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Minerals and metals scarcity in manufacturing: the ticking timebomb

Sustainable Materials Management

A survey of senior executives of leading global companies on the impact of minerals & metals scarcity on business

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Interviews were conducted with 69 senior executives in seven different manufacturing industries across three regions

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Methodology

PwC's 'Minerals and metals scarcity in manufacturing: the ticking timebomb' survey is based on a structured quantitative questionnaire. Senior executives from 69 leading companies in seven different manufacturing industries across three regions were interviewed by GBI Research between July 2011 and September 2011.

The questionnaire was designed to aggregate and compare responses on various subjects, such as awareness, preparedness, impact, causes, risks and opportunities and responses to the scarcity of minerals and metals affecting key manufacturing industry sectors.

The survey included companies and respondents in Europe, the Americas and Asia Pacific in the automotive sector (11), aviation (6), chemicals (9), energy & utilities (14), high tech (9), infrastructure (11) and renewable energy (9). 84% of the companies that responded have revenues over $10 billion and the remaining 16% have revenues from $2 billion to $10 billion. The respondents included directors, vice-presidents and other senior executives.

All interviews were conducted by telephone and the responses were tabulated on a Likert scale of 1-5, where 5 indicates high intensity and 1 low intensity.

PwC is grateful to all the respondents for their contributions to this first global survey. We would also like to thank our local PwC teams and partners for their insightful guidance throughout this project.

Foreword

The world's growing population, an increase in GDP levels and changing lifestyles are causing consumption levels to rise globally - creating a higher and higher demand for resources. Governments and companies are becoming increasingly cognisant of the scope, importance and urgency of the scarcity of both renewable and non-renewable natural recources including energy, water, land and minerals. The interrelationships between these resources are strong, which means that both the causes of scarcity and the solutions to it are complex. There can be a fine line between 'just in time' and 'just not there'.

Policymakers are starting to take action on the issue of resource supply. The European Union is pursuing a number of initiatives to mitigate the risks of minerals and metals scarcity by using scarce minerals and metals more efficiently in applications, by recycling, and by developing substitutes. It is also pushing for trade policies that favour international open markets for scarce minerals and metals. This contrasts with China's imposition of trade barriers to restrict the outflow of these resources to support its domestic industries. In the U.S., the Dodd Frank Act forces companies to become transparent with respect to the use of conflict minerals. And, resource scarcity is likely to be a central issue at the 'Rio + 20' Conference on Sustainable Development. Stock depletion is a factor behind resource scarcity for some commodities, but for others, badly functioning markets and the wrong policy are more important drivers. Even when global deposits will be sufficient to meet increasing demand over the coming decades these stocks are not equally distributed over the world; they tend to be located in a limited number of countries. This causes an increasing dependency on imports which, in turn, feeds concerns about commodity prices, the new world order and security of supply.

Managing scarcity is about ensuring that the right amount of minerals and metals is present in the right place in the right form. Three dimensions play a role here: physical, economic and political. Physical scarcity relates to the availability of resources and is affected by the depletion of non-renewable reserves and the sufficiency of renewable resources and stocks. Economic scarcity concerns the functioning of markets and the matching of production processes, raw material supplies and end-product demand. Finally, the geopolitical dimension relates to the functioning of policy and involves such aspects as trade barriers, export disruptions and national and international conflicts.

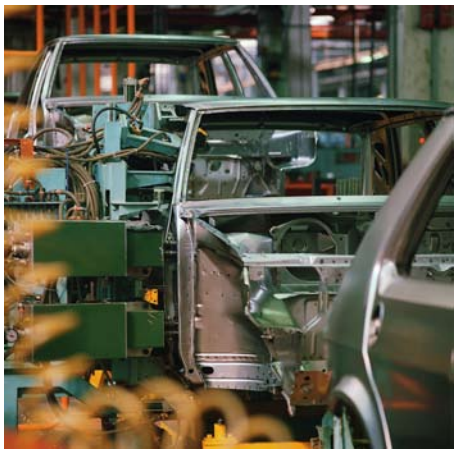
In this report, PwC has looked at the impact that minerals and metals scarcity is likely to have on seven different manufacturing industries. Through interviews with senior executives in many of the leading organisations that are central to the future growth of these industries, we have been able to gauge the importance of minerals and metals scarcity and highlight the likely impact on different regions and sectors. We have focused our analysis on critical minerals and metals that are important to the operations and supply chains of the companies we spoke to and to the economies of the countries and regions in which they operate.

Malcolm Preston
Global Sustainability Leader

Joseph Herron
Global Industrial Products Leader

Executive Summary

Executives of leading global manufacturing companies believe that the impact of minerals and metals scarcity will increase strongly in the next five years. However, there are large variations in the likely impact on different sectors and regions and their state of preparedness. Economic and political dimensions are generally more important than the physical dimension of scarcity. Collaboration within the supply chain and new business models will be fundamental to the ability to respond appropriately to the risks and opportunities posed by the scarcity of minerals and metals.



1. Major manufacturing companies consider minerals and metals scarcity as an important issue for their business, but do not see sufficient awareness of this topic among all their stakeholders.

In all of the sectors covered by our survey, and in all regions, business seems to be aware of the issue of scarcity, but the importance of the four natural resources varies, with minerals and metals scarcity (77%) and energy scarcity (75%) being high on the agendas of top executives, while water (57%) and land (35%) are perceived as less scarce. In addition, these executives perceive the level of awareness of stakeholder groups, customers and employees to be comparatively low.

2. The risk of scarcity is expected to rise significantly, leading to supply instability and potential disruptions in the next five years, but this also creates opportunities for competitive advantage.

Risk arising from minerals and metals scarcity is expected to increase across all industries in the next five years. The survey showed that renewable energy (78%), automotive (64%) and energy & utilities (57%) are currently experiencing instability of supply. Especially aviation, high tech and infrastructure believe to see a high rise of instability of supply from now to 2016.

While companies in Europe believe that there will be a high risk in the future, primarily due to an instability of supply, they also see the issue as an opportunity. European companies seem to feel better prepared, with policies and programmes to mitigate risk. Examples of particular opportunities suggested by the respondents included the backward integration of operations, exploring new technology and substitutes, and prospecting for new mineral reserves.

3. Because of the crucial nature of these minerals and metals, companies expect that the impact will be felt throughout the entire supply chain.

The impact of minerals and metals scarcity tends to increase as you move down the supply chain, but it may also cause stress all along the supply chain. For example, 89% of renewable energy respondents expect that their suppliers will be impacted. Even though the current direct financial costs are relatively low, the risk of instability of supply is high because of the crucial nature of minerals and metals in production (from 'just in time' to 'just not there').

Although some Asia Pacific countries, especially China, have abundant reserves of scarce minerals and metals, the expected impact of scarcity on companies in these countries over the next five years is still substantial (53%). The percentage of companies that expect to be affected by this scarcity will triple in the chemicals industry, whilst it will double in the renewable energy and high-tech sectors.

4. Economic and political drivers of scarcity are generally seen as much more important than physical drivers.

The most important drivers overall are growing demand (65%) and geopolitics (54%). The exhaustion of reserves rates less highly (30%). Low substitution is named as a very important driver for the renewable energy (89%), energy & utilities (79%) and chemical (78%) industries.

Given the range of factors that contribute to resource scarcity, it is clear that all stakeholders in the supply chain need to be involved in addressing this issue. Mining companies have a key role in identifying and developing new reserves and managing existing reserves; governments should remove trade barriers; universities and research institutions should accelerate R&D; companies should invest more in innovations for substitution and resource efficiency, and consumers need to take responsibility by recycling waste materials.

5. The renewable energy, automotive and high-tech industries have a high level of co-operation with their first-tier suppliers and customers.

The survey results indicate that a majority of 73% feel that they are sufficiently prepared. Companies in Europe are highly prepared in terms of policies and programmes to mitigate the potential impact of scarce minerals and metals, followed by the Americas and Asia Pacific. At present, the renewable energy (67%) and automotive (64%) industries are better prepared than aviation (50%), high tech and the chemical industry (both 33%), which demonstrate a relatively low level of preparedness. In contrast to industrial organisations and suppliers, the respondents perceive NGOs, customers and employees as being much less prepared to tackle the issue.

The automotive and high-tech industries show the highest degree of collaboration with first-tier suppliers and customers to reduce the impact of scarcity on their companies, compared to the aviation and chemical sectors.

6. For a large majority of the companies we interviewed, efficiency and collaboration throughout the supply chain are seen as essential to responding to the risk.

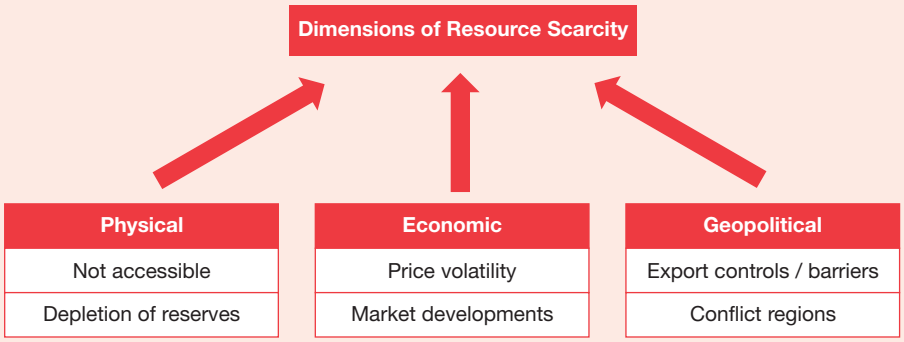
Resource efficiency is seen as the single most effective response to address resource scarcity (75%). However, strategic alliances with suppliers (68%), supplier diversification (67%), more R&D (65%), more re-use (64%) and more geodiplomacy (61%) all rate highly. More extraction (55%) and relocating production (42%) scored less strongly, perhaps indicating that the physical dimension of scarcity is seen as relatively less important.

In Europe, end-users are seen as a relevant party because of the possibility of re-using minerals and metals (92%). Respondents in the Americas and Asia Pacific perceive re-use as a less applicable response, but are instead more focused on resource efficiency.

Data information, recycling technology, substitution technology and regulation are all considered as required elements of any response to the issue of minerals and metals scarcity.

Dimensions of scarcity

Scarcity can be divided into three dimensions: physical (just not there), economic (volatile or increasing prices) and geopolitical (political barriers). For renewable resources, the economic dimension is typically the main driver. But what about non-renewables such as minerals and metals?



Captured in our earth's crust and concentrated in only a few regions, minerals and metals are relatively difficult and expensive to extract. The process is capital-intensive, not only financially but also in terms of energy consumption, land use and water extraction, so the environmental and social impact is of growing concern.

The supply of many minerals and metals is struggling to keep up with rapid increases in consumption, resulting in price hikes and delivery delays. For example, dysprosium, an essential component of super magnets, and tantalum, an important component in aircraft and medical equipment, automotive electronics, mobile phones and LCD screens, have both experienced explosive price increases in recent years.

Resource scarcity is becoming a central issue on the policy agenda for many countries. The European Union is pushing for resource efficiency and trade policies that favour international open markets. In the U.S., the Dodd Frank act is forcing companies to become transparent with respect to the use of conflict minerals.

Meanwhile, the producing countries are starting to protect their interests with export taxes and trade restrictions, particularly for metals and minerals with high innovative value. China, for example, has imposed trade barriers for some metals to protect its domestic industries. These developments are adding to the concerns of international manufacturers regarding costs and security of supply.

Checklist - 10 "golden" questions to identify and prevent resource scarcity risks and address lifecycle opportunities

1. Have you developed a set of leading risk indicators that is forward-looking and is based on continuous monitoring and analysis of critical resources?
2. Are you recognising all the different types of risk that could affect your supply chain and product portfolio, including factors such as physical risks (just not there), economic risks (volatile pricing) and geopolitical risks (political barriers).
3. Are risks being matched with appropriate remedial measures such as inventory cushions and strategic stock piling, dual sourcing, dialogue with suppliers and R&D on the substitution of resources at risk?
4. Do you have effective systems in place across your supply chain to identify and act on early-warning signs or, in the case of a sudden scarcity risk, to supply real-time information and enable fast implementation of preventive measures?
5. Are you consulting with your suppliers and customers to investigate new business models to reduce resource scarcity risks?
6. Are there opportunities in your sector to take an integrated, sustainable approach to your supply chain?
7. Are you identifying and promoting the environmental, economic and social added value of your products and feeding this back into product development?
8. Do you have modern process-control systems in place to manage production in ways that reduce or eliminate waste and, in turn, ensure minimal use of scarce resources like energy, water, metals, minerals and other scarce input?
9. Have you evaluated the potential of initiatives such as extending product life, take-back programmes, extended product responsibility and closing the loop in your product design to reinforce customer relationships and sustain revenue streams, as well as boosting environmental sustainability?
10. Do you have effective lifecycle assessment and 'cradle-to-cradle' strategies to design out or minimise harmful impact and maximise benefits for any give production process?

1. High relevance but limited awareness

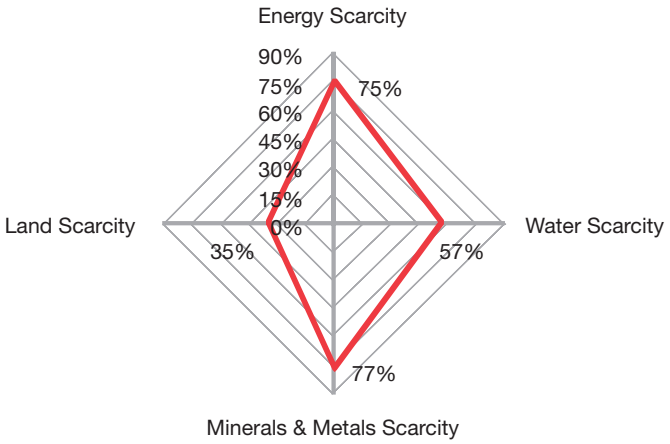
Companies consider minerals and metals scarcity as very relevant to their business, but do not see sufficient awareness of this topic among all their stakeholders.

In order to understand the general level of awareness concerning natural resource scarcity, company executives were asked about their own understanding as well as their perception of the awareness level of other stakeholders in the industry. While questioning them about awareness, PwC tried to gauge the extent to which the respondents considered minerals and metals scarcity in particular as an issue for their own company.

The scarcity of minerals and metals and a scarce energy supply were cited as concerns by 77% and 75% of respondents respectively, followed by water by 57% of respondents and land by 35% of respondents.

In the Americas, 73% of respondents identified energy scarcity as an issue compared to only 53% of respondents in Asia Pacific. Notably, among Europeans, 96% indicated energy scarcity and 92% material scarcity as issues relevant to their company. However, in Asia Pacific and the Americas, minerals scarcity was identified as an issue by 68% and 69% of respondents respectively.

Figure 1: Percentage relevance of the four resource scarcity topics as perceived by the company



All industries perceive minerals and metals scarcity as a pressing issue

When respondents were asked about whether minerals and metals scarcity is a pressing issue for their company, an average of 68% agreed. The highest concern was amongst participants from the infrastructure, high-tech and automotive industries. In contrast only half of the respondents in the aviation industry perceived minerals and metals scarcity as an issue. Across the regions, 79% from Europe, 63% from Asia Pacific and 62% from the Americas cited minerals and metals scarcity as a pressing issue. The awareness level of the stakeholder groups, NGOs, customers and employees is comparatively low.

When questioned about their perception of the extent to which various industry stakeholders consider minerals and metals scarcity as an issue, 83% of respondents say that their suppliers consider metal scarcity as a pressing issue, while only 61% perceive that their customers take this issue seriously. Here again, 96% of European respondents believe that their governments are aware of this issue, whereas this was only 58% for Asia Pacific and 54% for the Americas.

Figure 2: Percentage of respondents perceiving minerals and metals scarcity as a pressing issue for the company [by industry]

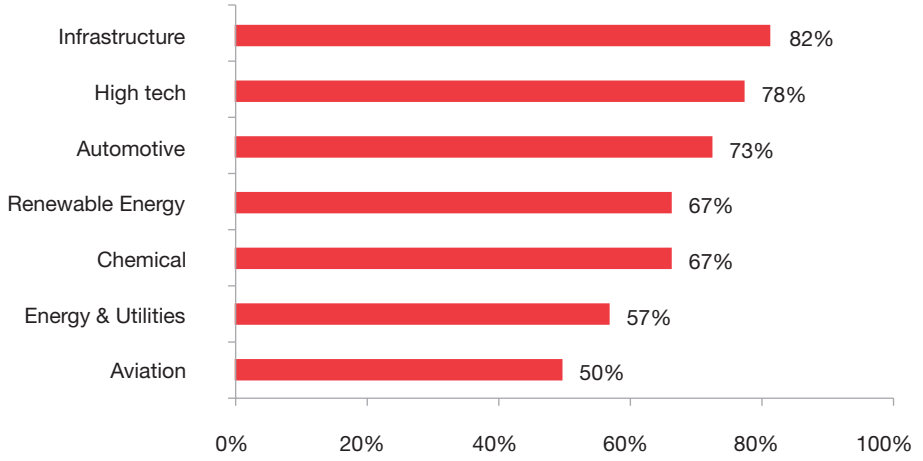
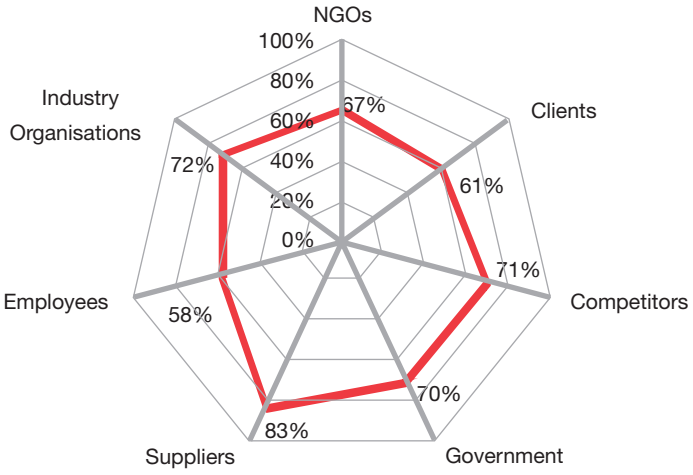


Figure 3: Stakeholder awareness of minerals and metals scarcity as a pressing issue, as perceived by respondents [percentage]



Scarce minerals and metals have become a focus of attention due to the concentration of deposits in a few countries, increased export restrictions, use in niche and strategic high-tech hardware sectors and a low substitution ratio. However, the issue of scarcity is relatively dynamic rather than static. The issue is therefore a function of demand, supply, substitution, the possibility of new discoveries and the cost and time expended in making available new sources for commercial exploitation

Source: PBL Netherlands Environmental Assessment Agency, 'Scarcity in a Sea of Plenty?', 2011

2. Scarcity brings risks and opportunities

The perceived company risk will increase over the next five years

For the manufacturing industries, rising demand and geopolitics are perceived as the main drivers for the unstable supply of minerals and metals. At present, 58% of respondents in Europe, the Americas and the Asia Pacific regions perceive minerals and metals scarcity as a risk. A higher figure of 72% of respondents see this as a risk over the next five years, of which 46% expect the impact of the risk to be 'high' or 'very high'.

Risks per region

A breakdown by region shows a high risk in Europe, where 71% of respondents consider minerals and metals scarcity as a risk, followed by Asia Pacific (53%) and the Americas (50%). Respondents from all regions see this risk increasing over the next five years.

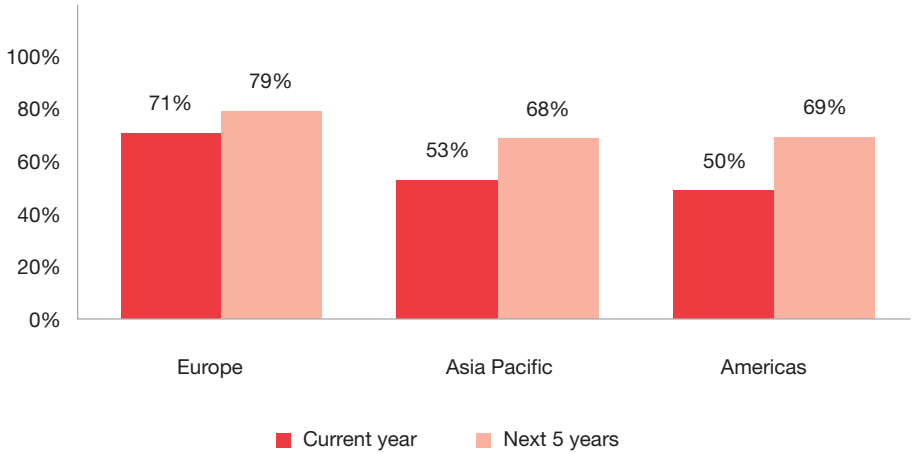
Another factor impacting the continued supply of scarce minerals and metals is the risk of steeply escalating costs in mining projects, which can result in projects been delayed or even cancelled. Examples of projects facing cost overruns include the Ambatovy nickel project in Madagascar with a cost overrun of around $1.2 billion and the Karara iron-ore project with around a 20% increase in costs[1].

Risks at stake for the mining industry

The typical risk factors that come into play in the mining industry are: regulatory risks due to monopolistic ownership of metals; the risk related to insufficient investments in research and development for substitutes and mining techniques, tools and machinery; a lack of access to remote areas for exploration due to infrastructural deficiencies; and environmental hazards and increasing operating costs. The unstable supply of critical metals, such as antimony, gallium, indium and platinum put the European industry at risk.

Source: Wuppertal Institute for Climate, Environment and Energy, 'Eco-Innovation', 2009

Figure 4: Percentage of respondents who perceive the issue of scarce minerals and metals as a risk to their company [by industry]

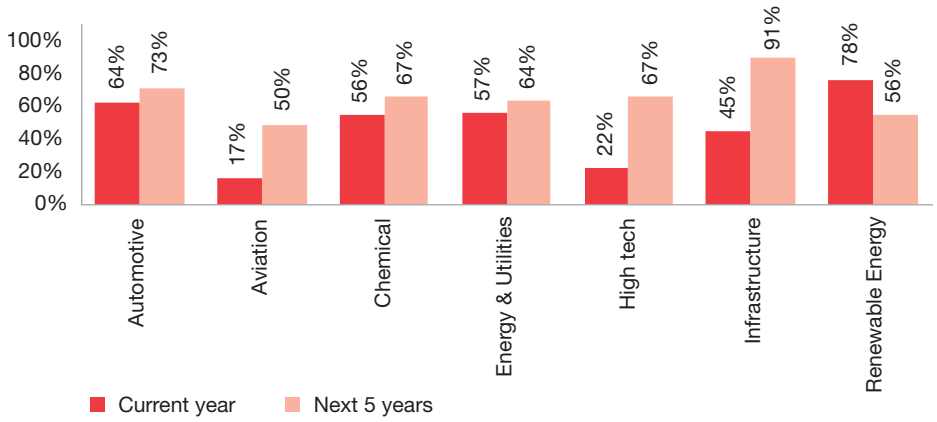


1 Source: The Globe and Mail, 'Sherritt's Madagascar mine hits new snag', 2010 and Australian Mining, 'Karara Cost Blowout', 2010

High tech is currently not experiencing an unstable supply

Overall, 51% of respondents believe their companies are being impacted by an unstable supply of minerals and metals, while 67% of respondents expect to face problems of an unstable supply in the next five years.

Figure 5: Percentage of respondents who experience the unstable supply of minerals and metals [by industry]



While 78% of respondents in the renewable energy industry are currently being impacted due to the unstable supply of minerals and metals, just 56% see this as a problem in the next five years. In contrast, only 22% of respondents in the high-tech hardware industry see a supply problem at present, while this figure increases to nearly 67% for the next five years; of these respondents, around 56% rate the severity as 'high' or 'very high'. Similarly, 55% of respondents in the automotive industry rate the current supply issue as 'high' or 'very high'. Respondents from the renewable energy and automotive industries who see a 'very high' impact are mostly from Europe or the Americas. There is a similar trend in the aviation and infrastructure industries. The number of companies that see an instability of supply in five years' time is three times higher (aviation) and two times higher (infrastructure) than the number of companies that currently experience this as a problem.

Critical minerals and metals are concentrated in a limited number of countries

Reserves of some specific minerals and metals are concentrated in a limited number of countries, which gives rise to concerns of potential political abuse of market power. A study by the British Geological Survey indicates that, of the 52 critical minerals and metals, China is the leading producer of 27 of these. While there are other countries where some of these metals are produced, there are a few strategically important metals, such as rare earth elements, which are almost exclusively produced in China.

Source: British Geological Survey, 'Risk List 2011', 2011

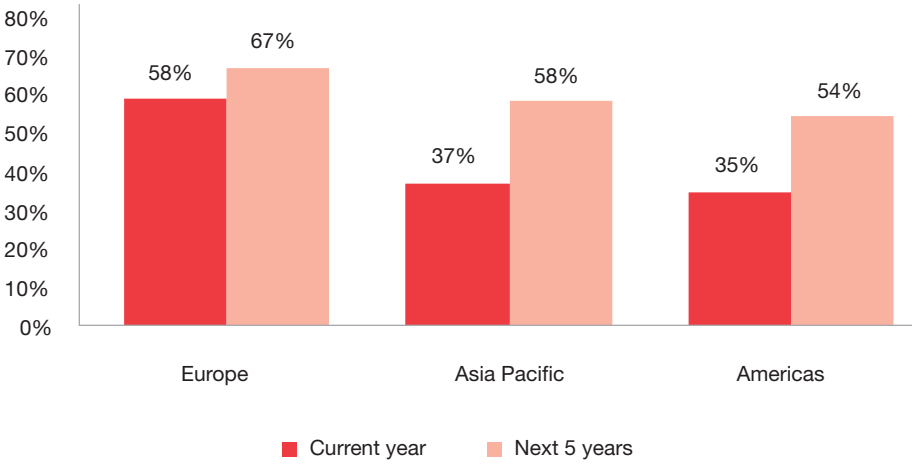
3 Source: The Globe and Mail, 'Sherritt's Madagascar mine hits new snag', 2010 and Australian Mining, 'Karara Cost Blowout', 2010

Respondents in the automotive sector are the most optimistic about opportunities

When questioned about the possibility of minerals and metals scarcity evolving into an area of opportunity, 43% of respondents perceive the scarcity issue as an opportunity at present, while 59% of respondents indicate that the opportunity will increase in the next five years. Currently, the perceived sense of an opportunity was higher amongst Europeans at 58%, compared to 37% for Asia Pacific and 35% for the Americas. Looking forward, the most positive sector was automotive, where 82% of respondents expect opportunities to increase over the next five years.

Opportunities identified by key industry participants in the automotive, aviation and chemical industries include buying power, a co-ordinated purchasing policy, an alternative approach (substitutes), recycling and extraction, upgrading technology and forward contracts with key suppliers.

Figure 6: Percentage of respondents who perceive the issue of minerals and metals scarcity as an opportunity [by region]



3. The impact of scarcity will increase substantially in near future

In the manufacturing industries in particular, scarce minerals and metals are considered strategically important resources mainly due to their character or function in the product or the limited availability or non-availability of substitutes.

Although 77% of respondents are aware of minerals and metals scarcity as a pressing issue for their organisation, only 58% indicated that this scarcity has any impact on their company at present. However, for the next five-year period, almost 70% indicated that the impact of scarcity on their company will increase.

Respondents see Europe as most vulnerable to minerals and metals scarcity

Around 67% of respondents in Europe said that they will be affected by minerals and metals scarcity compared to 53% in Asia Pacific, but the severity of the impact for companies in Asia Pacific is expected to be higher, with 42% indicating a 'high' impact.

The survey indicated that, at present, the renewable energy (78%), high-tech (67%) and infrastructure (73%) industries are affected by minerals and metals scarcity.

Figure 7: Percentage of respondents indicating that their company is affected by minerals and metals scarcity [by region]

Region	High impact	Medium Impact	Low Impact
Europe	25%	42%	33%
Asia Pacific	42%	11%	47%
Americas	23%	31%	46%

Europe is particularly concerned about scarcity, as the region depends heavily on foreign suppliers due either to limited economically extractable mineral deposits or underexplored or unexplored geological potential. In a highly regulated environment, mining opportunities are typically characterised by competing uses of land, and it usually takes a long lead time of eight to ten years from prospecting to extraction.

Source: The Hague Centre for Strategic Studies, Scarcity of Minerals, 2010

The impact of minerals and metals scarcity will increase substantially for the majority in the near future

Respondents in the renewable energy (78%) and aviation sectors (33%) expect the impact to remain the same over the next five years. The majority of respondents in automotive (64%), infrastructure (73%) and high tech (67%) indicate that they will be affected by metals and minerals scarcity and that this is likely to grow over the next five years. Energy & utilities and especially the chemical sector believe that they will see the highest rise in impact from now to 2016.

The contribution of minerals and metals to product value is substantial

Around 40% of respondents in the automotive industry indicated that components using scarce minerals and metals constitute more than 25% by weight and more than 25% in the value of the final product. Respondents from the energy & utilities (38%) and infrastructure (36%) sectors followed the automotive industry closely with a share of over 25% in terms of usage by weight.

First-tier suppliers are seen as most affected

Consistent with the perception that the impact of metals scarcity decreases further down the supply chain, 74% of respondents indicated that their first-tier suppliers are affected, whereas only 54% indicated that their customers are impacted.

Figure 8: Percentage of respondents indicating that their company is affected by minerals and metals scarcity [by industry]

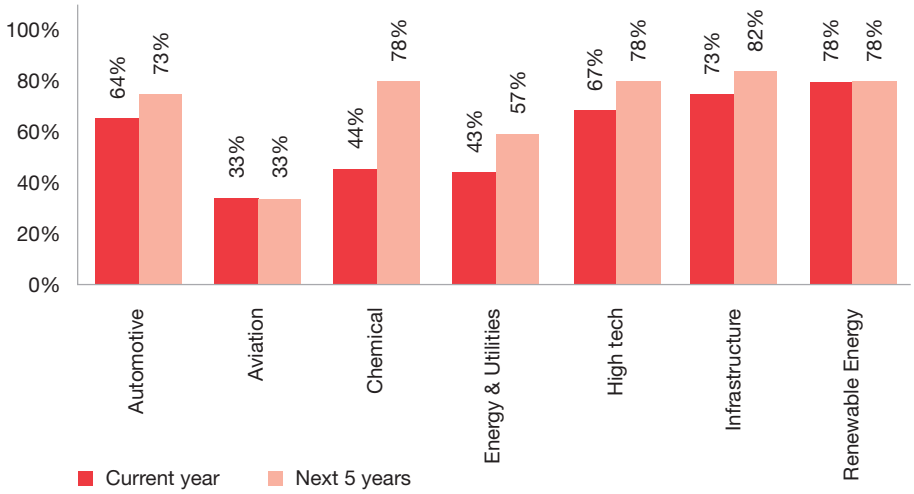


Figure 9: Percentage of respondents indicating value and weight of scarce minerals and metals in their main products as greater than 25% [by industry]

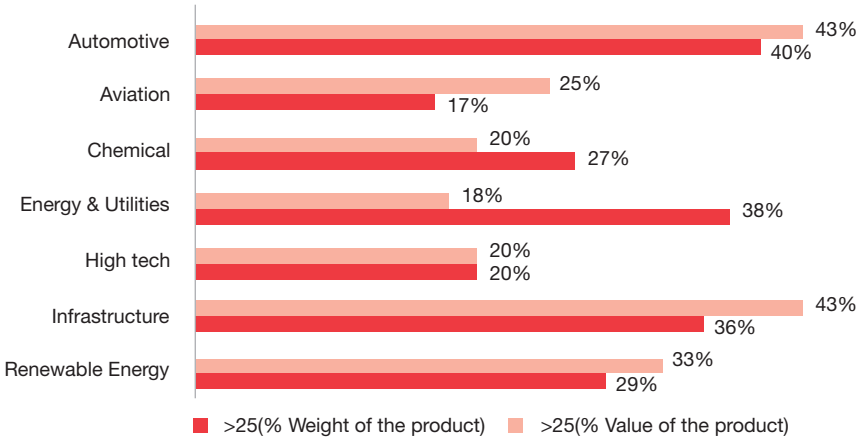


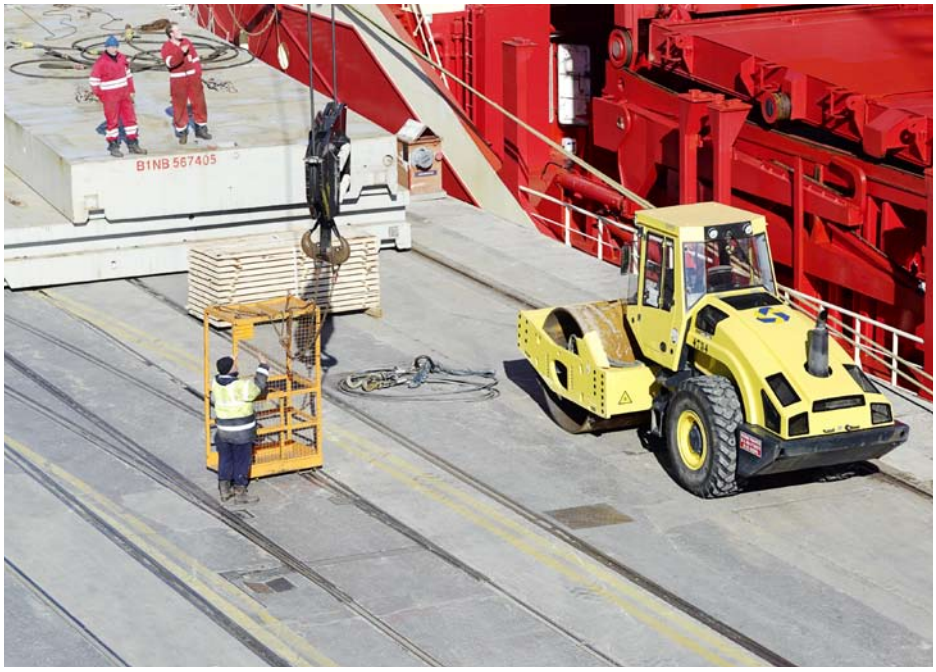
Figure 10: Percentage of respondents indicating the products and services of their first-tier suppliers are affected by the scarcity of minerals and minerals [by industry]

Industry	*High to very high impact*	*Medium impact*	*Total*
Renewable Energy	33%	56%	89%
Infrastructure	45%	36%	82%
Energy & Utilities	50%	29%	79%
Automotive	55%	18%	73%
Chemical	33%	33%	67%
High tech	44%	22%	67%
Aviation	50%	0%	50%

An analysis of these responses by industry shows that between 79% and 90% of survey participants from the energy & utilities, renewable energy and infrastructure sectors believe that their suppliers are impacted by minerals and metals scarcity. However, almost all the industry respondents perceive that their customers are not seriously impacted by the issue.

The 14 raw materials listed are critical because the risks of supply shortage and their impacts on the economy are higher compared with most of the other raw materials. Their high supply risk is mainly due to the fact that a high share of the worldwide production mainly comes from a handful of countries: Antimoon, Beryllium, Cobalt, Fluorspar, Gallium, Germanium, Graphite, Indium, Magnesium, Niobium, Platinum Group, Rare Metals (e.g. Neodymium, Dysprosium), Tantalum and Tungsten.

Source: Raw Materials Initiative (COM (2011) 25 final, 2.2.2011



The American Physical Society (APS) reported on the Energy Critical Elements (ECE). Energy Critical Elements (ECEs) are found in a myriad of high-tech, environmental and military equipment. From smart phones to solar panels to jet engine parts, ECEs play crucial roles in products affecting our daily lives: **TELLURIUM**—brittle, silvery-white metallic element used in solar panels. **GERMANIUM**—hard, grayish-white element with metallic luster; used in solar panels. **PLATINUM**—silvery-white, lustrous, ductile and malleable; used in pollution control devices for cars, and in fuel cells. **NEODYMIUM**—bright, silvery rare-earth metal element; used in wind turbines and hybrid cars. **LITHIUM**—a soft, silver-white metallic element; used in wind turbines and lithium-ion batteries in hybrid cars. **RHENIUM**—silvery-white metal with one of the highest melting points of all elements; used to make advanced turbines and jet engine parts. **TERBIUM**—a soft, silvery-white rare earth metal; used along with its fellow rare earth europium in compact fluorescent light bulbs to provide an acceptable color balance.

Source: American Physical Society (APS)

4. Increase of demand perceived as primary cause for scarcity

All regions and industries see an increase in demand as the primary cause.

For 84% of respondents the increase in demand is perceived as the main driver behind the issue of minerals and metals scarcity, followed by geopolitics (79%) and extraction shortage (73%).

Almost 75% of the companies operating in the European and Asia Pacific regions ranked the effect of growing demand as 'high' or 'very high'. Several countries such as China, India and Brazil are experiencing a phase of explosive economic growth, leading to an increase in consumerism and a higher demand for a variety of goods and services.

For all industries except aviation, over 70% of respondents indicated 'growing demand' as a cause of scarcity. The impact of the growing demand is highest for the players in the infrastructure industry, as indicated by an absolute majority of respondents in the survey.

Distinctions in causes of unstable supply

For European companies, 96% of respondents stated that geopolitics is another factor affecting industries such as energy, chemicals, infrastructure and automotive. How crucial this aspect is can be understood from the recent ruling by the World Trade Organization against China's rare metals export policy. The U.S., E.U. and Mexico petitioned against China at the WTO forum in 2009, citing export restrictions on minerals and metals, such as bauxite and magnesium, as discriminating against foreign manufacturers and giving an unfair advantage to domestic Chinese producers. China produces nearly 50% of the world's supply of scarce metals and around 97% of rare minerals and metals[2].

Figure 11: Percentage of respondents indicating the extent to which the factors contribute to minerals and metals scarcity

Causes	High to very high Impact	Medium Impact	Total
Growing demand	65%	19%	84%
Geopolitics	54%	25%	78%
Extraction shortage	32%	41%	72%
Low substitution rate	38%	32%	70%
Re-use rate low	36%	29%	65%
Over demand (supercycle)	39%	23%	62%
Reserves run dry	30%	29%	59%
Insufficient R&D	25%	25%	49%

2 Source: Reuters Africa, 'China vows to appeal raw materials WTO case', 2011 and British Geological Survey

Figure 12: Percentage of respondents indicating the extent to which the factors contribute to the issue of minerals and metals scarcity [by industry]

Industries	*Reserves run dry*	*Low substitution rate*	*Growing demand*	*Geopolitics*	*Insufficient R&D*
Automotive	82%	64%	73%	82%	45%
Aviation	33%	50%	67%	50%	33%
Chemical	78%	78%	89%	89%	33%
Energy & Utilities	57%	79%	93%	93%	64%
High tech	44%	67%	78%	56%	33%
Infrastructure	45%	55%	100%	82%	64%
Renewable Energy	78%	89%	78%	78%	56%
Average	61%	70%	84%	78%	49%

Over 80% of respondents in the automotive industry perceived 'reserves running dry' as the primary cause of metals and minerals scarcity, compared to 33% in aviation.

Low substitution was indicated as a serious cause by respondents in the renewable energy, energy & utilities and chemical industries with 89%, 79% and 78% respectively indicating a high impact. For example, metals such as indium and neodymium used in the manufacture of solar cells and wind turbines have a very low substitution rate, since the substitute metals known currently either increase the costs or affect efficiency.

While a response to the low substitution rate would have been investments in R&D for developing substitutes, insufficient R&D was considered a factor by only 56% of respondents in the renewable energy sector. Insufficient R&D was cited as a high impact cause by participants from the energy & utilities and infrastructure industries.

5. Preparedness differs considerably per sector

Overall, 49% of respondents indicated that their company's degree of preparedness to mitigate the impact of scarce minerals and metals is 'high' to 'very high'. Various industry participants are actively collaborating with stakeholders to foster and promote win-win strategies to overcome the issue of scarcity.

In the present situation, the infrastructure, renewable energy and automotive industries are almost equally prone to risk, as indicated by almost 60% of respondents. However, 89% of respondents stated that the chemical industry will be prone to higher risks in the next five years. This is consistent with the fact that 78% of chemical industry participants indicated an impact in the next five years, and 44% said that their company does not have adequate plans in place to mitigate the impact. In contrast, automotive and renewable energy companies have reported a high level of preparedness, with 64% and 67% indicating high to very high preparedness respectively.

Figure 13: Percentage of respondents indicating the degree of preparedness based on their company's policy to mitigate the impact of scarce minerals and metals [by industry]

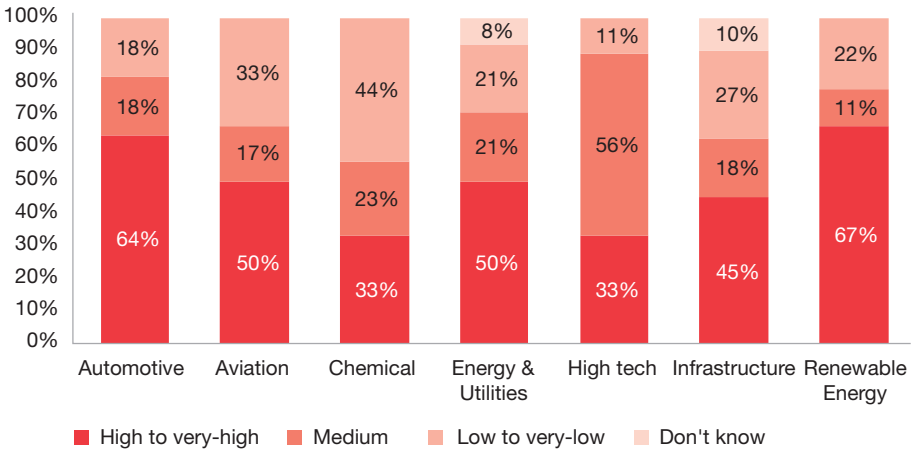


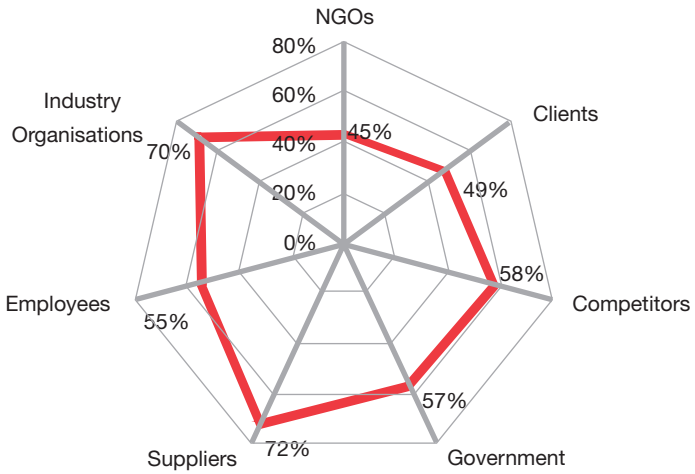
Figure 14: Percentage of respondents indicating their company's degree of preparedness to mitigate the impact of scarce minerals and metals [by region]

Region	*High preparedness*	*Medium preparedness*	*Total*
Europe	58%	17%	75%
Asia Pacific	42%	32%	74%
Americas	46%	23%	69%

A majority of 74% of respondents in Asia Pacific indicated that companies are prepared by having policies in place. This is in line with companies in Europe, where 75% of respondents indicated that companies demonstrate 'high' to 'medium' preparedness in terms of policies and programmes to face the impact of risk.

When participants were questioned concerning their perception of the extent to which the various stakeholders in their industry are active regarding the issue, they responded that 70% of industry organisations and suppliers were active; the perception of all the other stakeholders being somewhat active was shared by only around half the participants.

Figure 15: Percentage of respondents who perceive the stakeholders as reacting or active to some extent regarding the issue of scarce minerals and metals [by stakeholders]



The renewable energy, automotive and high-tech industries have a high level of co-operation with their first-tier suppliers and customers.

When questioned about the extent of collaboration between the companies and their customers and first-tier suppliers, three-quarters of the respondents indicated some level of collaboration with suppliers, and about half indicated some level of collaboration with customers on the scarcity issue. However, out of all the respondents who indicated that their suppliers are 'highly' or 'very highly' impacted by metals scarcity, only 68% have a strong level of collaboration with their suppliers, and the remaining 32% have a low or medium level of collaboration. Specifically in the automotive industry, while collaboration with suppliers was high, collaboration with customers was also high, as indicated by nearly three-quarters of the respondents in the industry.

Collaboration with suppliers plays an important role in reducing the impact arising from supply-side bottlenecks. The various measures suggested by industry participants are R&D activities, searching for substitutes and redesigning products, sharing market forecasts, trends, cost projections and price controls, long-term forward contracts and upgrading technology. Joint development with suppliers of certain product lines that require scarce minerals and metals was also suggested.

Figure 16: Percentage of respondents indicating collaboration with first-tier suppliers in reducing the impact of scarce minerals and metals on their company [by industry]

Industry	*High to very high collaboration*	*Medium collaboration*	*Total*
High tech	44%	44%	88%
Automotive	73%	9%	82%
Infrastructure	55%	18%	73%
Energy & Utilities	57%	14%	71%
Chemical	22%	44%	66%
Renewable Energy	44%	11%	55%
Aviation	17%	17%	34%

6. Efficiency and collaboration: the right response

Efficiency is seen as most plausible response to scarcity

When asked about various measures that could be taken to counter the issue of scarcity, around three-quarters of the respondents think that efficient utilisation of resources will be an important factor. In addition, suppliers are seen as key to addressing this issue, with responses of 68% and 67% respectively identifying strategic alliances with suppliers and diversification of suppliers as applicable factors. Overall, reallocating production (40%) is seen as the least relevant measure for tackling scarcity after an increase in extracting minerals and metals (55%).

Responses per sector

Companies in the renewable energy sector unanimously highlighted the importance of resource efficiency, followed by the automotive sector with a response rate of 82%. Responses peaked at 82% in the case of geopolitics as a measure for the infrastructure sector, whereas only 17% of the aviation sector is convinced about this option. The high-tech industry perceives more substitution as the most suitable measure (89%), followed by the automotive segment.

Figure 17: Percentage of respondents who indicated the particular factor that is most applicable to their company in its response to the issue of minerals and metals scarcity

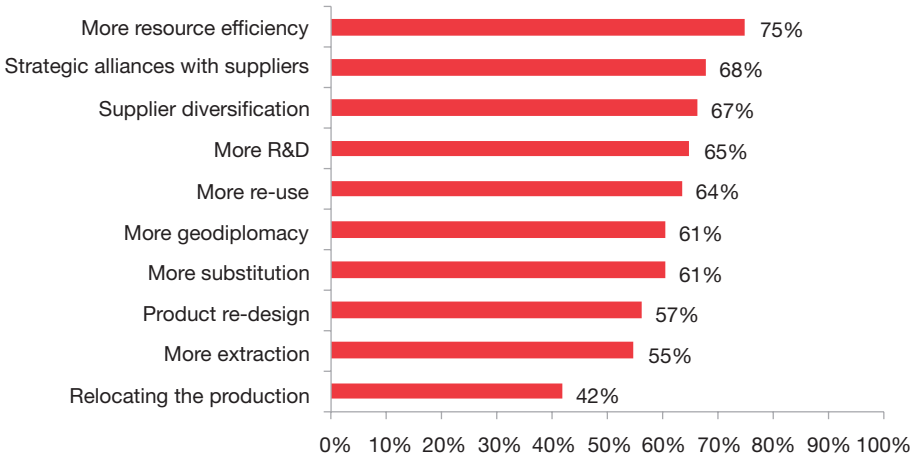


Figure 18: Percentage of respondents who indicated the factor most applicable to their company in its response to the issue of minerals and metals scarcity [by region]

Region	More re-use	More resource efficiency	More R&D	Supplier diversification	Strategic alliances with supplier
Europe	92%	79%	88%	71%	71%
Asia Pacific	47%	74%	47%	58%	63%
Americas	50%	73%	58%	69%	69%

Responses by region

Across all three regions, resource efficiency was uniformly considered to be an important measure to mitigate minerals and metals scarcity, as indicated by an average of three -quarters of respondents.

The factors most applicable among European companies were more re-use, more substitution and more R&D, as indicated by over 85% of respondents. However, only about 50% of participants from Asia Pacific and the Americas thought that these three factors applied to their companies. Almost three-quarters of the participants from Asia Pacific and the Americas indicated that 'more resource efficiency' and 'strategic alliances with suppliers' were the most suitable responses.

Satisfactory actions?

In response to the question about the executives' satisfaction with their company's response to the issue of metals scarcity, 46% said they were 'highly' or 'medium' satisfied. However, the split across regions was uneven, with 58% in Europe, 47% in Asia Pacific and only 35% in the Americas stating that they had a 'high' or 'medium' level of satisfaction with their company's response to the issue.

Respondents from the automotive and infrastructure sectors indicated satisfaction levels of 'high' or 'very high' with 64% and 73% respectively. However, over half the participants from the aviation industry indicated 'low' satisfaction with the actions taken.

Figure 19: Percentage of respondents who are satisfied with the initiatives of their company regarding the issue of scarce minerals and metals [by industry]

Industries	High to very high satisfaction	Medium satisfaction	Total
Energy & Utilities	57%	36%	93%
Infrastructure	73%	18%	91%
Automotive	64%	27%	91%
Chemical	22%	67%	89%
High tech	33%	56%	89%
Renewable Energy	33%	44%	78%
Aviation	17%	33%	50%

Desired facilities to respond to risks

When asked about the facilities that the company perceives to be important in combating scarcity, substitution technology was cited by almost three-quarters of the respondents. Substitution technology was also suggested by over 91% of respondents from the automotive sector.

Data information plays a prominent role in the automotive and infrastructure sectors, as indicated by around 90% of respondents. Respondents in the infrastructure sector also indicated the importance of regulations as a means of mitigating minerals and metals scarcity.

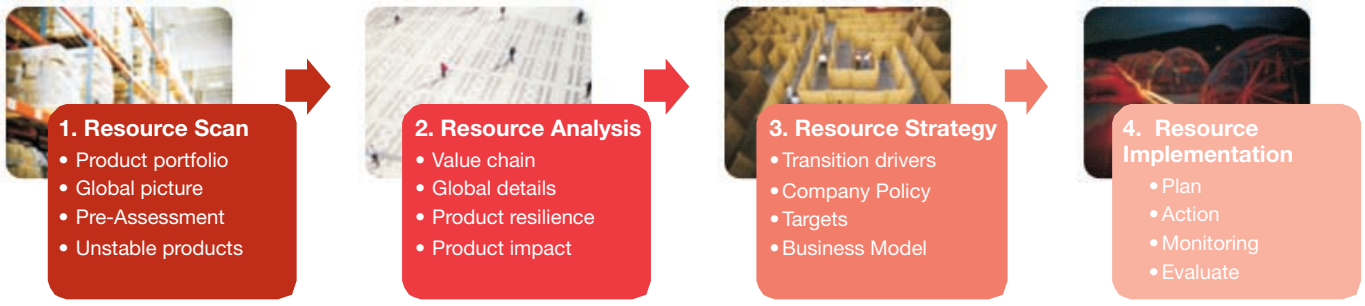
Figure 20: Percentage of respondents indicating a facility required by the company in order to respond to the issue of scarce minerals and metals [by industry]

Industry	*Data-information*	*Recycling technology*	*Substitution technology*	*Regulation*
Automotive	91%	73%	91%	73%
Aviation	83%	50%	50%	50%
Chemical	33%	56%	67%	33%
Energy & Utilities	71%	79%	79%	57%
High Tech	56%	67%	67%	56%
Infrastructure	91%	82%	73%	91%
Renewable energy	56%	89%	78%	56%
Average	70%	72%	74%	61%

PwC Services

Resource scarcity is likely to be a central issue for business leaders and for policymakers in coming decades. At PwC we are helping our clients respond to the challenges and opportunities that resource scarcity presents, drawing on our leading capabilities in sustainability and climate change and our industry expertise. Our sustainability and climate change network offers a range of products and services to help companies explore the implications of resource scarcity. The PwC Resource Scan provides you with valuable insights into the risks and opportunities of your product portfolio, identifies potentially unstable products and supply chains, and allows you to formulate mitigation strategies.

If you would like to discuss resource scarcity or see a demonstration of our Resource Scan, please contact the editorial team or our Industrial Manufacturing contact for your territory. Or just call your local PwC office.



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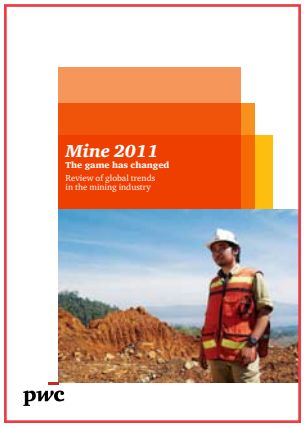

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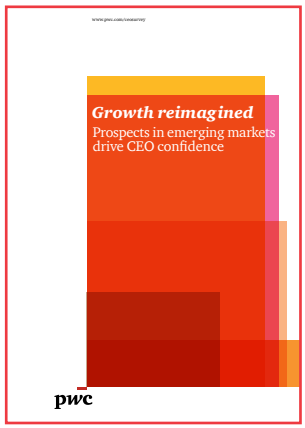

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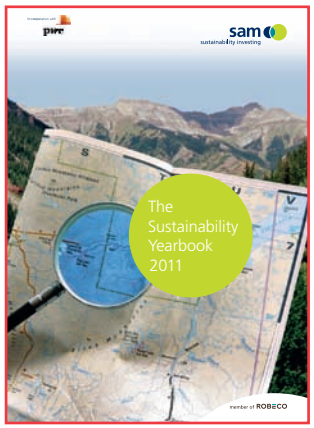

The Sustainability Yearbook 2011
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