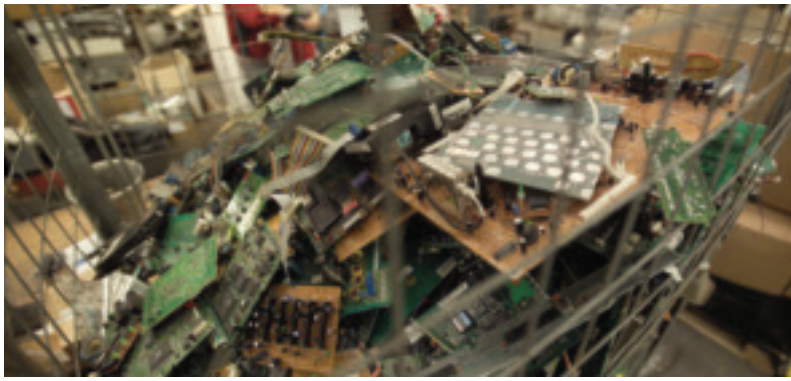
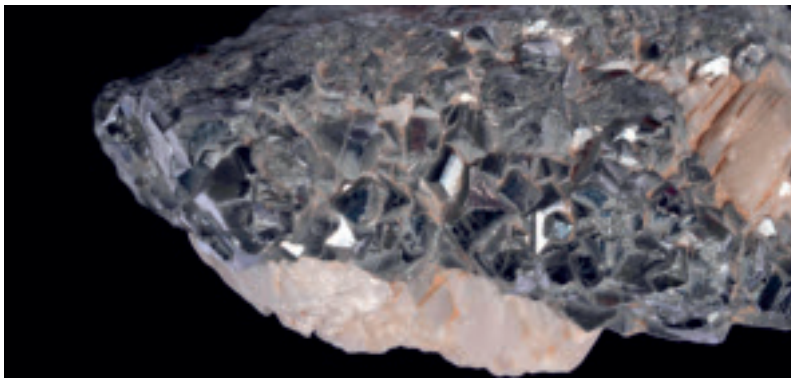
Resource Security Action Plan: Making the most of valuable materials





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Ministerial Foreword

Lord Taylor of Holbeach, Parliamentary Under-Secretary, Defra and Mark Prisk MP, Minister of State for Business and Enterprise, BIS

The UK economy and our way of life are reliant on a range of renewable and non-renewable resources. They are essential to the products and services we make and use, and contribute to sustaining and growing our economy.

Increasing global demand is leading to strains on supplies of some raw materials, such as those found in high-tech, defence and green technologies, contributing to price and supply pressures. This is a concern for many UK companies. Organisations such as the CBI and the EEF have called for the Government to look more closely at resource security pressures, as has the House of Commons Science and Technology Committee. This Action Plan has been developed in response to these concerns.

We see this agenda as a business **opportunity** – we need to make the most of valuable materials. By using resources more efficiently, innovating and 'closing the loop', we can ensure materials are re-used, re-manufactured or recycled. Creating this stream of secondary resources will boost the **resilience** of UK businesses. It will enable them to become more competitive in the face of increasing and fluctuating commodity prices. There may also be opportunities to supply more of our own demand from sustainable mineral resources in the UK.

Some businesses are already responding to this challenge, and benefiting from cost savings, and new market opportunities. But there are many more companies, particularly SMEs, who are yet to react or are unaware. Government's role is to act as a catalyst for change, facilitating and supporting business action, to make sure that UK companies are best placed in the global market. This Action Plan provides a framework for partnership between Government and businesses. It sets out how Government will support business. It contains a commitment by interested businesses to work together to address resource opportunities and concerns.

We are committed to working together, and with other Departments, to help businesses improve their resource security. To simplify this relationship, Defra will act as Government's **first point of contact** for businesses on this issue.

Lord Taylor of Holbeach
Parliamentary Under-Secretary
Defra

Mark Prisk MP
Minister of State for Business
and Enterprise, BIS

Executive Summary

(i) This document has been developed **in response to private sector concerns about the availability of some raw materials.** It details how the Government recognises these issues, provides a framework for business action to address resource risks, and sets out high level actions to build on the developing partnership between Government and businesses to address resource concerns.

(ii) The risks identified by businesses relate to increasing competition for resources, price volatility and potential interruptions in supply, caused by a combination of growing worldwide demand, concentration of supply in a small number of countries, trade restrictions in some cases, lack of currently viable alternatives in key applications, and time lags in the supply response to increased demand. Government attention is warranted by a series of market failures: prices for many resources are not reflecting the full environmental cost of extraction, there is a lack of readily available information about resource risks which may affect UK businesses, particularly small and medium-sized enterprises (SMEs), and behavioural barriers impede action to improve resource efficiency.

(iii) **The scope of this Action Plan covers a broad range of renewable and non-renewable resources not covered by government policies on energy and food.** While in practice much of the focus of the short-term actions is on metals and minerals which have been identified as critical by many UK businesses, the analysis and statement of policy are relevant to a wider range of resources that are important to the UK economy.

(iv) The UK's prosperity and national security depend heavily on global stability. This paper considers the risks posed to the UK economy from a reduction in the availability and supply of natural and material resources, which go into the products and services we make and use. Access to reliable supplies of such resources is essential for our economy to prosper and grow.

(v) The growing world population and the success of developing countries since 1980 in lifting over 500 million above the poverty line[1] have heightened global competition for a range of resources. This growing pressure on resources can be seen in the generally increasing and volatile prices of a range of commodities over the last decade, most pronounced for 'speciality' metals (Figures 1a, b and c).[2]

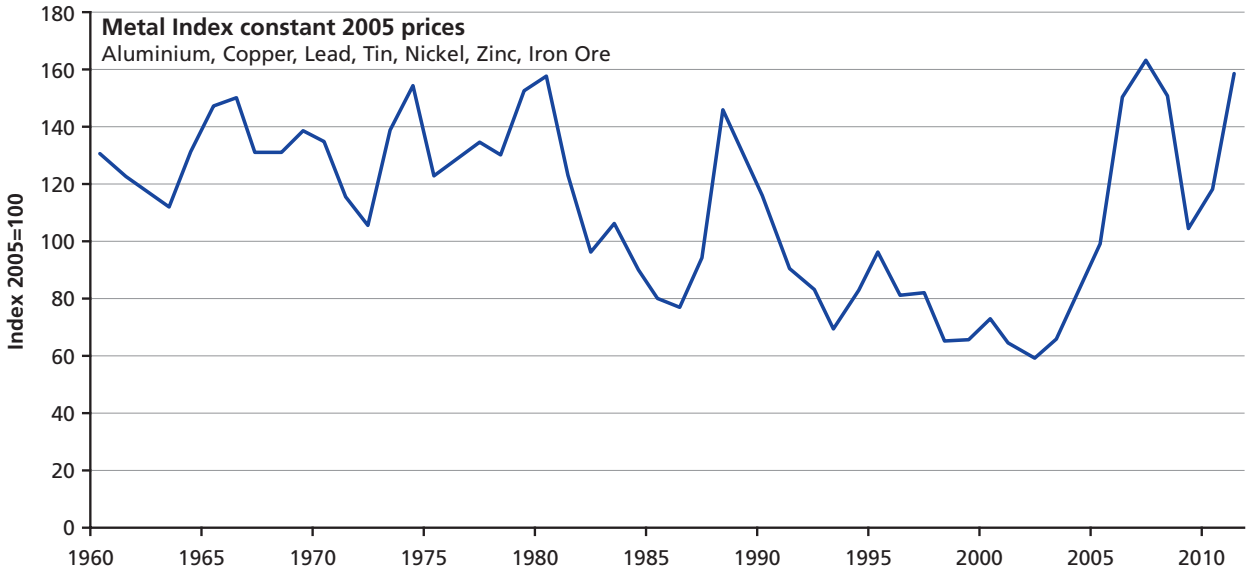
(vi) **These trends are already having an impact on UK businesses,** in more acute cases leading to concerns about access to resources. 29% of profit warnings issued by FTSE350 companies in 2011 were attributed to rising resource prices.[3] In a recent survey of their membership by EEF the Manufacturers' Organisation, over 80% of chief executives of manufacturing companies said that raw materials shortage was a risk to their business in 2012.[4]

(vii) **Increasing competition for resources is also leading to additional pressures on the environment.** Where easily accessible resources have already been exploited, opening up new sources of supply often involves more energy intensive mining and refining, with higher greenhouse gas emissions and increased demands on water supplies and other natural systems.

1 Department for International Development (2008) DfID Research Strategy 2008-2013, Working Paper Series: Economic Growth
2 Speciality metals in this paper refers to materials with particular properties used in a range of high-tech applications and green technologies.
3 Ernst and Young (2011): Analysis of profit warnings issued by UK quoted companies.
4 EEF: The Manufacturers' Organisation (2012) Executive Survey 2012.

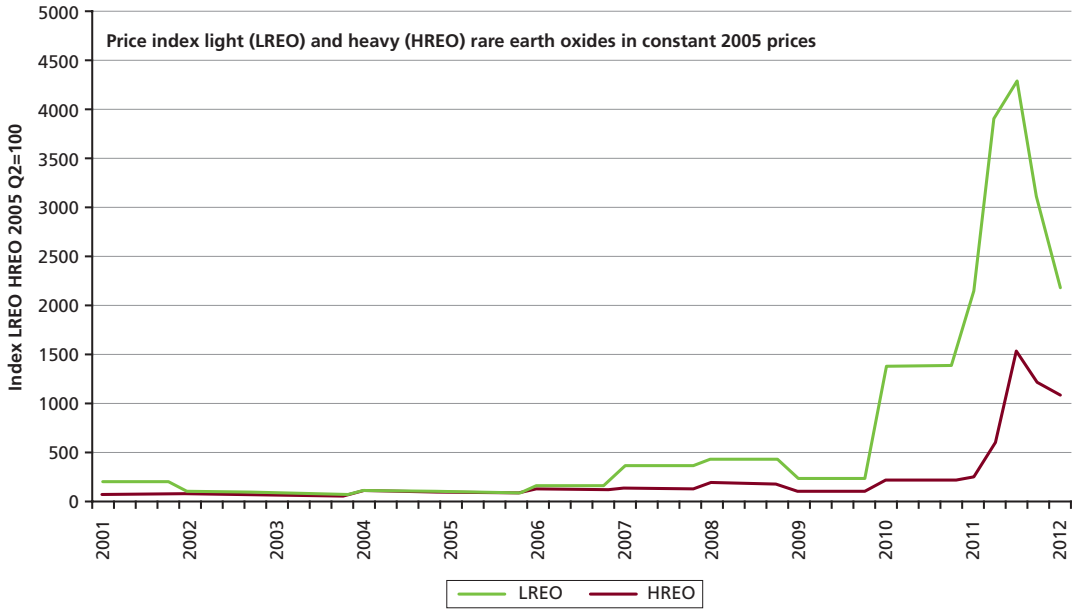
(viii) The focus of this document is policy in England. Wales, Northern Ireland and Scotland, while working within the same EU legislative framework, are responsible for their own resource policies and delivery. However, all four parts of the UK work closely together on this agenda and will take forward complementary actions in many of the areas covered in this document with UK businesses.

Figure 1a: Price trends for selected metals since 1960 (seven metals index)



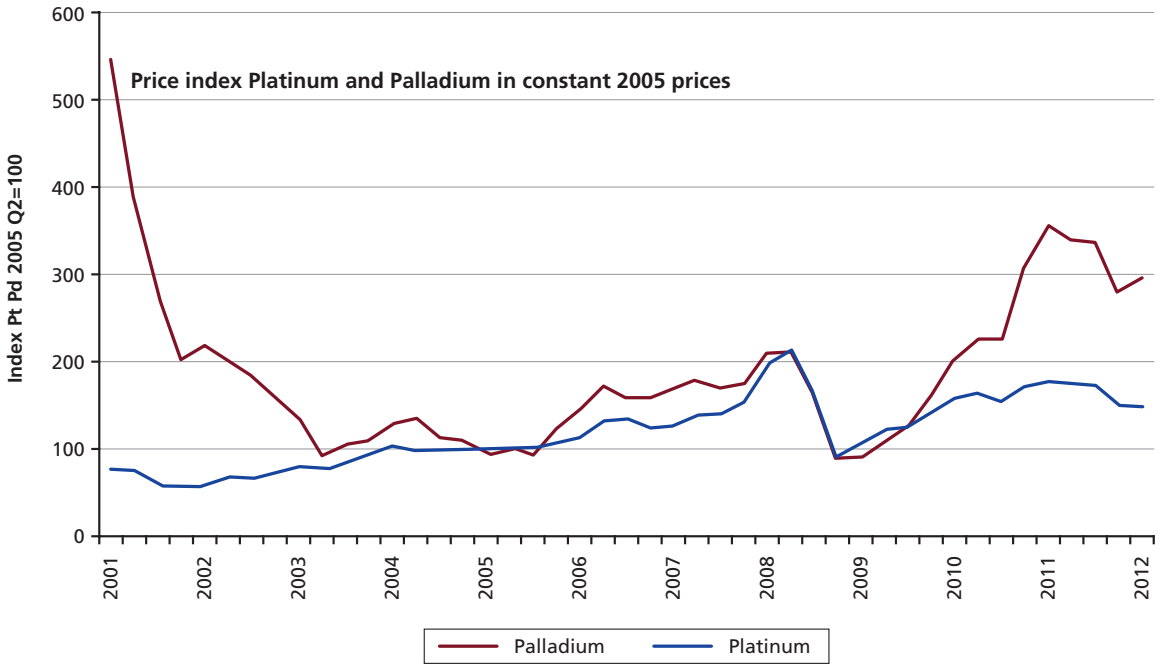
Source: World Bank Pink Data and US total GDP deflator

Figure 1b: Price trends for selected light and heavy rare earth oxides since 2001 (La, Ce, Nd, Pr, Dy, Eu and Tb)



Source: Lynas Corporation via British Geological Survey, US total GDP deflator

Figure 1c: Price trends for Platinum and Palladium since 2001



Source: Metal Bulletin via British Geological Survey, US total GDP deflator

(ix) The focus of this action plan is on **resource 'security' rather than 'scarcity'** as supplies of most resources are not expected to run out. Reports to the contrary are often based on analyses of declared reserves, which represent a snapshot of what is economically efficient for companies to mine within the period for which they have planned operations, rather than total resource available. Over time innovation in exploration methods, mining and mineral processing techniques can enable the development of resources that were undiscovered or not previously economic to exploit.

(x) **Security of supply relates to a combination of physical risks and geopolitical risks.** Physical risks include the accessibility of resources as the quality of ores mined decreases, and temporary shortages of supply because new mining operations can take significant time to come into production and so supply can lag behind increases in demand. Geopolitical risks include concentration of production in a relatively small number of countries, and restrictions on trade as producing countries seek to exert their market power.

(xi) **The economic value to the UK of critical materials** is not straightforward to assess. Many enter the UK embedded in products and components. Absolute quantities are often relatively small, but small quantities are present in a wide range of products where they sometimes perform essential functions often in high value goods or strategic technologies.

(xii) **Future demand for critical resources is difficult to predict** given the wide range of influences and potential responses. Projections of demand based on key low carbon technologies underlie some of the analyses of criticality referred to in Table 1 and pinpoint particular risks associated with some of the speciality metals. Leading businesses are already undertaking such projections for themselves to assess their own exposure to such risks. While it is not possible to be definitive about the risk in relation to any individual material, any action which can reduce demand for critical materials will reduce exposure to risk. Improvements in design and the optimisation of reuse, recycling, recovering or sustainably substituting for material already circulating in the economy will be beneficial. Nevertheless, for many critical materials further primary extraction will be needed to meet the predicted increases in demand.

(xiii) Innovative approaches and new solutions to secure raw materials also present **new business opportunities** (section 1.7).

(xiv) A range of existing research studies have highlighted the business **opportunities for cost savings and competitive advantage in resource efficiency.** A recent McKinsey report[5] indicates potential global savings of between $2.9-$3.7 trillion by 2030 through a range of resource productivity measures, 70% of which would have investment returns of 10% or more per year.

(xv) There are also **opportunities in making greater use of sustainable extraction of critical materials from the UK's own indigenous resources.**

(xvi) This Resource Security Action Plan is in two sections, and is accompanied by a review of national resource strategies and research (summarised in Annex 1). The first section sets out how the Government sees these issues, providing a framework for business action to address resource risks and covers the following considerations:

- Action to secure resources now will ensure the UK's resilience to supply problems in the future,
- Managing the environmental impacts of metal and mineral extraction must be balanced with securing future supplies, including from indigenous sources,
- The economic value of secure resource supplies is difficult to quantify precisely,
- Some UK sectors are particularly exposed to resource risks,
- Future demand for critical materials is set to increase,
- There are wider economic and environmental opportunities in the development of more sustainable management of resources.

(xvii) The second section sets out a number of areas where by working together Government and business can take some specific actions to:

- Address barriers to greater recovery of critical materials from secondary sources,
- Facilitate provision of relevant information to help businesses manage related risks and opportunities,

5 McKinsey Global Institute (2011) Resource Revolution: Meeting the world's energy, materials, food and water needs

- Promote and support innovation and research,
- Engage with EU and international partners to help promote the right international framework for addressing these issues, and
- Ensure a continuing focus on these issues.

Box 1: Overview of key new actions

- **Innovation Challenge:** Defra will fund an Innovation Challenge Fund for local economy closed loop projects in 2012-13. Coordinated by the Technology Strategy Board (TSB) through the Small Business Research Initiative (SBRI), this will establish the feasibility of new approaches enabling local businesses to extract value from domestic and commercial waste streams (i.e. through re-use and recovery). This should encourage partnerships between business, local authorities and local communities. (Lead: Defra with the TSB)
- The Government will investigate the feasibility of applying the principle of **Individual Producer Responsibility** (IPR) more generally to the Waste Electrical and Electronic Equipment (WEEE) system. (Lead: BIS)
- The Government will work to support UK businesses by extending **data capture of waste electrical and electronic equipment** being treated by waste management companies and other players outside the current 'WEEE system'. (Lead: BIS)
- **A new critical resources dashboard will be launched:** The Environmental Sustainability Knowledge Transfer Network (ES KTN) together with the British Geological Survey and other partners including the Waste and Resources Action Programme (WRAP), BIS, and Defra will develop and test a 'critical resources dashboard'. This will seek to better provide companies with information they need to take more informed decisions on the resource risks to their operations, to be launched by the end of January 2013. (Lead: Environmental Sustainability KTN)
- **Development of a materials flow analysis, initially for WEEE 'hot spots':** WRAP will develop a high level critical materials flow analysis in key WEEE product categories. (Lead: WRAP)
- **Demonstration trials:** WRAP will conduct demonstration trials to highlight the potential to improve recovery of critical materials through the WEEE treatment process. (Lead: WRAP)
- **A new industry-led consortium,** convened by the Green Alliance, will bring together interested businesses and business groups to provide a mechanism to further develop links between government, business and other organisations to address resource opportunities and concerns, to disseminate leadership thinking and best practice and to provide a forum for policy innovation. (Launch by May 2012) (Lead: Green Alliance)

Box 2: Which resources are critical to the UK economy?

This Action Plan does not provide a list of resources critical to the UK economy. The criticality of a particular raw material will depend on a range of factors and will change over time.
Any assessment of criticality involves a combination of:

- the importance of the uses of the raw material;
- the availability of alternatives;
- the availability, and diversity of supply, trends in demand and environmental impacts;
- the ability of the market to adapt (its 'resilience') and its ability to exploit potential opportunities resulting from resource insecurity.

All of these can change in response to innovation, technological advances and changes in world markets.

Several recent studies have assessed criticality of resources based on different parameters. A study for the European Commission[6] identified a list of 14 economically important raw materials subject to a higher risk of supply interruption. The House of Commons Science and Technology Committee's Strategically Important Metals report[7] identified a list of 43 materials (including 17 rare earth elements and 6 platinum group metals) as being of strategic importance. Research for Defra[8] and the Scottish Government[9] considered a wider range of materials including renewable resources. Green Alliance's report 'Reinventing the Wheel – a circular economy for resource security'[10] undertook a comparison of these and other relevant studies which they summarised (Table 1). All of these analyses are valid, reflecting the current lack or otherwise of data and different methodologies and perspectives, and they may change over time. However, the table highlights the consensus on the criticality of a number of the precious and 'speciality' metals.

The UK Government's approach is to facilitate business action where there is greatest scope to reduce risk and environmental impact and to capture value for the UK economy. The focus here is on metals and minerals, but the response is broadly similar for a wider range of resources, including embedded water[11] and those natural assets covered recently by the UK National Ecosystem Assessment.[12]

The response is also relevant to managing the supply chain risks to materials from the impacts of unavoidable climate change, such as extreme weather events, and to the risks from natural disasters.

6 Report of the Ad-hoc Working Group on defining critical raw materials (2010), Critical raw materials for the EU.
7 House of Commons Science and Technology Committee (2011) Strategically Important Metals Inquiry
8 AEAT for the Department for Environment, Food and Rural Affairs (2011) Review of the Future Resource Risks Faced by Business and an Assessment of Future Viability.
9 SEPA (2011) Raw Materials Critical to the Scottish Economy
10 Green Alliance (2011) Reinventing the Wheel: a circular economy for resource security
11 HM Government (2011) Water White Paper: Water for Life.
12 UNEP-WCMC, Cambridge. (2011) UK National Ecosystem Assessment: understanding nature's value to society synthesis of the key findings

Table 1 – Materials deemed insecure or at risk by recent reports[13]

Material/report	EU	TSB	Defra	SEPA	STC	BGS	US
Aggregates			X	X			
Antimony	X	X			X	X	
Beryllium	X				X		
Bismuth						X	
Bromine						X	
Chromium					X		
Cobalt	X			X	X		
Copper				X			
Fish			X	X			
Fluorspar	X						
Gallium	X				X		
Germanium	X				X		
Gold		X			X		
Graphite	X						
Hafnium					X		
Indium	X		X	X	X		X
Lithium			X	X	X		X
Lead				X			
Magnesium	X				X		
Mercury		X				X	
Nickel					X		
Niobium	X				X	X	
Palm oil				X			
Phosphorus			X	X			
Platinum group metals ruthenium, rhodium, palladium, osmium, iridium and platinum	X	X			X	X	
Rare earth metals	X		X	X	X	X	X
Rhenium					X		
Silver		X					
Strontium		X				X	
Tantalum	X				X		
Tellurium					X		X
Thorium						X	
Timber				X			
Tin		X		X			
Tungsten	X					X	

EU: Raw Materials Supply Group, chaired by the European Commission, 2010, *Critical raw materials for the EU: report of the ad-hoc working group on defining critical raw materials*

Technology Strategy Board (TSB): Oakdene Hollins, for the Resource Efficiency Knowledge Transfer Network, 2008, *Material security; ensuring resource availability for the UK economy*

Department for Environment, Food and Rural Affairs (Defra): AEA Technology for Defra, 2010, *Review of the future resource risks faced by UK business and an assessment of future viability*

Scottish Environment Protection Agency (SEPA): AEA Technology for the Scotland and Northern Irish Forum for Environmental Research (SNIFFER), 2011, *Raw materials critical to the Scottish economy*

Science and Technology Committee (STC): House of Commons Science and Technology Committee, 2011, *Inquiry into strategically important metals*

British Geological Survey (BGS): British Geological Survey, 2011, *Risk list 2011*

US: US Department of Energy, 2010, *Critical materials strategy*
Boldface in the table indicates that more than two reports identified these materials as critical.

13 Green Alliance (2011) Reinventing the Wheel: a circular economy for resource security

SECTION 1: Why is Resource Security an Issue?

1.1 Resource risks

1. Businesses are best placed to identify and manage the risks, and to take advantage of the opportunities that may arise through resource security and resource efficiency. It is their responsibility to ensure they have access to reliable, sustainable sources of supply and that they use resources in an optimal manner.

2. But there are several reasons why markets in this area are not operating efficiently, and why businesses have identified issues for Government consideration.

   - The costs associated with the extraction and production of resources such as metals and minerals are generally well reflected in their prices, with the market responding through rising prices as stocks deplete. Some environmental costs, associated with the impacts of extracting, using and disposal of certain materials are not priced in, leading to inadequate consideration for the environment when making decisions. Although there are a number of interventions aimed at addressing environmental externalities, such as the EU Emissions Trading Scheme and the UK Landfill Tax, many externalities are not addressed. And these externalities are likely to increase for **physical reasons** as higher quality ores are depleted and lower quality deposits are exploited in their place.
   - There may be cases where the market strength of producers can be used to influence supplies of materials, particularly in the short-run. These **geopolitical actions** can result in short-term price fluctuations and shortages, which can disadvantage companies outside the producing countries. Where other suppliers of materials can respond there may be a significant time lag for new production to come online to meet rapidly growing demand. New mining operations can take 10-20 years to be developed from scratch, hence **physical** supply responds more slowly than the economic cycle.
   - Although larger businesses are better placed to respond to the risks associated with price fluctuations and short-term shortages (e.g. through hedging), it is likely to be more difficult for SMEs, which are typically less able to access capital at short notice, and may **be less informed about such risks as well as the substitutes** that are available (see section 2.2). And there may also be **behavioural barriers** that could act as a barrier to the adoption of optimal efficiency (see section 1.7).

3. The physical attributes of some of these resources also influence their supply. Critical materials are usually found mixed with a number of other elements, and are mined as 'by-products' or 'co-products' of major industrial metals. The recovery of these minor components can be difficult and costly, and energy intensive. Therefore, the decision to extract these materials will depend on whether it is cost effective to (i) extract the base metal in the first place and (ii) to obtain the secondary product, meaning that the economic feasibility of the primary metal removes the usual effect of a rise in demand being met with a rise in production of the secondary metals. Figure 2 illustrates base metals associated with some critical elements.

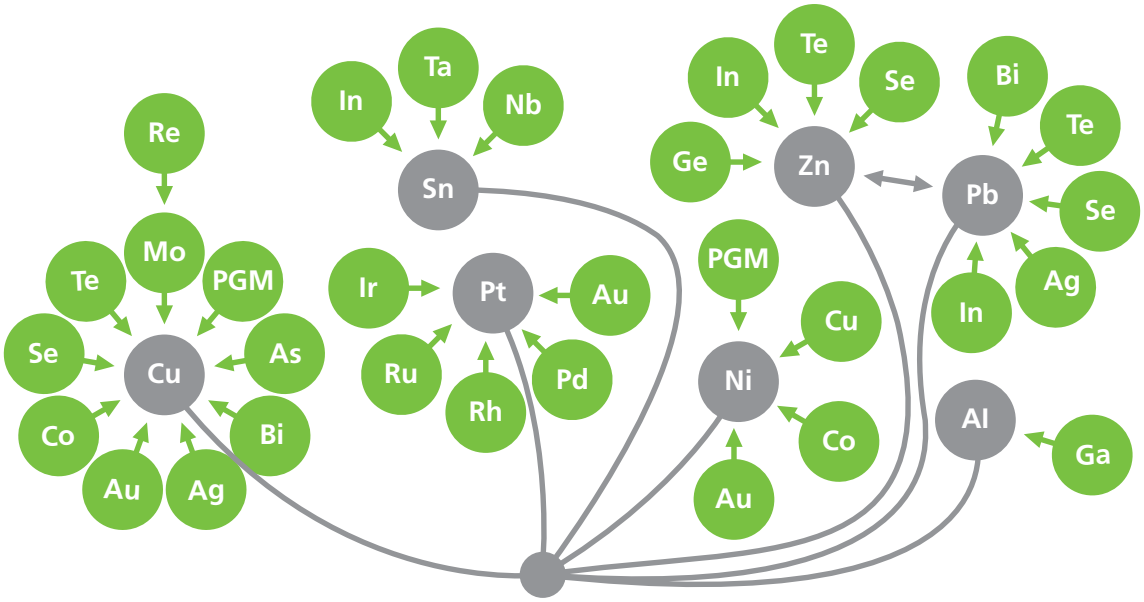
4. The Government's role is to act as a catalyst for change, facilitating and supporting action to help businesses overcome clear market failures.

5. The focus of this Action Plan is the 'security' rather than 'scarcity' of resources, since most non-renewable resources are not expected to run-out in the near future. Reports to the contrary are often based on analyses of declared reserves, which is a snapshot of what is economically efficient for companies to mine within their 10-30 year planning horizons, rather than total resource available. Over time, innovation in mining techniques and newly acquired sources open up more of the available resources although this will be constrained by energy and environmental considerations.

6. Although the scope of this Action Plan excludes energy and food, the critical resource security challenges are inextricably linked to these and to those of climate change. These include access to affordable water and energy for food; the electrification of transport and the expansion of green energy capacity – all of which require speciality metals in growing quantities (see section 1.6); and impact on water availability and quality due to demand for production processes.

7. Risks to supply chains can also arise from unavoidable climate change, from extreme weather events and from natural disasters. The Thailand floods reportedly led to a shortage of components for UK car manufacturers. And the wider impacts of climate change are likely to present challenges to manufacturing, such as instability of water supply; business demands for water are predicted to increase by more than 200% in developing countries by 2050. Manufactured products are the largest UK import group, about 4% of the total world exports of manufactured goods and chemicals. Disruption to overseas processes could have a negative impact on the UK's security of supply of resources and manufactured goods.

Figure 2: Critical elements produced as by- and co-products of base metals[14]



Source: Hagelüken and Meskers, 2010 as adapted by the Resnick Institute

14 Hagelüken, Christian and Meskers, Christina E. M. (2010) "Complex Life Cycles of Precious and Special Metals." Strüngmann Forum Report: Linkages of Sustainability. E.d. Thomas E. Graedel and Ester van der Voet. MIT Press. pp 163-197 as adapted by the Resnick Institute (2011) Critical Materials for Sustainable Energy Applications. See annex for key to element names and abbreviations.

1.2 Action to secure resources now will ensure the UK's resilience to supply problems in the future

"The world in which UK businesses operate is changing. In the coming years growth in emerging markets will see greater competition for our remaining natural resources."
CBI, Made To Last[15]

"This soaring demand will occur at a time when finding new sources of supply and extracting them is becoming increasingly challenging and expensive, notwithstanding technological improvement in the main resource sectors." McKinsey Global Institute, Resource Revolution[16]

8. The physical resource risks, coupled with geopolitical risks such as trade restrictions, stockpiling and concentration of supply feed into economic risks of price volatility.

9. For UK businesses this raises concerns over access to reliable and sustainable supplies of resources. Interruptions to these supplies, coupled with increasing global demand, can lead to price volatility and strains on UK businesses if they are unprepared.

10. Raw material price data can reflect information about the state of the market and the expectations of future demand and supply. Cobalt, Molybdenum, Platinum and Palladium are traded on global commodities markets such as the London or New York Metals Exchange which allow them to be traded at spot and futures prices. Traders and business can choose to manage price risk that they may be exposed to due to fluctuating spot prices by hedging in the futures market. Although this can be a useful tool for business to protect against resource risks, future demand is difficult to predict as it is influenced by a wide range of external factors.

11. Other critical resources are not traded on global commodity markets and therefore are not traded at international spot and futures prices. Price information on these resources is available but it is generally compiled from prices paid by producers, consumers and traders. Although futures contracts do not formally exist for these commodities, long term private forward contracts may be used as a tool to secure future supply at a price agreed in the present. However, these contracts are subject to a degree of inflexibility.

12. There is a range of actions that can be taken now to reduce exposure to pricing and supply risks through improved **resource efficiency** and the development of **'secondary' supplies, or development of alternative materials**. This means using less, wasting less, and reusing and recycling more. Risk can be reduced through a range of innovative approaches such as ecodesign, adoption of alternative business models to provide products and services in less resource-intensive ways and, in some cases, material substitution. At the same time there are business opportunities in taking advantage of new markets and maintaining 'whole lifetime' control over material resources.

15 CBI (2011) Made to Last: Creating a resource efficient economy.
16 McKinsey Global Institute (2011) Resource Revolution: Meeting the world's energy, materials, food and water needs

13. The available **environmental and economic** benefits of resource efficiency actions are illustrated by research[17] which shows there are around **£23 billion worth of savings per year available to UK companies through simple measures that would pay back in less than a year**, delivering a saving of around 4% on our annual CO_2 emissions, and further benefits if we look at longer pay back times. Another study[18] indicates potential global savings of between $2.9-$3.7 trillion by 2030 through a range of resource productivity measures, 70% of which would have investment returns of 10% or more per year. The study asserts that these measures alone would deliver around half of the CO_2 savings required to keep global temperatures below a 2°C increase (450 ppm CO_2e).

14. Government and business are already working closely to deliver more of these benefits, for example through the advice and support offered by bodies such as the Waste and Resources Action Programme (WRAP) and through the support of the Technology Strategy Board (TSB) in bringing innovations to market.

15. Defra and WRAP have developed a number of voluntary agreements and responsibility deals with businesses to bring through successful changes in business practices such as the Courtauld Commitment on packaging and food waste, and the Home Improvement Sector Commitment. Building on these agreements, the Product Sustainability Forum[19] has been established by WRAP to improve the availability and accuracy of environmental impacts data for consumer products. This aims to create a joined-up approach to researching, measuring, communicating and reducing the environmental impacts associated with everyday products.

16. Many businesses need little help from Government, and already realise the economic value of reducing their resource use (box 3). But there is evidence to suggest that many, particularly small and medium sized businesses, are not as aware of the risks and the opportunities available. Such concerns were recognised in the House of Commons Science and Technology Select Committee Report on Strategically Important Metals,[20] and research for Defra.[21]

17 Oakdene Hollins for the Department of Environment, Food & Rural Affairs (2011) The Further Benefits of Business Resource Efficiency.
18 McKinsey Global Institute (2011) Resource Revolution: Meeting the world's energy, materials, food and water needs.
19 The Product Sustainability Forum is a UK wide initiative, co-sponsored by Defra, the Scottish Government, Welsh Government and Northern Ireland Executive
20 House of Commons Science and Technology Committee (2011) Strategically Important Metals Inquiry
21 AEAT for the Department for Environment, Food and Rural Affairs (2011) Review of the Future Resource Risks Faced by Business and an Assessment of Future Viability.

Box 3 – Case studies of businesses taking action to reduce their resource impact

- Ricoh, provider of managed document services, production printing, office solutions and IT services, developed a 'GreenLine' of products with the aim of minimising the environmental impact of its products at customers' sites. Previously leased printers and copiers are inspected, dismantled, renewed and provided with updated software and replacement components before being sold as remanufactured products on the GreenLine label. This initiative has been a huge success story – with 'GreenLine' products being BSI certified, their performance matches that of new machines and holds the same warranty.
- As well as GreenLine, Ricoh has committed to reduce its overall input of new resource by 25% by 2020 by maximising reuse of parts and products, extending product lifetimes through remanufacturing and substituting with lower risk materials. The company operates a 'Comet Circle'[22] to embed the practice of closed-loop resource use and believes that all products should be designed for reuse.
- The agriculture sector (and with it the supply of raw materials to make products) is on the front line in the fight against climate change. Recognising that its growers in the UK and across the world were experiencing the impacts of more frequent extreme weather conditions, such as floods and drought, was one of the reasons why in 2010 PepsiCo UK launched its "50 in 5" initiative. This is a commitment to reduce the water use and carbon emissions of its key crops by 50% in the next five years. PepsiCo aims to work in partnership with growers to identify and reduce key environmental impacts in a way that brings long term economic, environmental and social sustainability to its growers and to the company.
- PepsiCo is helping growers by:
  - Giving them the tools to measure their use of carbon and water through leading edge but practical technologies;
  - Helping them to better understand the decisions they are taking in the field such as on fertilisation and irrigation;
  - Sharing decades of investment in new crop varieties that improve yield, are more disease resistant and take less water and fertiliser;
  - Investing in low carbon fertiliser and by working with fertiliser companies to develop and make available to its growers low carbon alternatives;
  - Offering new technologies that deliver better environmental performance and save money, such as drip irrigation.

1.3 Managing the environmental impacts of metal and mineral extraction must be balanced with securing future supplies, including from indigenous sources

17. The global environmental impact of extracting and using mineral resources will vary according to the mineral exploited and the location of extraction. This impact needs to be considered against the utility and use of the product made from those resources, and the lifetime and

22 Ricoh Comet Circle

lifecycle of that product use. The lifetime of a product may extend for hundreds of years, as in the case of bricks, or substantially less than a year, as with aluminium foil. In general, the extraction and processing of some minerals can result in significant greenhouse gas emissions, require significant water and chemical use, and give rise to substantial volumes of waste. Mineral extraction can impact on local wildlife and natural systems such as woodlands, rivers and groundwater, although positive contributions to biodiversity can also be achieved through, for example, restorative action. There may also be significant environmental health and social concerns associated with poor working conditions depending on the source of the material.

18. While the UK does have indigenous sources of construction and some industrial materials, many resources are currently sourced overseas. As much of the extraction and processing of metals and some industrial minerals needed by the UK take place abroad, the issue for the UK is about understanding and taking steps to reduce our environmental footprint. The metals mining industry has been estimated to account for between 7-10% of global greenhouse gas emissions. The carbon impacts of mining some of the precious and speciality metals are significantly greater than those associated with the more common base metals, e.g. the emissions in kgCO_2e per kg of material from mining to refining have been estimated to be around 14,500kg for platinum and nearly 10,000kg for palladium (compared to around 2-3kg for copper, zinc and lead), while the processing of 1 tonne of aluminium from bauxite creates 9 tonnes CO_2e. In comparison secondary recovery of platinum and palladium accounts for around 750kg CO_2e per kg, so significant reductions can be achieved in greenhouse gas emissions through this route.[23]

19. Many mining companies have taken great strides to reduce their wider impacts on the environment. But there remains a significant challenge in quantifying and managing the environmental impacts of unregulated industry in some other parts of the world, and in finding technological solutions to improve productivity at the same time as reducing greenhouse gas emissions from the industry in future.

20. Leading businesses have already taken action to reduce environmental risks in their supply chain. Businesses which do not identify and manage environmental and social risks in their supply chain may find themselves facing reputational and financial damage as consumer concern rises, and they lose out to companies who do.

21. It is essential that there is an adequate and steady supply of minerals to provide the raw materials for infrastructure, buildings and goods that society, industry and the economy need. Government recognises that where there is increasing and unprecedented demand for new mineral resources, such as the 'speciality' metals vital for a range of high-tech applications and green technologies, further primary production will be necessary as there is insufficient recyclate from end-of-life products to meet new demand.

22. One way the UK can help to mitigate both our global and internal environmental impacts is to manage our own mineral resources (both primary and recycled) and their use more effectively and efficiently. While the majority of the minerals which UK businesses require for use as a basic raw material will still need to be sourced from overseas, there remain resources of a number of

23 Sources: WRAP and European Aluminium Association (2008) Environmental Profile Report for the European Aluminium Industry.

minerals in the UK that could potentially contribute to meeting demand should their extraction become economically viable. However, since minerals are a finite resource, it is important to make best use of them. This provision needs to be made in accordance with the principles of sustainable development. This means making the best use of resources currently in use, reducing as far as practicable the quantity of material used and waste generated, and using as much recycled and secondary material as possible, before securing the remainder of material needed through new primary extraction. Updated minerals planning policy will form part of the National Planning Policy Framework.

Box 4: An example of supplies of critical materials in the UK – Hemerdon, Devon

Hemerdon is the fourth largest deposit of tungsten in the world. It is an example of the new opportunities for the UK to provide secure supplies of critical and economically crucial minerals for our economy from within our own significant and undeveloped resources. Tungsten is important as it is an essential mineral for use in cutting tools and for hardened steel. Currently almost 78% of the world's production of Tungsten comes from China.[24] The annual production from Hemerdon will provide around 4% of global demand, meet the demand from within the UK and contribute towards exports. The mine will employ around 250 people directly, with additional indirect employment.

1.4 The economic value of critical resources to the UK economy is difficult to quantify precisely

"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 and utilities (38%) and infrastructure (36%) sectors followed the automotive industry closely with a share of over 25% in terms of usage by weight." PWC, Minerals and metal scarcity in manufacturing: the ticking timebomb

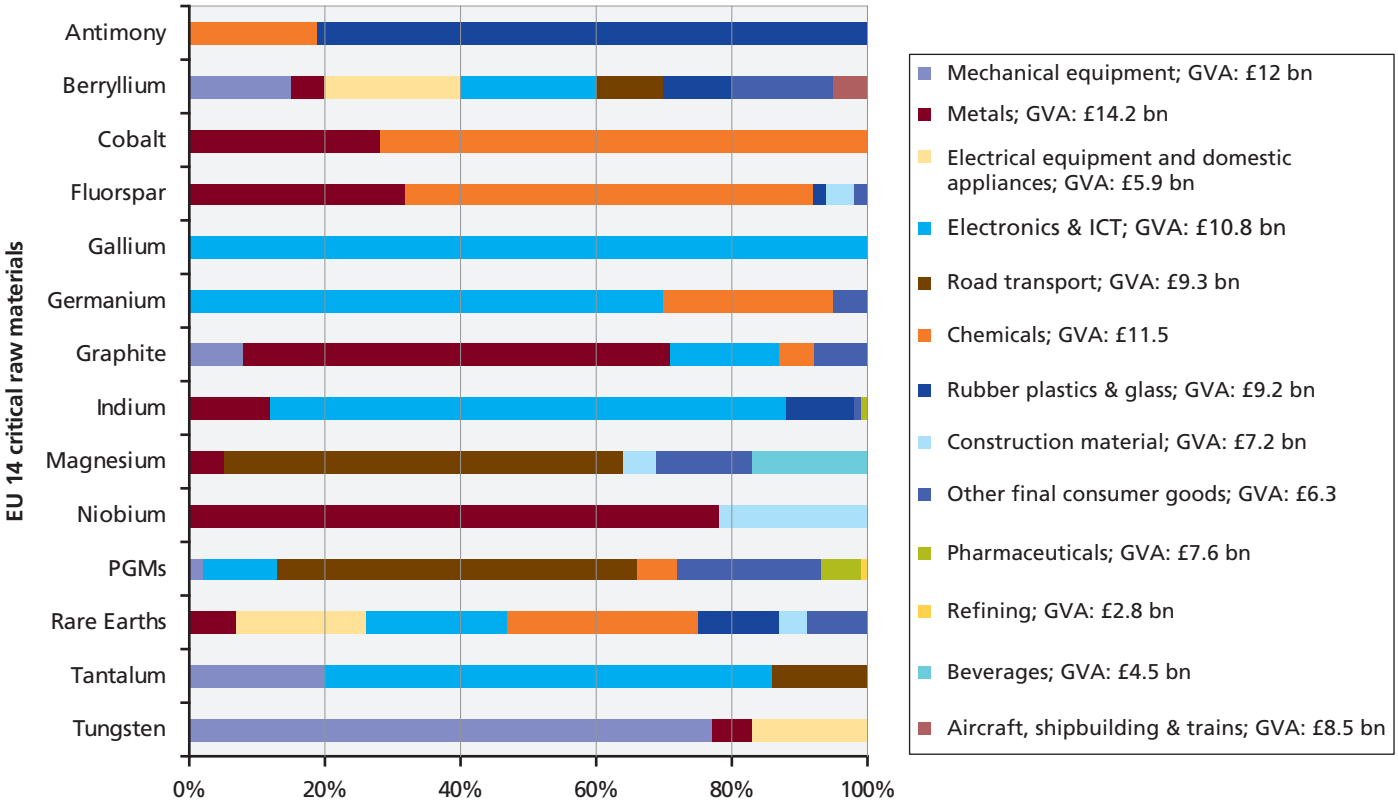
23. In order to better inform policy and decisions by business on raw materials supply, it is important to have a good understanding of the direct and indirect contribution to the economy of critical raw materials and the potential impacts of interruption in supply. Official data on the value of critical materials is typically limited to import/export data which restricts our understanding of the true 'value added' of critical materials.

24. Critical materials are present in a wide range of products across many sectors of the economy. In many cases they appear in relatively small quantities, but they frequently perform essential functions, often in high value goods or strategic technologies.

25. Figure 3 shows how each of the EU critical materials are used by sector and the gross value added that the whole of these sectors contributed to the UK economy in 2008. Figure 4 illustrates how one material – magnesium – is used across a wide range of products and sectors.

24 `Report of the Ad-hoc Working Group on defining critical raw materials (2010), Critical raw materials for the EU'

Figure 3: The sectoral use of the EU critical 14 raw materials as a proportion of their total use in the EU and 2008 UK GVA of 'Megasectors'[25]



26. Shifts in technology can contribute towards a change in demand for critical materials. This is exemplified by the shift towards clean and energy efficient technologies which has led to an increase in demand for certain raw materials and is expected to continue to drive demand in this area.[26] If new technology is crucial to the economy, supply disruptions can have wider economic implications beyond price increases if substitution is difficult or impossible.

27. A global market exists for some critical raw materials and supply chain managers may already assign values to critical materials reflected by the commodity prices listed on the exchanges. Many businesses will have developed their own ways of assessing criticality and risk.

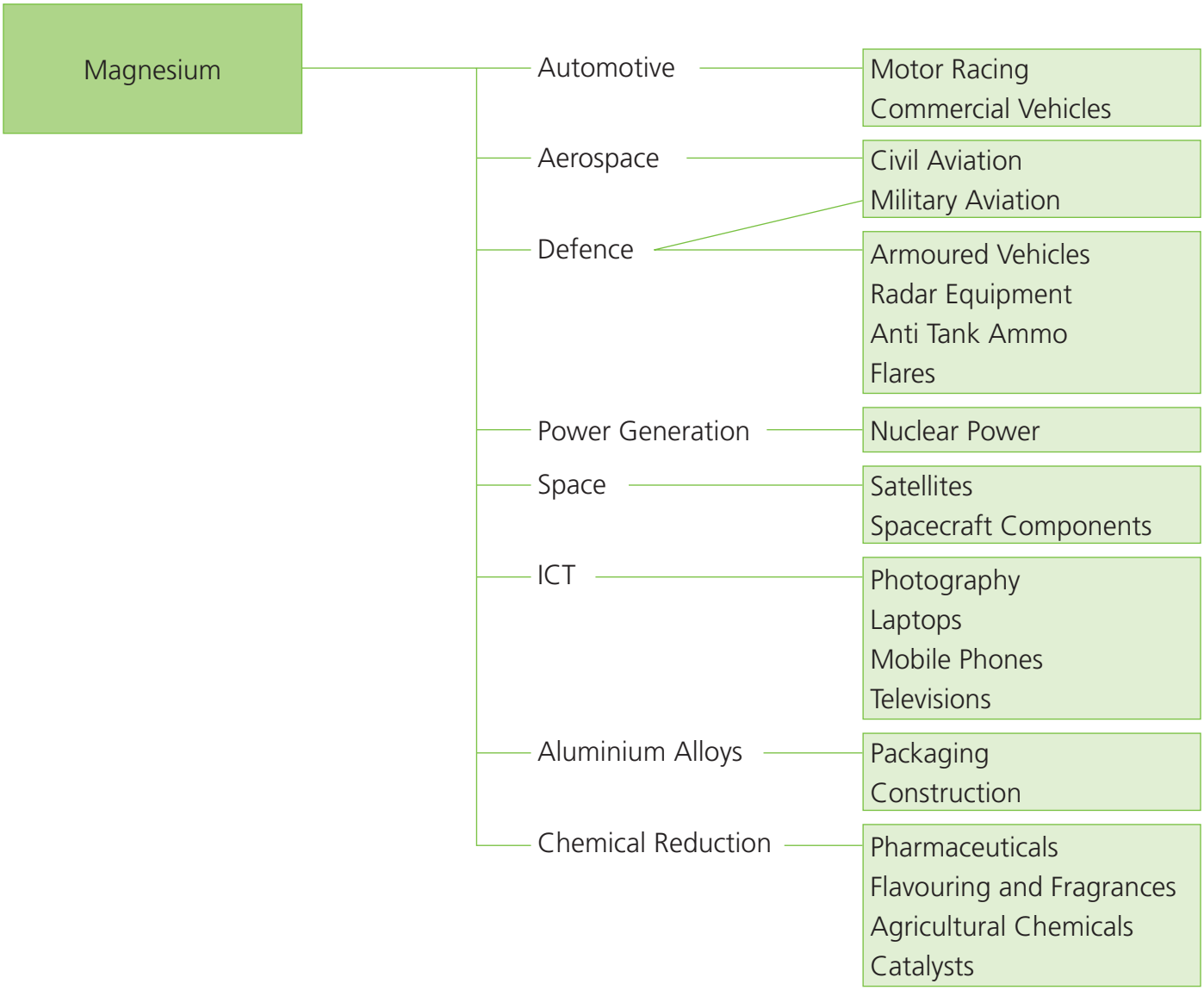
    "A recent Eurobarometer survey of European entrepreneurs found that 75% have seen the material costs of their businesses increase in the past five years, with 26% seeing a dramatic increase. 87% said they expect prices to continue rising over the next decade." CBI, Made to Last.

28. Improvements in data collection and availability could make valuation of critical materials easier in future. This underscores the need for a better understanding of materials flow (see section 2.2).

25 BIS Analysis. Sectors used here are defined as the 'Megasectors' in the EU report on criticality (2010). For information on what is included see annex II of the EU report. The proportions of critical materials used in each megasector are as specified in the EU report annex document. These proportions were estimates allocated by the panel for the purpose of calculating the 'economic importance' indicator.

26 BGS (2011) Rare Earth Elements profile sheet.

Figure 4: An example of sectors and industries using magnesium[27]



1.5 Some UK sectors are particularly exposed to resource risks

29. It is important that businesses assess their own particular resource needs and the risks they may face. They must consider not only their direct resource inputs but the indirect ones that they utilise in the form of purchased components and equipment. In looking at UK resource risks, a study for Defra[28] identified a number of other resources that might be of concern for particular sectors (summarised in table 3). These are only a snapshot and were the views of the stakeholders concerned expressed at workshops and during interviews, but they provide an illustration of the wider types of resources that UK businesses may need to think about in their operations when looked at from a sector perspective.

27 Source: BIS

28 AEAT for the Department for Environment, Food and Rural Affairs (2011) Review of the Future Resource Risks Faced by Business and an Assessment of Future Viability.

Table 3 – Examples of potential sector specific resources

Sectors	Resources identified by desk research	Additional resources identified in sector business discussions
Construction	Aggregates	Iron and Steel
	Timber	Mineral Sands
	Lead	Glass
	Copper	Cement
Automotive (vehicle production)	Rare Earths	
	Lead	
	Lithium	
	Cobalt	Tungsten
Electronics and IT Hardware	Rare Earths	Chromium and Chromic Oxide
	Indium	Rhenium
	Copper	Magnesium
	Lithium	Nickel
	Tin	Tantalum
Mechanical, electrical and process engineering	Tin	Niobium
	Rare Earths	Gallium
	Indium	Platinum Group Metals
	Cobalt	
	Copper	
Food and Drink	Palm oil	(Many food-specific issues)
	Fish	Soya
Agriculture	Phosphorous	
Cosmetics	Palm Oil	
Chemicals	Tin	Yellow Phosphorous
	Cobalt	Silicon Carbide
	Phosphates	Fluorspar
	Rare Earths	Molybdenum
		Antimony

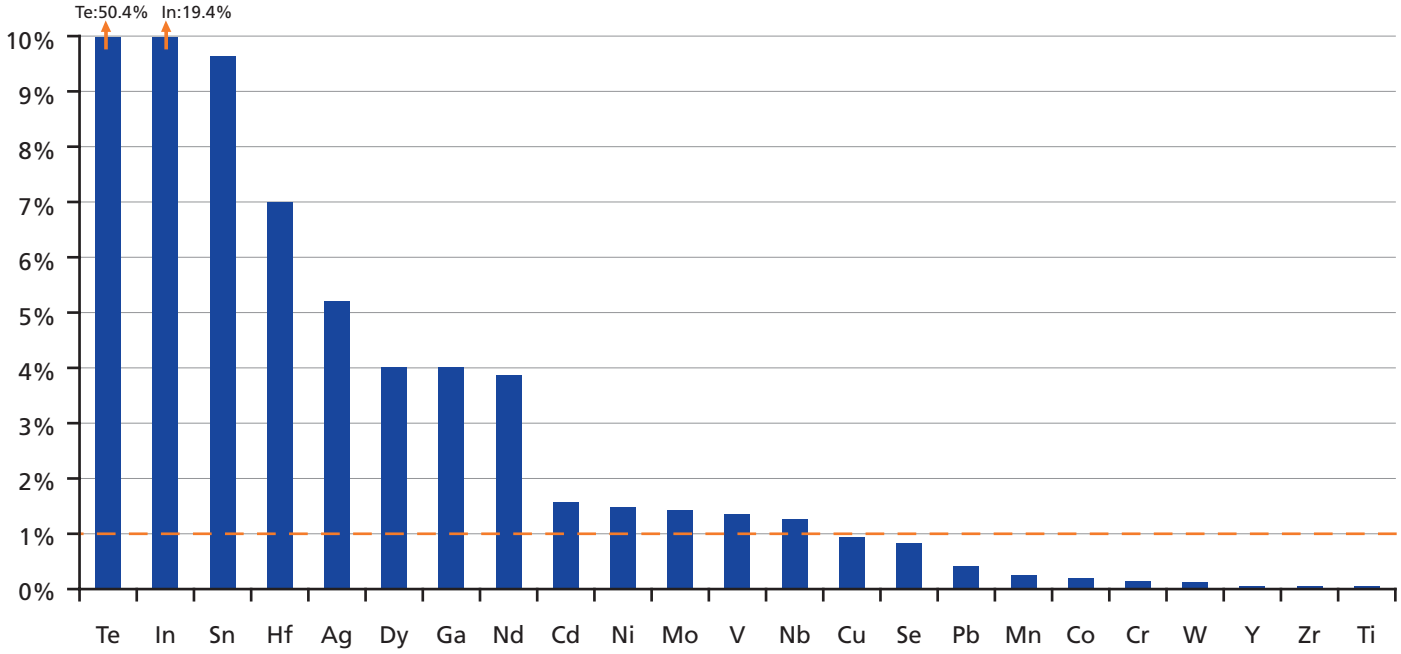
1.6 Future demand for critical materials

30. It is difficult to predict future resource needs with any certainty given the huge range of influencing and response factors, such as the global economic situation, the technological and social response to temporary shortages of resources, the uptake of more resource efficient solutions, secondary production (remanufacturing,[29] re-use and recycling) and long-term trends in consumption.

29 Remanufacturing is defined by the British Standards Institute in BS8887: Part 2 as "returning a used product to at least its original performance with a warranty that is equivalent or better than to that of the newly manufactured product"

31. But it is useful to consider potential future resource demand for policies (for Government) and investment decisions (for businesses). A recent Joint Research Centre study[30] looked at whether material shortages could jeopardise the objectives of the EU's Strategic Energy Technology Plan. The study examined the average annual demand for metals needed for the deployment of six key low carbon technologies in Europe between 2020 and 2030, compared to the global production in 2010 (Figure 5). The report pinpoints five of the fourteen metals identified to be at high risk; neodymium and dysprosium, indium, tellurium and gallium.

Figure 5: Metals requirements of Strategic Energy Technologies – Plan in 2030 as % of 2010 World Supply



32. Other studies[31,32] have also examined the role of rare earth elements and other materials used in clean energy technologies and low carbon vehicles. These identified concerns around five rare earth elements (dysprosium, neodymium, terbium, europium and yttrium), as well as indium, in the short term.

33. Those businesses who are more aware of their resource risks are already taking actions to modify their own future demand in design and investment decisions. But Government has a role in helping to ensure critical materials are reused and recycled to help meet that demand, for example, in looking at existing producer responsibility arrangements to see how they can better promote extraction of essential materials of all types from products, and provide manufacturers with an incentive to re-use and remanufacture products at end of life. It is important that Government and its agencies work with business to ensure that new primary production helps reduce risks, by diversifying supply, reducing environmental impacts and improving the social impacts of further extraction.

30 Joint Research Centre (2011) Critical Metals in Strategic Energy Technologies
31 US Department of Energy (2010) Critical Materials Strategy
32 Oakdene Hollins for DfT and BIS (2010) Lanthanide Resources and Alternatives

Box 5: Business taking action to reduce their exposure to resource risks

- GE use a metric to assess their vulnerability to supply disruption of raw material inputs and inform future decision making. The indicator includes consideration for the impact that a supply restriction would have on GE's revenue and ability to substitute.
- Rhenium is used as a strengthener for superalloys which are used in a variety of applications including turbine engines. To manage potential risks to supply of this material GE looked at reducing use and waste through recovering Rhenium from grindings, recycling from returned parts and the development of new superalloys with reduced amounts of the element.

1.7 There are wider economic and environmental opportunities in the more sustainable management of resources

"It is increasingly evident that resource efficiency – that is, the systematic reduction in the quantity of resource employed to produce goods and services in the economy – will be one of the key determinants of economic success and human well-being in the 21st century". Aldersgate Group, Beyond Carbon

"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." PwC, Minerals and metals scarcity in manufacturing: the ticking time bomb

34. Many of the approaches to mitigating the risks to resource use present **financial and environmental opportunities** for UK businesses and the economy. These can broadly be categorised as optimisation strategies, such as more resource efficient production techniques to reduce costs and improve competitiveness, and opportunities for growth in new markets, i.e. for entirely new technological or service solutions.

35. Through optimisation UK businesses can save around £18bn annually from the more efficient use of materials and minimising waste.[33] There are also new business opportunities from creating and making better use of secondary sources of supply. Many key materials may be discarded during production processes, and even greater amounts exist in products that may otherwise end up in landfill at the end of their life, or are stored away in homes and businesses. Some of the critical materials will be in the products and equipment that are imported into the UK and although there has been no detailed study of the material flow for these elements, these 'invisible imports' are a potential future source of local supply (if viable recovery processes can be demonstrated). Increasing collection, re-use and recycling of these materials will mean that we can reduce reliance on primary extraction, give the UK greater control and independence in terms of materials supplies, and reduce greenhouse gas emissions and other environmental impacts.

33 Oakdene Hollins for the Department for Environment, Food and Rural Affairs (2011) The Further Benefits of Business Resource Efficiency.

36. Research for WRAP has examined the extent to which 13 'quick-win' resource efficiency strategies that reduce UK GHG emissions could also reduce the UK's water use, reliance on specific materials and ecological footprint. These strategies include approaches such as lean production, lifetime optimisation, shifting towards selling services rather than goods and materials substitution. The report found our reliance on some specific materials, such as rare earths, cobalt and lithium, could be reduced by 10-25% by 2020 through implementing these strategies.[34]

37. To encourage more joint working across the supply chain Defra is working with the Environmental Services Association which is developing a code of practice for Materials Recovery Facilities (MRFs). This code of practice will see increased information and transparency to MRF customers (local authorities and reprocessors) on information such as quality and contamination levels of recyclates. This will help the supply chain to operate more efficiently, increasing visibility of where waste and recycling ends up, potentially increasing the capture rate and the quality of recyclates.

38. Although improving use of resources will not significantly affect the overall prices of resources (as they are traded in a large global market), improved use will lead to a reduction in the cost of inputs UK businesses face to produce a given output. Research[35] has shown that there are a range of barriers associated with improving resource efficiency and that these may become more apparent in SMEs. For some resource efficiency opportunities, businesses will have made rational decisions not to take them up (as the costs are real and the appropriate trade-off has been made – e.g. due to associated financial and time costs, such as management and training, that outweigh the potential savings over time). However, there are also opportunities where the benefits of action will justify the costs, and Government can seek to intervene to help businesses address behavioural barriers to realise the resource efficiency gains – for instance by helping them to tackle:

    - perception of high up-front costs;
    - difficulties in calculating the balance of costs and benefits over time, as the information available is too complicated to make fully rational decisions;
    - lack of prioritisation to address an issue within a company.

34 WRAP (2010) Securing the Future
35 Oakdene Hollins for the Department of Environment, Food & Rural Affairs (2011) The Further Benefits of Business Resource Efficiency.

Box 6: Business taking action to realise economic value from re-use and recycling

- Veolia Environmental Services plan to extract precious metals from road dust to reclaim platinum, palladium and rhodium deposited by catalytic converters for recycling. Around £80,000 worth of palladium is expected to be extracted from 30,000 tonnes of dust.
- SITA UK, a recycling and resource management company has developed a new facility at Willenhall that will process 50,000 tonnes of road sweepings a year. An estimated 98% of the material passing through the plant will be recycled for various uses in sand, washed aggregate and compostable material.
- A joint venture between Coca-Cola Enterprises Ltd and ECO Plastics will more than double the amount of high-quality recycled PET (Polyetheylene terephthalate that is recycled to make food-grade, sustainable packaging) currently produced in Britain. Used packaging will be sorted at ECO Plastics recently expanded recycling plant, the largest of its kind in Europe, for reprocessing at the joint venture facility, before being reused in domestic packaging. The collaboration will help Coca-Cola meet its aim to reduce the impact of its packaging, maximise use of renewable, reusable and recyclable resources, and drive towards its goal of 100% sustainable packaging by 2020.

39. Many of the techniques for **recycling** of critical materials are in their infancy. But there are examples where integration along the supply chain has resulted in reduced demand for imported primary metals (for example in the recovery and recycling of Nickel and Cobalt alloys in the aerospace sector).

    "In Europe, almost 80% of senior executives from global manufacturing companies cite mineral and metals scarcity as a pressing issue and 67% see this evolving into an area of opportunity, including the possibility of adopting alternative approaches or substitutes. In fact, having the ability to substitute technologies for those not requiring the use of critical raw materials is the most frequently cited requirement to mitigate the effects of mineral and metal scarcity". PwC, Minerals and metals scarcity in manufacturing: the ticking time bomb

40. While being more resource efficient with critical materials can have a strong effect in reducing risk it is important to consider sustainable **substitution** (box 7). Criticality is a driver for the development of alternatives, and in assessing criticality the substitutability of the material is an important consideration.

Box 7: Substitution of materials

There are two ways of substituting for specific materials – direct and indirect.

Direct substitution occurs where a material is replaced by another. It is rare for a straight simple replacement to be possible because these elements have been selected because their specific properties provide some advantages. But in some cases substitution is possible; if there was a shortage in the supply of Tellurium for the manufacture of cadmium telluride (Cd/Te) photovoltaic systems it would be possible to revert to silicone-based systems even if these delivered a slightly lower efficiency. In Japan long-term research programmes have been adopted to focus on the reduction in the demand for critical metals such as indium, rare earth elements, tungsten and platinum group metals.

The alternative to direct substitution is **indirect substitution** where instead of looking for a material to substitute for the critical element an alternate technology is developed which does not require the use of the critical element. For example, the University of Tokyo has developed an alternative electric motor type that can be used in conjunction with Lithium batteries for electric vehicles. The motor does not use rare earth elements.

41. For some materials on the EU critical raw material list, potential substitutes (for given applications) are close to market while for other uses no substitute is obvious. To reduce the risks in the development of alternatives, substitution forms part of the Technology Strategy Board's Resource Efficiency strategy[36] and critical materials have been a topic of a recent funding competition,[37] and will be an important component of future calls. The strategy recognises the opportunity for UK companies to help address these areas and to develop and open up new markets by commercialising new techniques and solutions (box 8).

Box 8: The UK is well positioned to develop new materials which offer enhanced performance/reduced environmental impact

- One such example is graphene, a technology in which the UK is a world leader. The UK will be building on this position with a £50m investment in a Graphene Global Research and Technology Hub, which will accelerate the development of commercial applications for this new material.

42. Substitution can also reduce risks from hazardous materials. For example substituting some of the cobalt in rechargeable batteries for a cobalt-manganese-nickel compound could minimise the risk of release of toxic substances, reduce the risk of overheating and also bring down the price and weight. This substitution could ensure cobalt demand remains stable or decreases even in the face of increased demand for these batteries. The use of hydrogen fuel cells in batteries could also reduce reliance on cobalt.[38]

36 Technology Strategy Board (2009) Resource Efficiency Strategy 2009-2012.
37 Technology Strategy Board (2011) Resource Efficiency: Supply Chain Innovation, competition for collaborative R&D funding
38 BGS (2011) Cobalt mineral profile sheet

43. New business models that allow companies to retain ownership or incentivise take back of products or materials for re-use or remanufacture could offer alternative sources of supply and new sources of revenue through repair, refurbishment and maintenance.[39] For example, there may be opportunities in providing services to businesses or consumers rather than one-off product sales (box 9). Moving from a product focus to a service and maintenance focussed approach may also yield customer relationship, reputational and social benefits.

    Potential benefits include:

    - reduced expenditure on materials and products;
    - reduced exposure to materials supply risks;
    - incentives for better design;
    - better brand image;
    - environmental benefits, including reduced greenhouse gas emissions, and air and water pollution impacts;
    - repatriation of some jobs from overseas manufacturing to UK based service delivery; and
    - longer term customer relationships through moving from one-off sales into areas such as product maintenance, leasing or take-back.

44. While the focus of this Action Plan is on metals and minerals, a wide range of other resources are important to the UK economy, and are the focus of other work. For example, the National Ecosystem Assessment[40] demonstrated that benefits provided by the natural environment can be of major importance to UK businesses and our economy.

39 WRAP (2011) The Benefits of Reuse
40 UNEP-WCMC, Cambridge. (2011) UK National Ecosystem Assessment: understanding nature's value to society synthesis of the key findings

Box 9: Benefits of 'circular economy' business models

Research for the Ellen MacArthur Foundation[41] found that adopting innovative business models can provide short-term cost benefits, longer-term strategic opportunities and new profit opportunities in services (e.g. collection, sorting, funding and financing of new business models).

Service offering is increasingly common in high-performing manufacturing sectors. According to an EEF and BDO survey in 2008,[42] two-thirds of companies are offering services on the back of production activities in order to retain customer loyalty, add profitability and distinguish themselves in the marketplace. In some cases, firms are offering a whole-life service to customers, from design and development through to manufacture and maintenance and ultimately to disposal. EEF's research found that complete solutions such as these offer the greatest revenue potential, on average accounting for 14% of turnover. However it was larger companies who were more likely to be realising the full benefits of such services.

Examples include:

- Making smartphones last longer through a combination of initiatives, such as changing product design, improving treatment technologies, and establishing incentives to boost the collection rate. These could reduce treatment costs for refurbishing smartphones by as much as 30%, making new business models more attractive.
- Chemicals leasing. Here a supplier is paid not on the amount sold but on the services provided by the chemical, turning the traditional business model on its head. Higher consumption becomes a cost to chemical suppliers. Instead of selling a client a quantity of chlorinated solvents for metal cleaning, it invoices for each square metre of metal cleaned. Rather than selling tins of paint, it charges for items of furniture painted. This means the commercial interest is not to maximise chemical use to drive higher earnings. Instead, increased consumption of a chemical increases a supplier's costs, not its revenues. Approaches such as these can deliver environmental benefits and financial savings for both suppliers and buyers.[43]
- Caterpillar Inc's (CAT) remanufacturing business model is based upon the incentivising of customers to return worn out products via its dealer network through a financial deposit system. The total invoice includes a deposit for the end-of-life product being replaced – when the product is returned, so is the deposit. On average, Caterpillar takes back over two million pounds weight of material from end-of-life products per year.
- Once received at CAT the products are disassembled down to the smallest part and each element cleaned and inspected against strict engineering specifications to determine if it can be remanufactured. Elements which pass the inspection are then salvaged using advanced technologies. The salvaged parts are assembled into CAT Reman products, which include applicable engineering updates. Each CAT Reman product is then tested, painted, and given a warranty equal to that of a new part. The offered products are the "same as when new" quality and frequently available at less than half of the new cost of similar items.

41 Ellen MacArthur Foundation (2012) Towards the Circular Economy: Economic and Business Rationale for an Accelerated Transiton
42 EEF The Manufacturers' Organisation (2008) Manufacturing Advantage – changing the ground rules of global competition
43 Ends (2009) Time to rent chemicals rather than buy

SECTION 2: Acting in Partnership – Current Activity and Future Action

Box 10: Overview of key new actions

- **Innovation Challenge:** Defra will fund an Innovation Challenge Fund for local economy closed loop projects in 2012-13. Coordinated by the Technology Strategy Board (TSB) through the Small Business Research Initiative (SBRI), this will establish the feasibility of new approaches enabling local businesses to extract value from domestic and commercial waste streams (i.e. through re-use and recovery). This should encourage partnerships between business, local authorities and local communities. (Lead: Defra with the TSB)
- The Government will investigate the feasibility of applying the principle of **Individual Producer Responsibility** (IPR) more generally to the Waste Electrical and Electronic Equipment (WEEE) system. (Lead: BIS)
- The Government will work to support UK businesses by extending **data capture of waste electrical and electronic equipment** being treated by waste management companies and other players outside the current 'WEEE system'. (Lead: BIS)
- **A new critical resources dashboard will be launched:** The Environmental Sustainability Knowledge Transfer Network (ES KTN) together with the British Geological Survey and other partners including Waste and Resources Action Programme (WRAP), BIS, and Defra will develop and test a 'critical resources dashboard'. This will seek to better provide companies with information they need to take more informed decisions on the resource risks to their operations, to be launched by the end of January 2013. (Lead: Environmental Sustainability KTN)
- **Development of a materials flow analysis, initially for WEEE 'hot spots':** WRAP will develop a high level critical materials flow analysis in key WEEE product categories. (Lead: WRAP)
- **Demonstration trials:** WRAP will conduct demonstration trials to highlight the potential to improve recovery of critical materials through the WEEE treatment process. (Lead: WRAP)
- **A new industry-led consortium,** convened by the Green Alliance, will bring together interested businesses and business groups to provide a mechanism to further develop links between government, business and other organisations to address resource opportunities and concerns, to disseminate leadership thinking and best practice and to provide a forum for policy innovation. (Launch by May 2012) (Lead: Green Alliance)

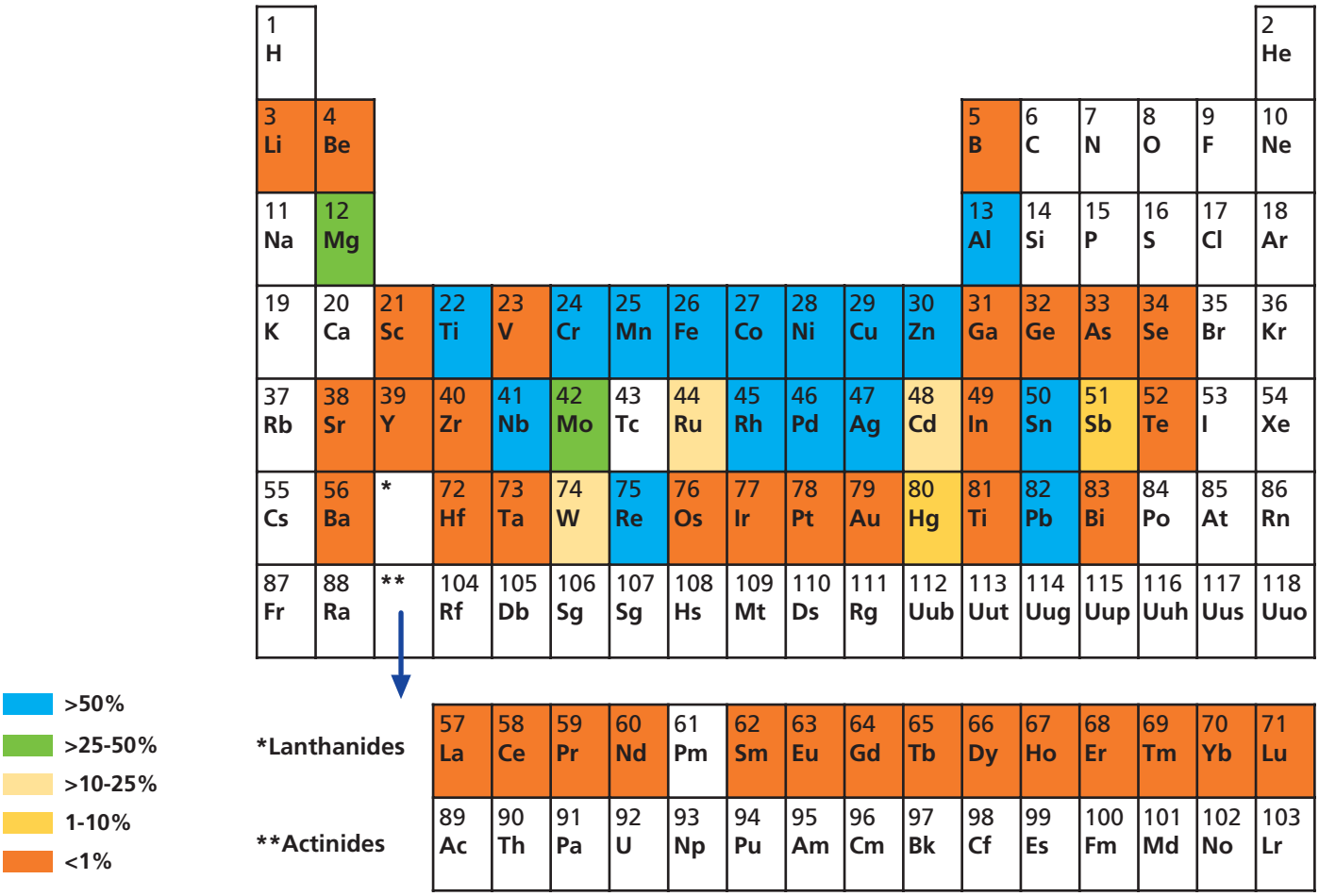
2.1 Overcoming barriers and promoting improved efficiency, re-use, recycling and recovery of critical resources

45. The main barriers to improved resource efficiency, re-use, recycling and recovery of resources are documented in the recent Government Review of Waste Policy in England.[44] But there are some acute challenges when it comes to some of the more critical resources.

44 Defra (2011) Government Review of Waste Policy in England.

46. The United Nations Environment Programme (UNEP) International Resource Panel[45] has identified global recycling rates of less than 1% for a range of critical metals (Figure 6), and we would expect a similar picture domestically. In many cases technologies exist to recover and recycle critical metals to purity levels required for re-use, although for some of those metals and minerals which have only relatively recently become widely used recycling technologies are still quite new with limited commercial application. However, the main barriers are the **dispersal** of such metals where very small quantities exist in huge numbers of items of electrical and electronic equipment, e.g. on printed circuit boards, and the difficulty in establishing the **commercial value** of recycling given the **practical difficulties** of collection and separation of high value metals.

Figure 6: Global end of life recycling rates for 60 metals



45 UNEP International Resource Panel (2011) Recycling Rates of Metals, A Status Report. Key to elements names and abbreviations in annex.

"Given the widespread concern about raw materials shortages, it is perhaps unsurprising that nearly six in ten companies are taking action to manage supplier relations. This may involve increased collaboration, forward planning or indeed looking to increase the number of suppliers and source from multiple vendors." EEF: the Manufacturers' Organisation, Executive Survey 2012[46]

47. The simplest way for businesses to manage the risk is to make the most efficient use of their critical resources. Additionally by increasing their interest in maintenance and repair, product take-back, upgrade and remanufacture, businesses in the UK can minimise the risk from being overly reliant on supplies concentrated in particular areas of the world, and reduce environmental impacts by reducing the need for primary extraction. The development of maintenance, refurbishment and remanufacturing operations has wider economic benefits for the UK. It can provide opportunities for new and existing companies as well as new employment opportunities. And it has the potential to realise some of the value currently being lost to the economy through failure to recover critical materials.

48. Different businesses are taking different approaches to capturing more of the value in the critical materials they use.

- The most ambitious are taking opportunities to change their **business model,** by offering services or leasing rather than selling products, to create a 'closed loop' circular model, recovering some or all of their own products (see examples in Box 9).
- Other businesses and some social enterprises are **increasingly offering take-back services** to capture the economic value of products and their components. For example, with companies such as Tesco and charities collecting mobile phones.
- There are examples in the UK of **commercial partnerships between manufacturing and waste management companies to source used components which can be re-used in the manufacturing process from general waste streams.** For instance, environCom has a partnership with Dixons Group for WEEE recycling and re-use. There may be scope for developing more relationships of this sort in the UK.
- There are examples from Japan[47] of **'resource cycles' being formed on a regional or local area basis** where there is a concentration of a particular type of business. In the UK the Industrial Symbiosis programme under WRAP has put businesses together bilaterally to use one company's waste as another's resource, while the 'SE7' partnership of local authorities in the South East are exploring options to work together on a regional basis to increase the re-use and recycling of WEEE. And some Local Enterprise Partnerships, such as New Anglia, are developing regional approaches to green economy issues.

49. In line with other EU Member States the UK has a collective producer responsibility scheme for Waste Electrical and Electronic Equipment under which producers are apportioned the end of life recycling and final disposal costs of their equipment according to their market share. Individual Producer Responsibility is intended to create a greater economic incentive for producers to design their products with sound waste management in mind.

ACTION: The Government will investigate the feasibility of applying the principle of Individual Producer Responsibility (IPR) more generally to the WEEE system. (Lead: BIS)

46 EEF: The Manufacturers' Organisation (2012) Executive Survey 2012.
47 Ministry of Environment, Japan (2008) The World in Transition and Japan's Efforts to Establish a Sound Materials Society.

50. The illegal export of certain waste streams, in particular end-of-life vehicles or WEEE, leads to the loss of critical materials from the UK and wider EU economy; it also has detrimental impacts on the environment and human health of the receiving countries. Combating illegal exports continues to be a priority for the Government and UK regulatory authorities and much effort and resource are being put into this issue with a number of prosecutions undertaken and in train. In taking this work forward, the Environment Agency will work closely with UK customs authorities, the shipping lines and overseas regulators.

ACTION: The Government will continue to encourage the Environment Agency, Scottish Environmental Protection Agency and Northern Ireland Environment Agency to prioritise combating the illegal trade in waste using an intelligence-led approach to target effort and resources onto suspected unlawful operators. Government will assist with the provision of a necessary legal gateway to enable the sharing of information between the authorities. (Lead: Defra)

Box 11: Waste and Resources Action Programme (WRAP)[48]

WRAP helps businesses, local authorities, Government Departments, civil society organisations and consumers to become more resource efficient. It delivers a number of programmes and activities to improve resource efficiency, including:

- A Waste Prevention Loan Fund in England to support organisations wishing to introduce business models and processes which make more efficient use of material resources.
- An Industrial Symbiosis programme to develop collaborative approaches between companies or organisations so that the waste products of one can be used as the raw materials of the other.
- Voluntary agreements and responsibility deals to help stimulate businesses to work collaboratively to reduce waste and resource use across supply chains.
- Case studies, trials and best practice to help raise awareness of the opportunities to business.

51. The Government is developing a Waste Prevention Programme which encompasses re-use. During the programme's development, Government will work with stakeholders to address the barriers and highlight opportunities for re-use. The Government is also encouraging more careful collection of waste and sorting for re-use, by local authorities through the Bulky Waste Guidance.[49] Such waste can typically include items such as white goods and small and large WEEE.

The EU Registration, Evaluation, Authorisation and Restriction of Chemicals

52. The EU Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) legislation provides a single regulatory framework for the control of chemicals – including critical metals. The UK Competent Authority for REACH provides information and advice to businesses and this will remain a priority, particularly for SMEs, as registration deadlines in 2013 and 2018 approach.

48 In Scotland, known as Zero Waste Scotland
49 WRAP Bulky Waste Guidance

53. The European Commission is currently carrying out a review of a number of aspects of REACH, including 'lessons learnt' from the first registration deadline in 2010, the functioning of the European chemicals market after the introduction of REACH, and the impact on the innovativeness of the EU chemical industry. The Commission's report and conclusions will be published in June 2012 and will then be the focus for further examination and discussion with Member States, industry and other stakeholders. The Government has listened to the concerns of industry, particularly smaller businesses, regarding the costs of implementation. So in light of the Government's Red Tape Challenge the UK will wish to focus in particular on reinforcing the aim of fair distribution of costs amongst companies, especially SMEs.

54. At the same time the Government is working with UK industry bodies to gather accurate information about the impacts of REACH to develop our position on this review to ensure that it provides the most appropriate business and environmental approach to the issues without sacrificing the aims of the Regulation.

ACTION: The Government will look for opportunities to streamline the working of REACH across the EU including reducing costs to businesses. The Government will assess how REACH has improved both the knowledge of hazards presented by chemical substances, including metals, and the effective management of risk in the supply chain. (Lead: Defra)

Standards

55. Environmental product standards are used to describe the changes we want to see in products, in order to deliver environmental outcomes. Many different standards have been developed and publicised for a huge range of products, as summarised in table 4.

56. Waste prevention criteria are already included in some product standards. **Government's objective is to bring better resource use criteria into the mainstream, so they are routinely included in the range of minimum and best practice product standards.** For example, with Government Buying Standards,[50] this can mean developing criteria that aim to reduce demand for new products in the first place (e.g. the standards require a 5% re-use target for furniture before purchasing new), or through buying products that are easily separable and upgradeable. New Government Buying Standards for IT products require that plastic parts are free from metal inlays or have inlays that can be removed with commonly available tools and that upgrading can be carried out (e.g. with processor, memory cards or drives).

57. The Government will continue to focus on non-regulatory approaches such as voluntary standards where possible, to better ensure action is focused higher-up the waste hierarchy where there is greatest value to UK businesses.

ACTION: The Government will use the re-cast of the WEEE Directive to give a fresh impetus to the re-use of electrical and electronic equipment through the promotion of standards for re-use (e.g. BSI PAS[51] 141 and the voluntary industry standard for re-use WEEELABEX[52]). (Lead: BIS)

50 Government Buying Standards
51 British Standards Institute
52 WEEE Forum

Table 4: An overview of product standards

Standard	Level of challenge	Countries	Products covered
EU Ecodesign Directive standards for energy using products	Minimum mandatory	EU	Energy using products, widening to energy related.
EU Energy Labelling Directive standards	Information mandatory	EU	Energy using products, widening to energy related.
Government Buying Standards	Minimum mandatory and best practice	National	Key products that Government buys.
ISO standards, including 14000 series for lifecycle analysis	Best practice	International	Large range of products and processes. Environmental issues feature in several process standards, not so much product standards.
EU Ecolabel standards	Best practice	EU	26 varied products, more in development.
BSI standards (including PAS141 on the reuse of waste electrical and electronic equipment)	Best practice Framework	National National	Large range of products and processes. Environmental issues feature in several process standards, not so much product standards. A framework for the concepts, techniques, tools and methodologies that can be used to support decisions surrounding the sustainable use of materials.
Independent standards e.g. Green Guide /BREEAM, on pack recycling label, FSC timber, MSC fish, EST recommended, Carbon Reduction Label, Organic, Fairtrade, EPeAT	Best practice	National	Various individual products – construction, packaging, timber, fish, energy using products etc.
Testing standards	Linked to compliance testing	EU and international	Large range of products and processes.

ACTION: The Government will continue to work to ensure a level playing field through fewer, but more stringent international standards. It will press for Implementing Measures under the Ecodesign for Energy Related Products Directive to address more efficient use of resources (including critical raw materials).

Skills

58. The Government report 'Skills for a Green Economy'[53] identified the skills needed to support the transition to a strong and sustainable green economy. The report assessed the evidence of employer demand and potential responses from the skills system which will lead to these skills being delivered. The six recommendations of the report offer a clear statement of Government intent, but allow partners the flexibility to shape them to industry need. The Government's approach is to put learners and employers in the driving seat, giving them the support, funding and information to make the right choices and to help employers shape the skills system.

59. The Institute of Environmental Management and Assessment (IEMA) has worked with the EEF, the Manufacturers' Organisation to deliver skills to people in manufacturing, linked to a professional qualification. IEMA has developed a Skills Map[54] that sets out the skills that individuals with environmental responsibility require. It is being used by companies to look more strategically at environmental skills to support the transition to a low carbon, resource efficient and sustainable economy.

Reducing Metal Theft

60. Metal theft continues to rise, in part driven by high commodity prices. There were between 80,000-100,000 police recorded metal theft offences in 2010/11 and figures from 18 police forces in 2011 showed a 56% increase in offences for the first six months of the calendar year compared to the same period in 2010. Theft causes significant disruption to our transport and communication networks. To counter this problem the Government announced the setting up of a £5 million metal theft task force to be co-ordinated through the Association of Chief Police Officers and involving key organisations such as the Environment Agency. The Government has also announced it will lay amendments to the Legal Aid, Sentencing and Punishment Bill that will prohibit the cash purchase of scrap metal and increase the penalties under the Scrap Metal Dealers Act 1964. Further measures will be brought forward in due course as the Government considers whether a new or amended robust licensing system for scrap metal yards to replace the 1964 Act might be introduced.

2.2 Improving the provision of information for businesses

"The other external and more significant risk identified by over 80% of manufacturing executives was a shortage of raw materials. This risk is pervasive, with the same proportion across all sizes of company and industry sectors seeing this threat. Indeed two thirds of companies say this will be the top risk to their business plan this year… being unable to secure or fulfil orders or indeed, having to run at less than optimal capacity is a real and tangible outcome due to a lack of raw materials." EEF: the Manufacturers' Organisation, Executive Survey 2012

53 HM Government (2011) Skills for a Green Economy, a report on the evidence
54 IEMA (Institute of Environmental Management and Assessment) Skills Map

61. One of the main barriers to business action is a lack of awareness amongst businesses of the risks around the resources they use, the potential for interruptions to supply and the alternative approaches they may take. Evidence demonstrates this is a particular issue for some Small and Medium Sized Enterprises.[55,56] While large companies have the resources and ability to research and assess longer term risks to their operations, smaller companies can find this more difficult. This means they may not be aware of potential interruptions to supplies, new technological developments that may increase competition for existing supplies, or of emerging environmental and related reputational concerns.

62. The length and global scope of the supply chains for many products can exacerbate these problems, with those further from the original source potentially less aware that components or supplies of products may be affected by risks elsewhere.

A resources dashboard

63. The House of Commons Science and Technology Committee,[57] and business bodies such as the Aldersgate Group[58] have called for a dashboard or database to raise awareness and help companies understand the risk and issues associated with the security of materials. To bring together in one place available information on mineral raw materials, the Environmental Sustainability Knowledge Transfer Network (ES KTN) and the British Geological Survey (BGS) are working to develop an online service for use by companies to identify materials supply and other risks by major product/component categories. The initial development of the Resources Dashboard has focused on key information that is required to inform businesses of the opportunities and threats resulting from the risk of supply disruption of specific resources.

64. A prototype dashboard has been designed so that businesses will be able to interrogate the data by either a specific mineral raw material, or a specific product category, and **is currently available as an online portal to encourage data entry by businesses.** Those with an interest in supporting and testing the development of this tool are encouraged to register at www.resourcedashboard.co.uk. This will help ensure the dashboard is interactive and will provide relevant and up to date information on products available in the UK. In parallel with data input from businesses, the project partners will collate data already available, such as case studies and new research information on opportunities for enhanced reuse of products and recovery of components and mineral raw materials, they will also generate new data for key products and mineral raw materials, in preparation for the launch of a more comprehensive product at the beginning of 2013.

ACTION: A new critical resources dashboard will be launched: The Environmental Sustainability Knowledge Transfer Network (ES KTN) together with the British Geological Survey and other partners including WRAP, BIS, and Defra will develop and test a critical resources dashboard. This will seek to better provide companies with information they need to take more informed decisions on the resource risks to their operations, to be launched by the end of January 2013. (Lead: ES KTN)

55 Oakdene Hollins for the Department for Environment, Food and Rural Affairs (2011) The Further Benefits of Business Resource Efficiency.
56 AEAT for the Department for Environment, Food and Rural Affairs (2011) Review of the Future Resource Risks Faced by Business and an Assessment of Future Viability.
57 House of Commons Science and Technology Committee (2011) Strategically Important Metals Inquiry
58 Aldersgate Group (2010) Beyond Carbon, Towards a Resource Efficient Future.

65. Longer term maintenance of a resources dashboard should not rest with Government. While it is right that the Government acts as a facilitator and enabler for its initial development, given market failures in this area, it should be taken forward by those best placed to act. Should business and industry find the dashboard a useful and effective tool then there is a case for it being taken forward by trade associations or business groups.

66. Defra, BIS, the BGS and the ES KTN will **monitor and evaluate** the use of the critical resources dashboard, and explore the potential for longer term industry ownership by April 2013.

67. As well as providing information on resource risk the dashboard will also offer pointers on how businesses can act on this information. Pricewaterhouse Cooper's recent 'checklist' offers an example of the actions for businesses to consider (box 12).

Box 12: Checklist – 10 "golden" questions to identify and prevent resource 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 given production process?

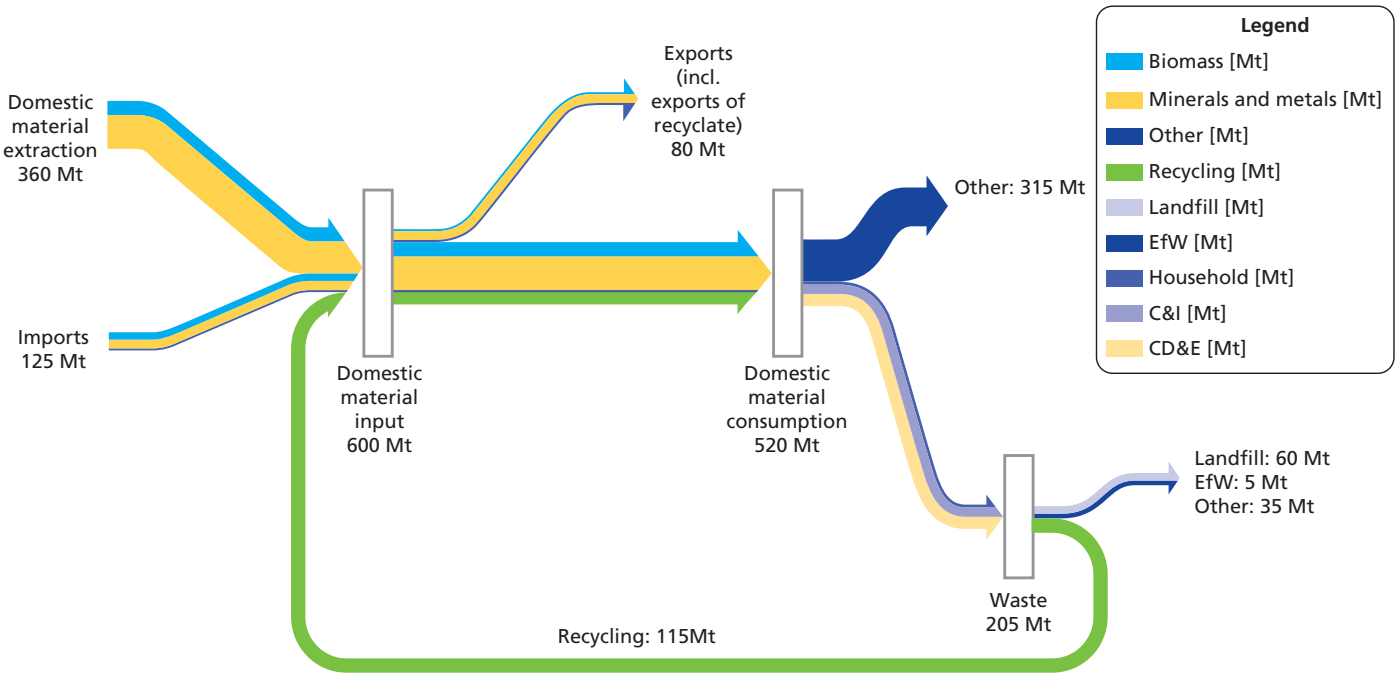
Source: Minerals and metal scarcity in manufacturing: the ticking time bomb, PWC 2011.

68. Large companies also have a role in leading by example and influencing those in their supply chains. Supply chain partnerships have been successfully piloted by WRAP on aspects of resource efficiency and similar approaches that include resource security aspects may be equally successful. The Government has launched the Advanced Manufacturing Supply Chain Initiative which aims to help existing UK supply chains grow and achieve world class standards while encouraging major new suppliers to come and manufacture here.[59] The new fund will support innovative projects in established UK advanced manufacturing sectors such as aerospace, automotive and chemicals. It will also target newer growth areas where the UK is well placed to take a global lead, such as energy renewables and other low carbon sectors.

Materials flow analysis

69. As Figure 7 shows, the UK economy is not a 'closed loop'. A significant amount of waste is still sent to landfill or sent abroad for treatment rather than recovered for re-use and recycling in the UK. But this is a very high level analysis, and does not provide an insight into the flow of critical or most valuable resources.

Figure 7: UK Materials Flow



Notes:

1. Other outputs include food and drink consumption (est. 35Mt), fixed assets and dissipative outputs to land and air.
2. Other disposal includes use on exempt sites (particularly for construction wastes).

Source: WRAP

70. A more detailed account of the amount, flow and value of critical metals and minerals would assist in the understanding of the opportunities for their recovery. It would allow the development of targeted policy approaches and assist companies in the waste industry to plan and invest for the longer term by helping them understand where materials are not currently

59 Technology Strategy Board Advanced Manufacturing Supply Chain Initiative

being recovered and the value of the amount lost in the system. It could also support the development of bilateral supply chain partnerships, or materials stewardship approaches, for example focussing on collection of redundant equipment for re-use and refurbishment.

71. Government's own research shows there is considerable potential to improve capture rates for critical resources, particularly from WEEE since critical metals and minerals are concentrated in these products, for example there are £350million worth of gold in all the EEE goods (Electrical and Electronic Equipment) we buy each year.[60] The Government will use this information to start development of a materials flow analysis for WEEE, to better identify risks and opportunities for UK businesses and waste companies in this sector.

ACTION: WRAP will develop a high level critical materials flow analysis in key WEEE product categories.

72. This will be added to WRAP's existing WEEE Market flows model, which estimates the flow of WEEE products through the treatment system. It will lead to the identification of potential opportunities to realise value through re-use, remanufacture and recycling and will support the resources dashboard and more broadly provide better information to businesses.

ACTION: WRAP will conduct demonstration trials to highlight the potential to improve recovery of critical materials through the WEEE treatment process and to help develop evidence on the value of changing technologies.

73. Supporting delivery of these objectives:

    a. WRAP will produce research to identify the largest resource efficiency and resource security benefits from alternative business models for electrical and electronic products. This will examine how scarce materials in existing products could be have a longer working life and will be published April 2012.

    b. A separate materials flow report on laptops, mobile phones, ICT, televisions and screens, and small household WEEE items will be published by May 2012. This will help develop the potential to recover scarce materials from these wasted products and provide the basis for further development of the materials flow analysis as data become available in future.

74. To better map materials flow, and to capture wider opportunities in the economy, it will be necessary to capture information beyond the current WEEE system.

ACTION: The Government will work to support UK businesses by extending data capture of waste electrical and electronic equipment being treated by waste management companies and other players outside the current 'WEEE system'. (Lead: BIS)

75. Businesses also derive value from the flow of natural resources and ecosystems. This is recognised in the Natural Environment White Paper,[61] which outlines the Government's vision for the natural environment over the next 50 years, with practical actions to help business, including:

    - Setting up a business-led Ecosystem Markets Task Force to review the opportunities for UK business from expanding green goods, services, products, investment vehicles and markets which value and protect nature's services.

60 WRAP
61 HM Government (2011) The Natural Choice: securing the value of nature.

- Establishing a new independent Natural Capital Committee, to put the value of England's natural capital at the heart of economic thinking.
- Developing communications tailored for specific users (including business) and jointly developed tools to help capture the value of ecosystem services in decision making.
- Development of business guidance for applying Payment for Ecosystem Services Schemes.

2.3 Supporting and promoting innovation and research

76. The management of resource risks present opportunities for the UK economy and individual companies through innovation. UK companies have the potential to lead the world in these innovations, which may also help reduce environmental impacts. Business will gain an advantage by examining how they operate in order to identify new ways of designing their processes and products, through vertical integration in their supply chains. Designing products for easier disassembly and access to materials could also lead to economically efficient processes for re-use, remanufacture and recycling.

77. The Government is putting innovation and research at the heart of its growth agenda through greater investment and increased collaboration. Government strategy[62] supports business R&D in areas in which the UK excels, within the context of developing the wider UK innovation eco-system including universities and other organisations.

78. Support for near-to-market innovation R&D is primarily channelled through the Technology Strategy Board. Resource efficiency is recognised as a cross-cutting discipline, and projects from many of its programmes (notably including areas such as Materials, Advanced Manufacturing and Low Carbon Vehicles) have a strong resource efficiency theme.

79. The TSB is investing up to £4.5 million in a competition aimed at encouraging industrial end-users to work with supply chains and innovators to create new products and services for a sustainable economy. These products will either have reduced environmental impact compared to current alternatives, and/or will be less dependent on the use of strategic materials.

Box 13: The Technology Strategy Board's Supply Chain Innovation Competition

Among twelve projects approved for funding in the TSB's Supply Chain Innovation Collaborative R&D competition in October 2011 was 'SAGE – Substitution of Silver (Ag) in electronic conductive inks'. This project aims to supplant the use of silver in these applications by improving the conductivity of carbon-based inks by up to ten-fold, building on recent developments which indicate that conductivity in these systems can be significantly improved through the addition of graphene and graphene nano-clusters. The inks are intended for the rapidly expanding smart packaging arena but can be expanded into numerous other markets. The use of carbon rather than silver in these systems brings both economic and environmental benefits – not only has the price of silver escalated four fold in the last five years but also silver ions are harmful in the waste stream as they are highly soluble and toxic to aquatic life.

A full list of projects approved for funding under this competition can be found on the Technology Strategy Board website.[63]

62 Department for Business, Innovation and Skills (2011) Innovation and Research Strategy for Growth.
63 Technology Strategy Board.

80. The TSB and the Chemistry Innovation, Materials and Environmental Sustainability Knowledge Transfer Networks are working to ensure that UK businesses are well placed to take these opportunities. These networks have established the Material Security Special Interest Group across its networks. This brings together designers, chemists, materials scientists, engineers, product developers and recycling and waste experts to facilitate the adoption of new business models and the rapid formation of new supply chains capable of delivering high impact, innovative solutions to material security challenges.

ACTION: The Materials Security Special Interest Group will produce a report by the end of 2012 that clearly outlines the innovation opportunities presented by materials security challenges and will continue to facilitate consortia to develop new solutions to materials security issues. (Lead: Chemistry Innovation KTN)

81. Collaborative working also presents opportunities for stakeholders to set up partnerships to address re-use. IKEA, for example, already works with the Furniture Reuse Network to help households in need access furniture, white goods and other household items.

82. The Small Business Research Initiative (SBRI), supported by the TSB, uses the power of government procurement to drive innovation. It provides opportunities for innovative companies to engage with the public sector to solve specific problems. Competitions for new technologies and ideas are run in specific areas and aim to engage a broad range of companies.

ACTION: Defra will fund an Innovation Challenge Fund for local economy closed loop projects in 2012-13. Coordinated by the Technology Strategy Board through the Small Business Research Initiative (SBRI), this will establish the feasibility of new approaches enabling local businesses to extract value from domestic and commercial waste streams (i.e. through re-use and recovery). This should encourage partnerships between business, local authorities and local communities. (Lead: Defra with the TSB)

83. This new Innovation Challenge Fund will be the first stage in a broader programme on the circular economy developed jointly by Defra and the TSB over the coming years.

Research and evidence

84. There is a large body of research on issues relating to resource security, and as outlined in section 1 a number of studies have attempted to define lists of critical materials. A review of national strategies and research has been published alongside this action plan (and country approaches are summarised in Annex 1).

85. The Government will help identify the priority gaps for policy development and ensure that departmental, Research Council and other activities are coordinated, directed and focused appropriately. Key evidence needs include the need to improve our understanding of the value of materials to the economy, materials flow, environmental impacts and future resource use and security scenarios.

The Natural Environment Research Council (NERC)

86. NERC funds world-class science to increase knowledge and understanding of the natural world, including issues such as climate change, biodiversity and natural hazards. Relevant programmes include:

- The 'Mineral Resources' research programme which will invest £7m over 5 years focusing on the processes determining the mobilisation and concentration of strategic metals and minerals needed in environmental technologies, in order that extraction can be more effectively targeted. The research will also look at methods by which extraction and recovery can be decarbonised, and the impacts of these on the wider environment.
- The 'Resource Recovery from Waste' research programme which will invest £6m over five years to develop strategic science to ensure that technologies that recover resource from waste reduce pressures on natural resource use and do not compromise the health of the environment or people.
- Natural Resource Management has been identified as a priority area with potential for NERC-funded science to be used in exploiting market opportunities for UK business and in contributing to UK policy. Starting in 2012 NERC will establish a three year Knowledge Exchange Programme focussing on Natural Resource Management to bring together NERC-funded scientists and users of that science (policy, business, civil society) to generate the maximum benefit from science investment.

European research activity

87. We also need to ensure that EU programmes address the priority needs. The 7th Research Framework Programme (FP7) has to date addressed R&D and co-ordination activity on raw materials, and resource efficiency. The content of the 2013 Work Programme is under discussion but is likely to include continued support for critical raw materials related R&D and on improving resource efficiency. FP7 ends in 2013. The Commission's proposal for a new EU research and innovation programme (Horizon 2020) for the period 2014 to 2020, was adopted on 30 November 2011. This will be the subject of negotiation over the next 18 months. Horizon 2020 reflects the policy priorities of the EU 2020 Strategy and will contain a small number of well-defined societal challenges including one focusing on 'Climate action, resource efficiency and raw materials'.

88. The UK will seek to ensure that EU research activity is focused on how we stimulate the economy and face the challenge of sustainable growth at a time of increasing energy prices, carbon constraints and greater competition for resources and markets. Research and innovation activities should aim to address the challenge of transitioning and measuring progress towards a green economy while supporting important EU policy commitments, including the Roadmap to a Resource-Efficient Europe.

2.4 The global dimension

89. The UK has been at the forefront of the international debate on climate and resource security. We will:

- continue to work with international partners to get climate and resource security issues embedded at the centre of general security debates, including in the EU Foreign Affairs

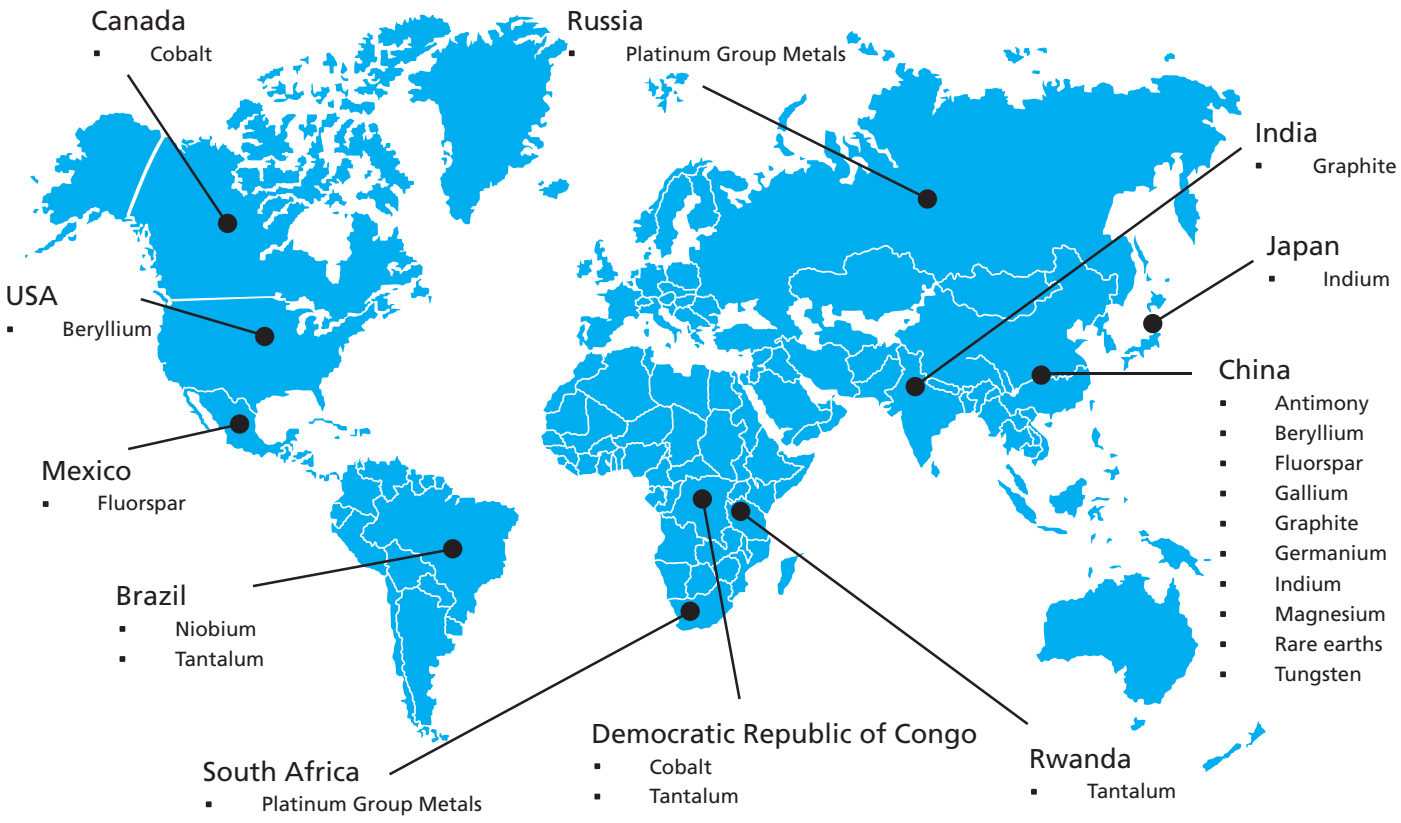
Council and the United Nations Security Council. Enabling the right conditions for international or regional co-operation is important, as the potential benefits of doing so – such as a reduction in the risk of conflict – are enormous;

- through our resource diplomacy and advocacy, continue to address how we engage with international partners to deal with the consequences of physical and material resource security. We will work to ensure that our approach is tailored to the concerns and requirements of individual countries, regions and groupings;
- work systematically with other countries and international institutions to share knowledge and planning;
- continue to support and reinforce existing and emerging rules-based institutional systems and instruments that provide for the necessary stewardship of these resources. We anticipate this will increasingly form the agenda of 21st century diplomacy.

90. Central to our future resource security and advocacy will be our support for the maintenance and expansion of free trade and open markets, particularly in relation to export restrictions and stockpiling.

The European Union

Figure 8: The production concentration of the 'critical' EU 14 raw materials by source country



91. The EU is becoming increasingly dependent on 'critical' raw materials concentrated in a small number of countries. This comes with the potential for countries to impose restrictions to secure resources for their own economies and promote their own industries. Combined with Europe's heavy reliance on imports of raw materials, both primary and secondary (i.e. ferrous and non-ferrous scrap), this poses significant risks to supply security for the future.

92. The Government has been broadly supportive of the Commission's Raw Materials Initiative,[64] its Strategy on Commodity Markets and Raw Materials,[65] and the Resource Efficiency Initiative and the Roadmap to a Resource-Efficient Europe.[66]

93. These aim to encourage transparency in raw materials trading worldwide, reduce waste and conserve resources, enhance expertise and develop new technologies, create a coherent mineral policy in Europe, and embed the principles of resource efficiency across EU dossiers.

94. Action so far at EU level includes defining a raw materials trade strategy, action to prevent illegal export of waste, proposals for new ambitious targets for WEEE recycling and funding of projects on mining and substitution.

95. Within the framework of the raw materials trade strategy, several actions have been pursued including (i) the inclusion of rules on export restrictions in all bilateral Free Trade Agreement negotiations, (ii) the launch of a World Trade Organisation (WTO) panel, jointly with the USA and Mexico, on some export restrictions imposed by China, and (iii) the tackling of individual barriers to raw materials trade through the Market Access Partnership.

96. The WTO challenge to China's export restrictions on a number of key raw materials was launched in November 2009. The action reflected EU industries' long standing concerns on export restrictions which China had applied on key raw materials. In July 2010, the WTO ruled against China's export restrictions finding that they were not justified on environmental grounds and should be removed. China appealed but on 30 January 2012 the WTO appellate body confirmed the ruling. The EU expects China to adhere to the ruling on raw materials covered by the dispute and will urge China to apply the same principles to rare earth materials and other raw materials.

The approach of other countries

97. Generally, while resource and technology rich nations outline actions to maintain and expand their exploration and production industries, resource 'deficient' nations plan to concentrate their efforts on diplomacy and resource efficiency to maintain supplies of critical raw materials. The review of national strategies and research which accompanies this document provides an overview of approaches in Germany, France, Finland and the Netherlands (the four EU nations that have formulated strategies so far), the US approach, and to illustrate the priorities of Asian economies, the Japanese and South Korean strategies.

64 COM (2008) 699 The raw materials initiative – meeting our critical needs for growth and jobs in Europe.
65 COM (2011) 25 Tackling the Challenges in Commodity Markets on Raw Materials.
66 COM (2011) 571 Roadmap to a Resource Efficient Europe.

Extractive industries abroad

98. The Government recognises the key role of extractive industries in ensuring the future resource security of the UK. But it is important that UK operations are not disadvantaged by lower standards (both environmental and ethical) abroad.

99. The UK is a strong supporter of the Extractive Industries Transparency Initiative (EITI) – a voluntary approach which aims to set a global standard for transparency in oil, gas and mining, so that natural resources benefit all. The initiative has contributed to $400bn revenues being reported under EITI in 23 countries round the world and $130bn revenues reported under EITI in Africa by over 150 companies between 2003-2008. The EITI has shown that transparency, coupled with engagement and dialogue, can promote accountability around natural resource wealth in developing countries.

100. The Government is also playing an active role at EU level to require resource extraction companies to disclose the payments they make to governments so their citizens have the information to hold their governments to account. This will promote open government, improve accountability and help to reduce corruption. The Government has already begun to engage with the Commission and other Member States in order to emphasise our support for an EU wide proposal, and we will continue to work with our EU partners over the coming months to press for an outcome in the EU that will bring the greatest benefit for developing countries.

ACTION: The UK will play an active role at EU level in discussions on the EU Transparency and/or Accountability Directives supporting requirements on resource extraction companies to disclose the payments they make to governments so their citizens have the information to hold their governments to account. (Lead: BIS)

2.5 The role of Government, business and society

101. As identified in Section 1.1 and the Government's Enabling a Transition to a Green Economy,[67] there is a legitimate role for Government to address areas of market failure to support the future sustainability of UK businesses. Government sets the policy framework and acts as a facilitator for action, and through its agencies provides information and support for innovation where market conditions are difficult. Government works internationally and through the EU to tackle market barriers, and ensure a level playing field for business for example through free and fair access to resources.

102. It is not the intention of the UK Government to become active in exploration, extraction or the stockpiling of resources. Businesses are best placed to pursue such options, to ensure they have the long-term supplies of key materials they need, and to assess their risks, identify opportunities and innovate. Businesses should work with Government to ensure their interests are best represented at UK, EU and international level, for example through the shaping of EU policy direction.

67 HM Government (2011) Enabling the Transition to a Green Economy: Government and business working together.

103. But Government does have a direct interest in the implications of resource risks on national security, and the critical resource needs for military equipment. The National Security Strategy[68] and Strategic Defence and Security Review[69] highlighted that some military applications and low carbon technologies are reliant on key materials. The recent White Paper[70] on National Security Through Technology, sets out how the Ministry of Defence will procure technology, equipment, and support to meet the UK's defence needs, at a cost which is affordable and represents value-for-money for the UK taxpayer. It urges Government and industry to work together to reduce vulnerability to shortages of supply of materials and energy. The Ministry of Defence has an ongoing interest in understanding and mitigating against the risks associated with the use of strategic and critical resources, and is conducting its own investigations in to how any risks can be managed so that military capability is maintained to required effectiveness levels.

104. Given the broad and systemic nature of resource security, **a partnership approach where Government, business and civil society work together to understand and address these issues is essential. Recognising calls from the private sector for greater clarity, Defra Ministers will act as a focal point within Government to liaise with business and connect into other parts Government.**

105. The Green Alliance has committed to develop a business-led consortium on resource security and the circular economy. This will help shape the agenda, provide better information and intelligence to businesses on long-term resource risks, galvanise action across supply-chains, between business, civil society and government, and further improve the interface between business and Government. This will help to ensure that UK business interests at EU and international level are better represented.

ACTION: A new industry-led consortium, convened by the Green Alliance, will bring together interested businesses and business groups to provide a mechanism to further develop links between government, business and other organisations to address resource opportunities and concerns, to disseminate leadership thinking and best practice and to provide a forum for policy innovation. (Launch by May 2012) (Lead: Green Alliance)

68 HM Government (2010) Cm 7953: A Strong Britain in an Age of Uncertainty: The National Security Strategy.
69 HM Government (2010) Cm 7948: Securing Britain in an Age of Uncertainty: The Strategic Defence and Security Review.
70 HM Government (2012) Cm 8278: National Security Through Technology: Technology, Equipment, and Support for UK Defence and Security

ANNEX 1: Overview of Illustrative and Selected International Approaches to Resource Security

Nation	Goal	Business Policy	R&D Policy	Materials of Interest
Japan	Secure a stable supply of raw materials for Japanese industries	• Funding for international mineral exploration • Loan guarantees for high risk mineral projects • Stockpiling • Information gathering	• Substitution research funded through METI and MEXT • Exploration, excavation, refining and safety research funded through JOGMEG	Ni, Mn, Co, W, Mo, V**
European Union	Limit the impact of potential material supply shortages on the European economy	• Mineral trade policy for open international markets* • Information gathering* • Land permitting streamlining* • Increased recycling regulations*	• Increased material efficiency in applications • Identification of material substitutes • Improved end-of-life product collection and recycling processes	Sb, Be, Co, Ga, Ge, In, Mg, Nb, REEs, Ta, W, PGMs, Fluorspar and Graphite
Netherlands	Reduce material consumption to prevent global shortages by employing 'managed austerity'. Support coordination, facilitation, encouragement and creation of frameworks and an open trading system for raw materials.	• Government-industry cooperation on material policy through the M2i institute • Seek new supplies, closing cycles (re-use, recycling) and alternatives • Improve the sustainability and restrict the use of raw materials in public procurement • Improve the efficiency and sustainability of raw materials consumption • International cooperation	• Substitutes of abundant or renewable materials • Processes for recycling depleting materials • Study consumption patterns as a result of policy • Encourage substitution, reduced consumption and reuse through the Small Business Innovation Research Programme	Ag, As, Au, Be, Bi, Cd, Co, Ga, Ge, Hg, In, Li, Mo, Nb, Nd, Ni, Pb, Pd, PGMs, REEs, Re, Ru, Sb, Sc, Se, Sn, Sr, Ta, Te, Tl, V, W, Y, Zn, Zr
China	Maintain a stable supply of raw materials for domestic use through industry consolidation, mitigating overproduction and reducing illegal trade	• Taxes and quotas on REE exports • Prohibition of foreign companies in REE mining • Industry consolidation • Unified pricing mechanisms • Production quotas • Moratorium on new mining permits until mid-2011	• Rare earth separation techniques and exploration of new rare earth functional materials • Rare earth metallurgy; optical, electrical and magnetic properties of rare earths; basic chemical sciences of rare earths.	Sb, Sn, W, Fe, Hg, Al, Zn, V, Mo, REEs

Nation	Goal	Business Policy	R&D Policy	Materials of Interest
South Korea	Ensure a reliable supply of materials critical to Korean mainstay industries	• Financial support for Korean firms at overseas mines • Free Trade Agreements and MOUs with resource-rich nations • Stockpiling	• Recycling end-use products • Designing for recyclability • Substitute materials • Production efficiency	As, Ti, Co, In, Mo, Mn, Ta, Ga, V, W, Li and REEs, PGMs, Si, Zr
Australia	Maintain investment in the mining industry while fairly taxing the depletion of national resources	• Low tax on the value of extracted resources • High tax on mine profits • Tax rebates for mineral exploration • Fast turnaround for land permit applications	• Promote sustainable development practices in mining	Ta, No, V, Li and REEs
Canada	Promote sustainable development and use of mineral and metal resources, protect the environment and public health and ensure an attractive investment climate	• Promote recycling industry and incorporate recycling as part of product design • Require accountability in environmental performance and mineral stewardship • Use life-cycle-based approach to mineral management and use	• Provide comprehensive geosciences information infrastructure • Promote technological innovation in mining processes • Develop value-added mineral and metal products	Al, Ag, Au, Fe, Ni, Cu, Pb, Mo
Germany	To reduce trade barriers and distortion, to help industry to diversify its source of supply, to establish resource partnerships with selected countries, to support new technologies and to align national with EU and international resource policy.	• Promote domestic exploration, extraction and reprocessing • Promote foreign investment in mining projects • Increase education and information • Establish partnerships with producer countries • Diversification of supply sources of materials • Material efficiency, recovery and recycling • Provide political support to German companies	• Resource efficiency and recycling • Substitution and resource intensity in key applications • Early warning system for global mineral economic developments	Ag,Be, Bi, Co, Cr, Ga, Ge, In, Mg, Nb, Pd, PGMs, Re, REEs, Sb, Sn, Ta, W, Fluorspar and Graphite

France	Support identification, recycling, sustainable exploration and substitution of metals which are of importance to French Industry	• Understand/audit industrial needs • Identify the most critical resources and update the mining inventory with a view to starting new prospecting, • Accelerate implementation of recycling projects. • Develop European and international co-operation	• Increase R&D efforts in recycling etc and, in particular on substitution	Au, Co, Cu, Ga, Ge, In, Li, Mg, Ni, Nb, Re, REEs, Se, Ta
Finland	Finland is a global leader in the sustainable utilisation of mineral resources and the minerals sector is one of the key foundations of the Finnish national economy	• International cooperation with Sweden and EU • Increase Finnish ownership in Finland's mineral sector. • Approaches with developing countries • Tax incentives for exploration and for recycling and reuse • Refine permitting procedures and land use planning. • Improve material and energy efficiency of mineral sector. • Invest in education	• Research programme (under Tekes) aimed at developing innovative solutions, products and services. • Promote cooperation between SMEs and research institutes • Enhance geo-scientific and environmental data.	Ag, Co, Cr, Cu, Fe, Li, Mn, Nb, Ni, PGMs, REEs, Ti, Zn
United States	To help inform policymakers and the public – focus on clean energy technologies expected to experience high growth in coming years.	• Identification and prioritisation of critical materials • Identification of research investment priorities (including training priorities) and establishment of linkages between research programmes • Bilateral and international dialogues to increase trade transparency, identify opportunities and share knowledge • Data collection and dissemination	• Recycling, design for recycling and more efficient use of critical materials, reduction of material intensity in products, substitution • Materials substitutes and alternative motor designs for rare earths in permanent magnets and for photovoltaics, batteries and phosphors • Demonstration project on new batteries and storage chemistry • Lithium-ion battery recycling. • Loans, incentives and tax credits available for clean energy technology development.	Ce, Co, Dy, Eu, Ga, In, La, Li, Nd, Pr, Sm, Tb, Te, Y

*Proposed policy **Current reserves.

Source US DOE, 2010 and US DOE, 2011, Defra analysis 2012. Country summaries are selective and illustrative – fuller details are available in relevant national strategies and policy papers.

Abbreviations

BGS – British Geological Survey
BIS – Department for Business, Innovation and Skills
BREEAM – Building Research Establishment Environmental Assessment Method
BSI – British Standards Institute
CBI – The Confederation of British Industry
Cd/Te – Cadmium Telluride
Defra – Department for Environment, Food and Rural Affairs
EEE – Electrical and Electronic Equipment
EITI – Extractive Industries Transparency Initiative
EPeAT – Electronic Product Environmental Assessment Tool
ES KTN – Environmental Sustainability Knowledge Transfer Network
FP7 – EU Seventh Framework Programme for Research
GVA – Gross Value Added
HREO – Heavy Rare Earth Oxides
IEMA – Institute of Environmental Management and Assessment
IPR – Individual Producer Responsibility
KTN – Knowledge Transfer Network
LREO – Light Rare Earth Oxides
MRF – Materials Recovery Facility
NERC – Natural Environment Research Council
NEWP – Natural Environment White Paper
NIEA – Northern Ireland Environment Agency
PAS – Publicly Available Specification
PGM – Platinum Group Metals (Ruthenium, Rhodium, Palladium, Osmium, Iridium, Platinum)
PWC – Pricewaterhouse Coopers
REACH – Registration, Evaluation, Authorisation and Restriction of Chemicals legislation
REE – Rare Earth Elements
SBRI – Small Business Research Initiative
SEPA – Scottish Environment Protection Agency
SMEs – Small and medium-sized enterprises
TSB – Technology Strategy Board
UK NEA – UK National Ecosystem Assessment
UNEP – United Nations Environment Programme
WEEE – Waste Electrical and Electronic Equipment
WEEELABEX – WEEE Label of Excellence
WRAP – Waste and Resources Action Programme
WTO – World Trade Organisation

Selected periodic elements highlighted in Figures 1b, 2, 5, 6 and Annex 1

Ag – Silver
Al – Aluminium
As – Arsenic
Au – Gold
B – Boron
Ba – Barium
Be – Beryllium
Bi – Bismuth
Ce – Cerium
Cd – Cadmium
Co – Cobalt
Cr – Chromium
Cu – Copper
Dy – Dysprosium
Er – Erbium
Eu – Europium
Fe – Iron
Ga – Gallium
Gd – Gadolinium
Ge – Germanium
Hf – Hafnium
Hg – Mercury
Ho – Holmium
In – Indium
Ir – Iridium
La – Lanthanum
Li – Lithium
Lu – Lutetium
Mg – Magnesium
Mn – Manganese
Mo – Molybdenum
Nb – Niobium
Nd – Neodymium
Ni – Nickel
No – Nobelium
Os – Osmium
Pb – Lead
Pd – Palladium
Pr – Praseodymium
Pt – Platinum
Re – Rhenium
Rh – Rhodium
Ru – Ruthenium
Sb – Antimony
Sc – Scandium
Se – Selenium
Si – Silicon
Sm – Samarium
Sn – Tin
Sr –Strontium
Ta – Tantalum
Tb – Terbium
Te – Tellerium
Ti – Titanium
Tl – Thallium
Tm – Thulium
V – Vanadium
W – Tungsten
Y – Yttrium
Yb – Ytterbium
Zn – Zinc
Zr – Zirconium

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