released from June–November 2012.

About ICMM

The International Council on Mining and Metals (ICMM) was formed in 2001 to catalyze improved performance and enhance the contribution of mining, minerals and metals to sustainable development. Today, it brings together 22 mining and metals companies as well as 34 national and regional mining associations and global commodity associations. ICMM's member companies employ close to one million of the 2.5 million people working in the sector worldwide. These companies have some 800 operations in over 60 countries producing 30–40% of the world's hard mineral commodities including iron ore, gold, platinum and nickel. We engage with a broad range of stakeholders – governments, international organizations, communities and indigenous peoples organizations, investors, civil society and academia – in order to build meaningful relationships. Our vision is one of leading companies working together and with others to strengthen the contribution of mining, minerals and metals to sustainable development.

About the authors

This series has been developed by ICMM with input from members, subject matter experts and representatives of organizations we work with. ICMM would like to thank them all for their contributions. Information on the authors and reviewers for each title is provided on the back cover.

Introduction

The mining and metals industry is well placed to contribute to the resolution of the climate change challenge. Many mining and metals companies are measuring, managing and reducing their own greenhouse gas (GHG) emissions. More significantly the industry is also supplying the materials needed to build a low carbon future. This latter role is less well understood and is the focus of this publication.

Lowering GHG emissions is a considerable challenge for many industry sectors. In the future, factors such as rapid population growth, high levels of industrialization and continued economic development in a number of regions will make this all the more challenging. Such future trends are expected to increase aggregate and per capita consumption levels of minerals and metals as increasing population and development translates into rising demand for goods, infrastructure and housing.

Minerals and metals are integral inputs to human development and the advancement of society. The industry already plays a critical role in supplying the inputs for current technologies and production practices. Similarly, it will provide vital inputs for fully realizing GHG emissions abatement opportunities across all sectors of the economy in the transition to a low carbon future.

Mining and metals industry emissions

A recent study commissioned by ICMM estimated that the global mining and metals industry makes up around 2% of global emissions. Approximately half of the industry's emissions are from fuel use in mining and processing operations, for transportation of ore and electricity generation at remote sites and from fugitive emissions (known as Scope 1). The other half are from electricity use, primarily in refining and smelting operations (known as Scope 2). Depending on the type and location of mineral resources and accessibility and fuel mix of the electricity grid, there are widely differing technical approaches to resource extraction and processing. With this in mind each site will therefore have a specific GHG profile.

Similarly, changing ore grades and characteristics are significant determinants of the energy profile of a mine. Factors include the depth of the ore body, the size and spread of the mineralized system and the designed production rate. These factors contribute to energy demand and associated GHG emissions per kg of mineral and metal extracted and processed. Lowering GHG emissions is one of many drivers for energy efficiency improvements in the mining and metals industry.

The underlying diversity of energy and emissions across mine sites makes sector-wide assessments a challenge. This is in contrast to the standardized approaches for reporting emissions taken by other industries.

ICMM and its members recognize their contribution to global GHG emissions and have introduced strategies to manage these emissions in a dynamic operating environment. ICMM members have taken significant steps to introduce emissions reduction strategies, ensuring the efficient use of natural resources and investments in low carbon technology research and development.

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Material contribution to the broader low carbon economy

In addition to managing their own emissions, the mining and metals industry also makes a broader contribution in providing the minerals and metals required for the transition to a low carbon economy.

Many abatement options have the potential for reducing global GHG emissions, including reducing consumption, low carbon energy technologies and improvements in transportation systems and building infrastructure.

The examples in this publication are illustrative rather than exhaustive. Further work is needed to understand the net impact of low carbon technologies on metals demand compared with current technologies. Once this has been achieved, policies can then be developed to incentivize the low carbon transition in a feasible and sustainable way.

An additional consideration will be the emissions profile associated with the production of these metals. A continual challenge for the industry will be to address emissions in the context of increasing demand and output of their products. Two key areas of mitigation potential are in energy efficiency improvements and low carbon power generation.

Energy efficiency

The transition to a low carbon economy will require a focus on energy efficiency on many fronts. The International Energy Agency's World Energy Outlook, 2011 projects that in order to stabilize global temperature increases to 2°C above current levels, half of the emissions abatement will come from energy efficiency measures.

Energy efficiency initiatives in the mining and metals industry are already driven by cost savings opportunities and security of supply considerations. Emissions management is another driver. Well-designed policies will encourage further energy efficiency improvements across all sectors of the economy in the transition to a low carbon economy.

The material implications of more energy efficient production practices need to be understood more fully. Multiple opportunities relating to energy efficiency are in the buildings and transport sectors. As illustrated below, there is currently only anecdotal evidence on the implications of these initiatives on demand and the use of minerals and metals.

Buildings
According to UNEP, buildings account for approximately 40% of global GHG emissions. There are a variety of potential abatement options through more efficient use of energy for lighting and heating, cooling and ventilation and the use of appliances.

Buildings are mostly concentrated in cities; urban communities are currently home to 50% of the world's population and make-up 75% of global GHG emissions according to Arup Associates. The UN estimates that by 2050, 70% of the world's population will live in cities. The demand for increasing efficiency and resilience to a changing climate in buildings will rapidly increase. Demand for metals in constructing these new buildings may also rise beyond current requirements. As well as being crucial inputs into the infrastructure of a building, minerals and metals have an additional role to play in making buildings more energy efficient.

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As an example, ICMM member Norsk Hydro has developed advanced façade technologies using aluminium to reduce energy and emissions from heating, cooling, ventilation and lighting. Façades are also manufactured from stainless steel containing molybdenum for added strength and corrosion resistance. These technologies create more energy efficient buildings with the aim of making them energy neutral.

Norsk Hydro has introduced the façade technology at its ThyssenKrupp AG headquarters in Essen. It has eliminated the need for air conditioning and the building's energy requirements are expected to be 20–30% below Germany's statutory requirements. Similarly, in 2009 Norsk Hydro opened the Wicona Test Center Ulm in southern Germany. The building is energy positive meaning the building is able to generate more power than it uses. On average, conventional new buildings have an energy demand of 100 kWh per square metre a year. Norsk Hydro's building consumes less than 40 kWh per square metre. This energy demand was fully met over the course of a year by the building's own power generation from solar panels and an advanced ground water heat pump system.

Transport

The transport sector provides further energy efficiency opportunities with possible implications for the mining and metals sector. Different technologies will have different metals profiles. For example, nickel alloys have been used to allow for more efficient fuel combustion in jet engines. Similarly, lighter and more fuel efficient vehicles will often be made of higher strength steels incorporating niobium, molybdenum or lightweight metals such as aluminium.

Similar to conventional vehicles, the various components of hybrid cars are made up of a multitude of metals as indicated in figure 1.

More transformative low emissions technologies such as electric vehicles also have a different demand profile for metals.

Electrification of the transport system has the potential to significantly reduce direct GHG emissions from transportation and will lead to a rise in the consumption of a number of metals across the supporting infrastructure. Changing the infrastructure and modernizing the power distribution to support an electrified transport system will require a number of metals including copper, zinc, nickel and steel.

Figure 1: Minerals and metals in hybrid car construction

HYBRID CAR	
Body of the car	Chromium, manganese, molybdenum, bauxite (aluminium), iron ore, coal
Wiring and circuitry	Copper, gold, platinum, tungsten
Batteries	Cadmium, cobalt, lead, lithium, nickel, rare earth oxides

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Low carbon power generation

A range of technologies exist to reduce the emissions-intensity of power generation, including energy systems based on renewables and carbon capture and storage (CCS) technologies. Each option has its own profile of mineral and metal inputs which needs to be understood more fully.

Renewables
Many different minerals and metals are required to construct wind turbines and solar panels as indicated in figure 2 and 3.

Both of these technologies need to be scaled up if they are to lower the carbon intensity of the global energy mix. The International Energy Agency (IEA) suggests the share of non-hydro renewable energy in power generation will increase from 3% in 2009 to 15% in 2035, with wind and solar power seeing the largest increase. The metal requirements for the physical structures of both wind turbines and solar panels are significant.

It is not just low carbon technologies like wind turbines and solar panels that require the use of metals. Biomass energy based on rape seed oil is estimated to use around five times more iron per kWh of electricity produced than regular fossil fuel based energy. This is due to high amounts of fertilizers and capital goods required. Expansion of nuclear capacity would increase demand for uranium and hydrogen fuel cells which could dramatically increase the demand for metal catalysts.

Figure 2: Minerals and metals in wind turbine construction

WIND TURBINES	
Wiring	Copper
Magnets and batteries	Cobalt and rare earth oxides
Tower	Bauxite (aluminium), metallurgical coal, iron ore, molybdenum (steel), zinc (used in galvanising)

Figure 3: Minerals and metals in solar panel construction

SOLAR PANELS	
Wiring	Copper
Cells	Cadmium, copper, gallium, indium, molybdenum, selenium, silica, tellurium
Semi-conductor chips	Arsenic, boron minerals
Frame	Bauxite (aluminium), coal and iron ore (steel)
Batteries	Lead
Panels	Titanium dioxide

"The International Energy Agency suggests the share of non-hydro renewable energy in power generation will increase from 3% in 2009 to 15% in 2035, with wind and solar power seeing the largest increase. The metal requirements for the physical structures of both wind turbines and solar panels are significant."

"A 2011 study into metal requirements of low carbon energy estimates that applying carbon capture and storage technology would increase metal requirements by 10–30% compared with the current electricity mix."

Hydrogen fuel cells
Hydrogen fuel cells, as the name suggests, use hydrogen to generate electricity, heat and water. Fuel cells offer high efficiency, versatility and scalability. A number of metals can be used as catalysts, e.g. zinc, aluminium, magnesium and platinum, to ensure zero emissions from electricity during the use-phase.

Anglo American Platinum profiled this low carbon technology at the UN Framework Convention on Climate Change COP17 conference in Durban in December 2011. They recently invested in platinum-based technology and development businesses in South Africa to accelerate the use of fuel cells in the small and large scale provision of electricity in mobile, stationary and portable applications.

Carbon capture and storage (CCS)
The wide-scale introduction of CCS, as anticipated in IEA scenarios towards the middle of the 21st century, would similarly increase the demand for many metals. A 2011 study into metal requirements of low carbon energy by R. Kleijn et al estimates that applying CCS technology would increase metal requirements by 10–30% compared with the current electricity mix. This is due to the additional infrastructure needed to capture, transport and store CO_2 emissions.

The exact trajectory and proliferation of these different low carbon power generation and storage options is not yet fully known. However, according to expert assessments, their uptake is crucial for making the transition to a low carbon economy. Each option will have a different mineral and metals profile and further work is required to understand the potential implications on metals demand if these technologies are introduced at a large scale.

Conclusions

The contribution of mining and metals to a low carbon economy extends far beyond reducing industry emissions. Minerals and metals are fundamental building blocks of all economies, including a future low carbon economy. Although the exact pathway to a low carbon future is not yet known, a number of viable elements are well understood in the areas of energy efficiency and low carbon power generation. All of these low carbon technologies will require mineral and metals inputs. The widespread adoption of these technologies has the potential to change global metals demand compared with demand from current technologies. This change in demand will also affect the emissions associated with metals production.

This change in the emissions profile of the industry also needs to be considered from a life cycle perspective. The emissions associated with the production of minerals and metals should be assessed against the uses of those materials over their full life cycle. This concept is described more fully in a later publication in this series, *Uses of minerals and metals*.

The examples of the metals inputs for low carbon technologies included in this publication are illustrative rather than exhaustive. The exact nature of the low carbon transition on both mineral and metals demand will differ depending on which technologies are favoured. Further work is needed to understand the feasibility and sustainability of these different options from a material viewpoint.

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The International Council on Mining and Metals (ICMM) was established in 2001 to improve sustainable development performance in the mining and metals industry. Today, it brings together many of the world's largest mining and metals companies as well as national and regional mining associations and global commodity associations. Our vision is one of leading companies working together and with others to strengthen the contribution of mining, minerals and metals to sustainable development.

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