UK Minerals FORUM

Future Minerals Scenarios for the UK

UK Minerals Forum Working Group 2013-14

July 2014

Foreword

This report on *Future Minerals Scenarios for the UK* has been prepared by a Working Group of the UK Minerals Forum (UKMF) established in late 2012. Its remit was to examine future scenarios and their implications for maintaining supplies of essential minerals to meet the needs of the UK economy over the 35 years to 2050, draw conclusions and make recommendations. The Group has looked particularly at minerals already being produced in the UK, or which might be produced here in the future, together with the wider factors that may influence future demand and supply.

Since 2007 the UKMF has brought together representatives of the UK's onshore extractive industries, NGOs with a particular interest in the environmental impacts and opportunities of mineral extraction, the sector's research organisation, local government planners and observers from central government, the territorial administrations and the main statutory regulators. The Forum is funded by the CBI Minerals Group but operates independently. It provides an opportunity for members to discuss matters of common interest in a neutral space, away from the pressures of traditional lobbying, campaigning, and formal dialogue about regulatory policy, legislation, minerals supply and environmental protection. UKMF sponsors Working Groups to look in detail at matters of particular interest or concern and to report their findings to Forum members, and the wider public through suitable websites and the biennial CBI *Living with Minerals* Conferences. Issues emerging from Working Groups are followed up with Government and regulators as appropriate.

The Working Group has addressed the key issue of future supply through:

- a backward look at trends in minerals production in the UK over the last 40+ years to identify possible drivers for the future;
- using the results of a Future Minerals Scenarios Workshop on alternative futures to gather and test views on the key issues to 2050;
- seeking more detailed views from different mineral sectors and other stakeholders on the primary issues most likely to affect access to minerals over the next 35 years;
- drawing conclusions and formulating recommendations.

This study was completed in July 2014 and the results will be presented at the CBI Minerals Group *Living with Minerals 5* Conference in London on 17 November 2014.

Acknowledgements

The *Future Minerals Scenarios Working Group* would like to thank members of the UK Minerals Forum, CBI Minerals Group and members of the minerals industry for their comments on the report. The Working Group would also like to thank Dr Alister Wilson of Waverley Management Consultants for facilitating the Future Minerals Scenarios Workshop in November 2013.

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Executive Summary

Need - Adequate and resilient supplies of minerals are essential to support the growth and success of the UK economy and therefore the well-being of its population. Under any future scenario to 2050 there will be a continuing need to access and use newly-extracted minerals despite increased use of renewable energy and recycling, together with waste minimisation, and improved resource and energy efficiency.

Internationally the UK is facing increasing global competition for raw materials driven by growing world population, rising incomes and expectations. In the global economy mineral supply is not guaranteed and may become more challenging through increasing geopolitical uncertainty and the risk of supply disruption. Domestically, population and household growth (requiring new homes and infrastructure development), and the need to improve resilience and adapt to climate change will continue to be important drivers for minerals.

Resources - Geology is fundamental to which minerals may be produced domestically. The UK is fortunate in being relatively well endowed with mineral resources, and their extraction and use have played an important role in the historic development of the economy. The UK continues to have an economically important minerals industry, with oil, gas, and construction the dominant sectors by tonnage and value. Although UK coal production is much diminished, coal still makes a vital contribution to our current energy mix. A number of industrial minerals support downstream industries and some important export markets. In addition, the UK's mineral potential still attracts interest - a major new tungsten mine in Devon will start production in 2015. However, the UK is not self-sufficient in a number of key sectors, particularly metals and, increasingly, energy - oil, gas and coal. The future potential to access unconventional energy resources, notably shale gas, is as yet unknown and requires significant further investigation.

History - Major changes in the fortunes of each of the UK's extractive sectors have occurred in the last four decades. Overall the trend has been one of decline, annual volumes of minerals production and consumption being roughly 200 Mt lower (by about 35%) in 2011 than in 1970, although this decline partly reflects the recent recession. A decoupling of economic growth with apparent minerals consumption suggests greater resource efficiency but this may mask under-investment in infrastructure and the move of manufacturing overseas. Nevertheless minerals remain the largest material flow in the economy with some 290 million tonnes produced in 2012, of which 193 million tonnes was from onshore.

The UK has become increasingly dependent on imports of minerals and minerals-based products; the change from self-sufficiency and even surplus in energy minerals (coal, and then oil and gas) to increasing import dependency being particularly rapid. The recession starting in 2008 has also had a marked impact on construction minerals, particularly primary aggregates, where production remained at levels not seen since the 1960s until early 2014 as signs of recovery emerged.

Drivers of change - Future demand and supply of the products of the UK minerals industry will be affected by a number of external factors. Major drivers of change include:

- growth in the **economy**;
- the security and cost of **energy** supplies;
- future investment in **construction and infrastructure**;

- evolving **technology;**
- the balance between the benefits of minerals extraction and the associated impacts on the **environment** and **society**; and
- the **political** (and regulatory) framework within which the minerals industry operates.

With rapidly declining domestic reserves of oil and gas, ensuring energy supplies at a cost acceptable to consumers as well as the environment is crucial. Despite the prospects of large shale gas resources, commercial evaluation in the UK is still in its infancy and commercial viability as yet unknown. Future population and household growth will require large-scale investment in more housing and new and improved infrastructure, including energy. These in turn will drive demand for construction materials (aggregates, cement, ready-mix concrete, asphalt, bricks, tiles, glass and plaster products), all of which are currently UK-sourced. Some, like cement, lime, bricks and glass manufacture are also energy-intensive.

Delivery **-** It remains to be seen whether regulatory systems and high energy costs frustrate the delivery of the essential raw materials needed by the UK economy over the next 35 years. Balancing such factors with the UK's carbon reduction targets for 2050 is also challenging. Importing minerals and minerals-based products transfers the environmental impacts of extraction and processing onto other countries, whilst adding embodied 'transport carbon'. The net balance of greenhouse gas emissions between locally sourced and imported materials is part of the environmental equation.

Conclusion **-** Future minerals supply, whether through imports or domestic production, cannot be taken for granted. Access to long-term supplies of minerals is of crucial importance if the UK is to achieve sustainable growth, a balanced economy, security of energy supply, renewal of infrastructure and increased climate change resilience. This cannot be left entirely to private industry or global markets. It is the responsibility of Government to establish an appropriate policy, regulatory and fiscal framework to encourage sustainable production that balances economic, social and environmental priorities. Given the crucial importance of minerals, and minerals-based products, to the economy and society, the *Future Minerals Scenarios Working Group* recommends that the minerals industry should work alongside policymakers and other interested stakeholders to develop a UK Minerals Strategy within the UK's wider industrial strategy. With good will and determined effort it is surely possible to conserve what is essential in our landscapes, habitats and cultural heritage while meeting UK demand for minerals over the next 35 years to 2050.

1 Background

The world's population is now around 7 billion and the United Nations expect it to increase to 9 billion by 2050. Most growth will occur in developing countries, accompanied by increased urbanisation and a burgeoning middle class. Driven by expanding populations, and rising incomes and expectations, particularly in emerging economies, mainstream projections suggest significant rates of growth in demand for critical resources from fossil fuel to minerals, fertilizers, food and timber at least to 2030. The issue of resource insecurity has returned[1]. Globally the UK will face increasing competition for raw materials, some of which can only be sourced overseas, and, at home, population and household growth will also be an important driver for minerals.

Minerals are basic and essential raw materials for:

- **energy,** including electricity generation and fuels for use in the home, industry and commerce, and for transportation;
- **construction** to develop, maintain, enhance and protect our infrastructure, built environment and coasts;
- **manufacturing** for the production of a wide range industrial and consumer goods; and
- **agriculture** to improve the productivity of the soil.

Adequate and resilient supplies of mineral raw materials are essential for the sustainable development of a modern and growing economy. The expansion of renewable energy, increased use of recycled materials and industrial by-products, and improved resource efficiency (doing more with less) must be maximised to meet part of our requirements, prevent waste and help reduce carbon emissions. However, under any future scenario there will be a continuing need to access and use newly-extracted minerals, even in a more resource and energy efficient world[2].

This report is principally about the UK's domestic minerals apart from offshore hydrocarbons. The offshore oil and gas industry remains very important to energy security and the economy, despite declining reserves and production. However, offshore resource development is subject to a radically different regulatory regime and involves different environmental issues. It does not share the onshore sector's constant need to access land through the spatial planning and environmental regulation systems, or have to respond to the same range of concerns and controls over its impacts on neighbouring populations and the terrestrial environment. While the broader issues of national energy policy, resilience and self-sufficiency that arise in the case of the onshore energy minerals – coal, conventional oil/gas and prospectively unconventional sources, including shale gas and shale oil – also apply offshore, the analysis, conclusions and recommendations of this report are focused on the onshore sector.

[1] Resources Future. A Chatham House Report. December 2012.

[2] World Economic Forum 2013. *Energy Vision 2013. Energy transitions: Past and Future* http://www3.weforum.org/docs/WEF_EN_EnergyVision_Report_2013.pdf

1.1 METHODOLOGY

The Working Group has addressed the key issue of future supply through;

- a backward look at trends in minerals production in the UK over the last 40+ years to identify possible drivers for the future;
- seeking views from different mineral sectors, and other interested stakeholders, on the primary issues most likely to affect longer term access to minerals in the next 10-20 years;
- using the results of a Future Minerals Scenarios Workshop on alternative futures to gather and test views on the key issues to 2050. The scenarios chosen were;
    - **Green Britain** - *UK has* a *decisive and ambitious approach to the environment*
    - **Britain Powering Growth** – *The UK* operates *within free markets and open borders generating strong cyclical growth*
    - **Insular Britain** - *Resource security in the UK overrides other issues and the state maximizes use of domestic resources;*
- drawing conclusions and formulating recommendations.

2 Geology and resources

Geology is fundamental to which minerals are, or potentially may be, produced in the UK. The complex geological history of the UK and its adjacent Continental Shelf has contributed much to our national wealth. The ancient trading of Cornish tin, the close association of coal and iron ore that supported the development of the Industrial Revolution and, more recently, the development of our offshore oil and gas reserves have all made crucial contributions to the economy. Moreover, the built environment, the most visible aspect of our cultural heritage, owes much of its character to the diversity of natural stone, and bricks and tiles used in its construction. That variety has helped create and preserve attractive environments in our towns, cities and rural areas.

2.1 PRIMARY RESOURCES

For its small size the UK is fortunate in having both abundant and a wide range of indigenous mineral resources (see Annex A), the extraction and processing of which supports an industry of considerable economic importance. Oil and gas, and construction minerals are now the dominant sectors in terms of value and tonnage (see Table 1 and Annex B). Although domestic coal production is much diminished, imported coal still makes a vital contribution to our energy mix. The UK produces a range of construction minerals – aggregates, brick clay, cement-making raw materials and gypsum, and a number of industrial minerals – kaolin, ball clay, silica sand, potash, industrial carbonates, fluorspar and barytes. Many of these support downstream, value-added industries, and some, like kaolin, ball clay and potash, also serve important export markets. Moreover, the UK's onshore mineral potential still attracts interest, as witnessed by the current development of a world class tungsten deposit in Devon, proposals for a new potash mine in the North York Moors National Park and the ongoing evaluation of the nation's shale hydrocarbon potential.

Table 1. Production (sales) and value of the major sectors of the UK minerals industry

	2011		**2012**	
	Thousand tonnes	***£million (a)***	***Thousand tonnes***	***£million (a)***
Oil, inc natural gas liquids (b)	51 972	25 505	44 560	22 975
Natural gas (b)	45 289 (c)	7 960	38 934 (c)	7 855
Coal	18 627	1 345	17 101	1 131
Aggregates	165 887	1 410	149 477	1 279
Other construction minerals	18 816	283	17 744	256
Industrial minerals	23 144	1 074	22 385	922
Metallic minerals	0 (d)	11	0 (d)	5
TOTAL	**323 735**	**37 588**	**290 201**	**34 422**

(a) Ex-works sales values *Source: UK Minerals Yearbook, British Geological Survey*

(b) Including offshore

(c) Oil equivalent

(d) 0 – small output

Fortunate as the UK is in terms of mineral resources, it is deficient in a number of key minerals, notably metallic minerals and increasingly energy minerals; oil, gas and economically viable coal (see Figure 1). The metallic minerals include - iron ore and the ferroalloy elements, non-ferrous metals and an increasing number of 'critical metals' important for new digital and low carbon technologies, notably the rare earths. Sources of some of these metals are few in number, with China being the predominant supplier of many by a considerable margin. This has led the European Commission to identify 20 'critical raw materials' on the basis of their economic importance to European industries and the likelihood of supply disruption[3]. There has been a resurgence of interest in metals in the UK with modest production of gold stimulated by the relatively high gold price, and the current development of a tungsten open pit mine in Devon, although the deposit has been known for over 100 years. Further discoveries will no doubt be made, perhaps in south-west England (where tin exploration is ongoing) as a result of the Tellus SW project[4], but it is difficult to foresee discoveries that would dramatically change the UK's current dependence on imports of most metals.

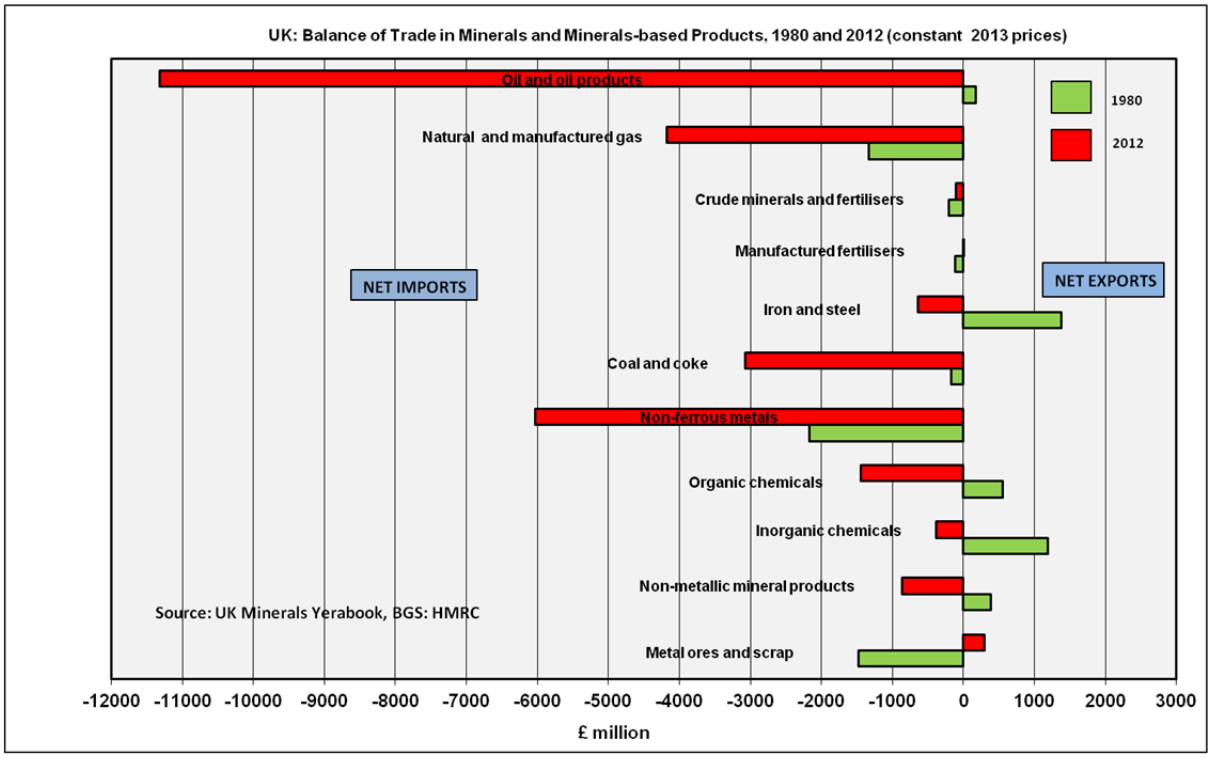

Figure 1. UK: Balance of trade in minerals and minerals-based products, 1980 and 2012 (constant 2013 prices)

Indigenous mineral resources are valuable national assets but unlike most other means of production and economic activity, are non-transferable and, as they fundamentally reflect geology, can only be worked where they occur. Uneven spatial distribution of the minerals produced in the UK means, for example, that some production is concentrated in or around protected landscapes in upland areas. The South East of England is almost totally devoid of hard rock suitable for use as construction aggregates and an alternative, land won sand and

[3] http://ec.europa.eu/enterprise/policies/raw-materials/critical/index_en.htm

[4] A low elevation, high-resolution airborne geophysical survey being carried out by the British Geological Survey. http://www.tellusgb.ac.uk/

gravel, is increasingly constrained by development pressures and environmental and agricultural considerations. Thus marine-dredged sand and gravel is a particularly important source of supply for London and the South East.

Moreover, the presence of an economically viable mineral deposit is no guarantee that mineral extraction will take place. The historic development of the industry demonstrates that the latent economic value of a mineral resource can only be converted to a continuous supply if production is economically viable – and now of crucial importance - there is an efficient and proportionate regulatory process for planning and environmental consents.

34.1 SECONDARY RESOURCES AND RECYCLING

Reuse and recycling is an integral part of sustainable resource management and improving resource efficiency. The UK has a good record of increasing the use of recycled and secondary aggregates, with the highest usage in Europe, although effective capacity is now being approached. However, where minerals are valued for their chemical properties recycling is more difficult. For example, there are no alternatives to potassium-bearing minerals as an essential plant nutrient, or salt as a source of soda (Na_2O) and chlorine as chemical feedstocks.

Most properties of metals are not destroyed in use and can be recycled back into the production chain. However, this does require provision of the appropriate processing facilities if they are to contribute to domestic consumption. A significant proportion of the secondary metals recovered in the UK has to be exported for processing and reuse. The tungsten and tin from the new Devon mine will also be exported for value-added processing as facilities are not currently available in the UK. Use of selected secondary materials is shown in Annex B.

As with primary minerals, there are also security of supply issues for secondary materials. For example, the longer term availability of blast furnace slag (a by-product of iron making) and pulverised fuel ash (a by-product of coal-fired power stations), both used in blended cements, and desulphogypsum (also derived from coal-fired power stations) used in plasterboard manufacture, is not assured.

In a globalised economy it is not efficient to have all parts of the production chain in every country and thus exporting metals or other materials recovered from waste streams is a valuable and usually energy efficient supplement to overall world supplies. However, where feasible, retaining domestic, integrated industrial supply chains through raw material extraction, processing and final product manufacture is an important element of security of supply.

3 A look back to the future

The four decades since 1970 have witnessed major changes in the fortunes of each of the UK's extractive sectors. As in the past, future demand for, and thus production and import of minerals is continually evolving and will be strongly influenced by a range of economic, political, technical, social and environmental factors.

Following the oil crises of the 1970s, after which the world could no longer count on cheap oil, few would have predicted that the promised new future for 'King Coal' would be followed by the rapid decline of the UK coal industry. Similarly, when North Sea gas was discovered in 1965, it was difficult to envisage that this premium fuel would become a favoured fuel for electricity generation. Privatisation of British Gas in 1986, the repeal in 1991 of the EC 'Gas Burn' Directive, and particularly the privatisation of the UK electricity supply industry in 1990, together with environmental policy linked to climate change, have all contributed to making natural gas more important for electricity generation, initially at the expense of coal. Combined cycle gas turbines offered cheaper generation with almost no sulphur dioxide and about half the carbon dioxide emissions of coal-fired power plants per kilowatt hour generated. As a result, the UK's offshore gas reserves were rapidly depleted and self-sufficiency in natural gas was only achieved in the brief period from 1995 to 2003.

An analysis of trends in UK minerals production has already been provided in a separate report for the UK Minerals Forum[5]. The headline findings are summarised below, with further statistical data provided in Annex B.

- The overall trend has been one of decline, in terms of both total mineral production and mineral consumption, with annual volumes being roughly 200 million tonnes (about 35%) lower in 2011 than in 1970, although this was during the recession;
- there has been a decoupling of economic growth (GDP) with apparent minerals consumption, suggesting greater resource efficiency within the economy. However, it may also reflect under investment in infrastructure and housing, and the shift of manufacturing offshore;
- the UK has become increasingly dependent on imports of minerals and minerals-based products, particularly for energy minerals and metals (see also Figure 1);
- the change from self-sufficiency and surplus in energy minerals (coal, and then oil and gas) to greater import dependency has been particularly rapid and is likely to increase as offshore oil and gas reserves decline;
- oil production increased from 156,000 tonnes in 1970 to 44.6 million tonnes in 2012. It peaked at 137.7 Mt in 1999;
- natural gas production increased from 9.7 Mt oil equivalent (oeq.) in 1970 to 38.9 Mt in 2012, but peaked at 110.9 Mt oeq, in 2000;
- domestic coal output fell by nearly 90% from 144.6 Mt in 1970 to 17 Mt in 2012;
- largely driven by climate change policies, major changes have taken place in the fossil fuels used for electricity generation, notably the increasing use of natural gas for power generation since 1990, mainly at the expense of coal. While high gas prices relative to coal have recently resulted in an increased use of coal, this cannot be sustained in the long-term due to operation of the EU's carbon reduction measures;

[5] Trends in UK production of minerals. *Future Minerals Scenarios for the UK Working Group*. 2014. http://www.bgs.ac.uk/ukmf/home.html

- despite large investments in renewable energy sources, coal and natural gas accounted for two-thirds of the electricity generated in the UK in 2013;
- the UK was last self sufficient in primary energy in 2004 and was only 57% self sufficient in 2012;
- the UK is moving towards higher energy costs and increasing insecurity of energy supply; this may well be the key to what kind of minerals industry the UK has in the future, as many energy-intensive industries are based on domestic minerals;
- a large part of the UK's non-energy minerals industry has been taken into foreign ownership;
- with the exception of ball clay and potash all other minerals have declined in production;
- kaolin (china clay) – a major export mineral – production fell by nearly 46% from 2.4 Mt to an estimated 1.3 Mt in 2012, in part due to the cessation of paper coating clays production in 2006;
- construction minerals (accounting for almost 80% of onshore minerals production) and particularly primary aggregates have seen the most serious declines, noticeably during the recession which began in 2008;
- from the early 1990s to 2012 construction became less aggregates intensive. This trend reversed in 2013 and the long term future relationship between demand for aggregates and construction output is uncertain;
- a construction revival started in 2013 but output of aggregates remains at levels not seen since the 1960s and 30% below pre-2008 output;
- since 1970 the use of recycled and secondary aggregates by the construction industry has increased substantially. In 2013 recycled aggregates accounted for 28% of the GB aggregates market;
- although self-sufficiency in many minerals has declined, only a few minerals have wholly ceased production since 1970 – e.g. iron ore, tin (and minor tungsten) and fuller's earth;
- potash is the only mineral to have started production since 1970 (in 1974); the UK has the potential to become a leading world supplier; and
- in 2015 tungsten production (with minor tin) will resume at the Hemerdon mine in Devon, which was last worked on a very small scale during WWII.

4 Drivers for future UK minerals supply

Future demand, and thus supply, of the products of the UK minerals industry will continue to be greatly affected by a range of external factors. Seven major factors driving change have been identified from past developments and discussions with the minerals industry (Figure 2). Most of these drivers are interlinked and within them is a multiplicity of other factors, all of which will have an impact to a greater or lesser extent.

Figure 2. Drivers for future UK minerals supply

4.1 ECONOMY

A steady and adequate supply of minerals is essential, not optional, to support the UK economy, and through the economy the life and well-being of its population. The overall aim will always be to meet society's need for minerals at acceptable social and environmental cost.

The Government is committed to strong economic growth and rebalancing the economy more in favour of production and manufacturing. There will remain uncertainties about the UK economic outlook which, for a trading nation, will inevitably be linked to the global situation. Despite these uncertainties there are predictions that the longer-term economic outlook for the UK is favourable. By 2060 the UK is forecast to have the largest population in Europe (Eurostat)[6] and some economists predict our demographic advantage could mean we have the largest economy in Europe by 2030[7].

Mineral raw materials provide key inputs to the economy. For large parts of British industry much of the supply chain inevitably lies outside the country. However, those UK-won minerals that support domestic downstream construction and manufacturing in an integrated industrial supply chain of extraction, processing and product manufacture represent an important element of security of supply.

4.2 ENERGY

Energy underpins the operation of a successful economy. The need for secure and resilient energy supplies cannot be overstated. The UK has moved away from energy self-sufficiency and surplus to increased reliance on imports of oil, gas and coal (Figure 3). This change has been rapid. It means that it is crucial to ensure a sufficient and secure supply, particularly of electricity (where the generating capacity margin is declining) at a cost acceptable to consumers as well as the environment. Despite energy efficiency measures, electricity demand is likely to continue to increase, particularly as the number of households, due to population and other factors, increases. Renewable sources have yet to make a significant impact on supply. Coal (now substantially imported) is currently the cheapest component of the UK's electricity generation, accounting for nearly 44% of electricity generation in 2012 compared to only 34% in 2000. The future for coal is unclear. EU and UK carbon reduction requirements mean that any long term use would need to be tied to Carbon Capture and Storage (CCS)[8] technology but in the interim old coal-fired stations may have to be retained subject to commercial and regulatory decisions to forestall any impending electricity shortage.

The UK Government's Carbon Plan[9] and Gas Generation Strategy[10], make it clear that gas will continue to play a major role in the UK electricity mix over the coming decades, alongside low-carbon renewable technologies, with nuclear also being a part of the long term solution. However, the UK's offshore gas resources are rapidly being depleted and continuing to ensure diversity of supplies remains important. The international gas market is also particularly vulnerable to geopolitical instability. Gas is expensive to import and, like high carbon or energy taxes, could impact detrimentally on the competitiveness of UK energy

[6] Eurostat, the statistical office of the European Union. 80/2011. June 2011.

[7] CEBR. December 2013.

[8] The process of capturing carbon dioxide before it is emitted into the atmosphere from large sources, such as fossil fuel power plants, and transporting it to underground reservoirs for long-term storage.

[9] The Carbon Plan: Delivering a low carbon future. HM Government, December, 2011.

[10] Gas Generation Strategy. Department of Energy and Climate Change, December 2012.

intensive industries, such as ceramics, glass and lime, which are highly dependent on gas as a process fuel and rely on secure energy for continuous high temperature processes. Many such industries advocate more UK gas storage and a public service obligation to store and use the gas as is common in other European countries, which generally have much higher storage levels than the UK's current 15 days. Large industrial users of gas are the first to be disconnected at times of shortage. Perceived poor electricity and gas security is compromising further investment by some of these industries.

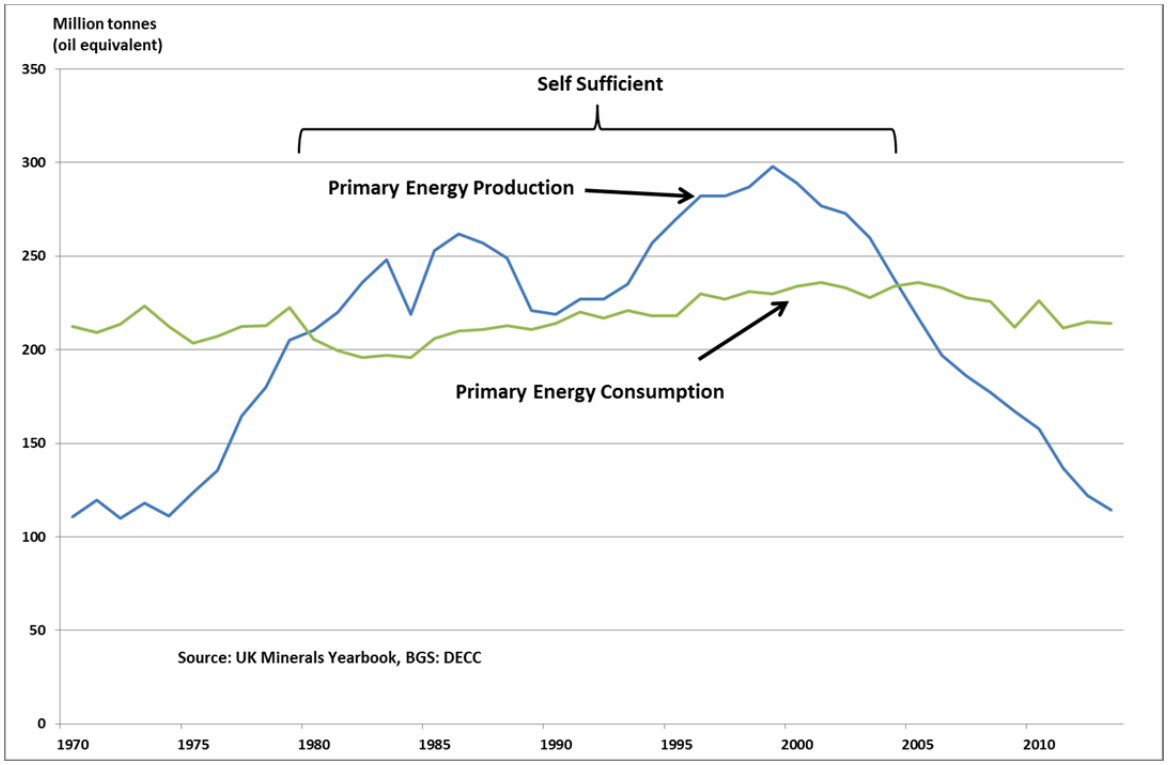

Figure 3. UK: Production and consumption of primary energy (energy supplied basis), 1970-2013. (Production includes biofuels and renewable energy; consumption figures exclude embedded energy contained in UK imports)

UK-won shale hydrocarbons (gas and oil) have the potential to become an important, new energy source, as in the USA, where they have transformed the country's energy position and manufacturing competitiveness. If large scale shale hydrocarbon development extends to other countries it also has the potential to radically change the geopolitics of world energy supply, because the distribution of shale hydrocarbon resources does not match that of current conventional oil and gas supply.

The UK has large shale gas resources, but the British Geological Survey has emphasised that 'The UK shale gas industry is in its infancy, and ahead of production testing there are no reliable indicators of potential productivity'.[11] Exploration is thus at an early, albeit highly-

[11] British Geological Survey (BGS) (2012) *The Unconventional Hydrocarbon Resources of Britain's Onshore Basins – Shale Gas*. Report for DECC (Department of Energy and Climate Change). https://www.og.decc.gov.uk/upstream/licensing/shalegas.pdf

publicised and controversial, stage.[12] However, the present UK Government is committed to the safe, responsible and environmentally sound recovery of all the nation's unconventional gas and oil resources. It has introduced competitive tax rates for new operators, streamlined the permit system and the regulation of exploration activity, and in June 2014 it announced legislation to facilitate underground access for extracting oil and gas at depths below 300 metres, subject to consultation currently in progress.

4.3 CONSTRUCTION AND INFRASTRUCTURE

It is now recognised that successive governments have under-invested in the UK's infrastructure and that this lack of investment has had a detrimental impact on economic growth[13]. The National Infrastructure Plan provides a long term commitment to reverse this trend with large investments planned for the energy and transport sectors. Flood and coastal protection, already important, will inevitably require major increases in allocated resources over the foreseeable future in the light of the events of winter 2013-2014 and the Government's promised response. In addition, with the Office for National Statistics predicting that the population of the UK will grow to over 73 million (a rise of over 10 million) by 2035 there is, and will continue to be a large demand for new homes and hence the need for a dramatic reversal of the decline in housing completions seen in recent years. At present about 110,000 new homes are completed each year whereas annually about 200,000-250,000 are required to meet demand. Household growth, driven by population and a range of other demographic factors, will be an additional driver for better and more efficient infrastructure and increasing capacity on the road and rail networks.

These factors will drive demand for construction minerals and materials (aggregates, cement, ready-mix concrete, asphalt, bricks, glass and plaster products), all of which are currently primarily UK sourced. The Government's construction strategy[14] is seeking a 50% reduction in the UK trade gap between exports and imports in construction products and materials by 2025. Whilst the UK has adequate resources of most of the minerals required for construction, maintaining access to adequate and steady supplies is problematic. It remains to be seen whether factors like the regulatory systems and energy costs frustrate the delivery of the materials needed for essential construction over the next 35 years.

4.4 TECHNOLOGY

Technology improvements aimed at extracting materials, including from waste, with reduced environmental and human impact, improving existing operations and processes, creating resource efficiencies, extending materials substitution, and achieving energy and cost reductions, should be a continuing feature of the minerals industry. The twin technologies of hydraulic fracturing and horizontal drilling also have the potential to transform the UK's energy position if shale hydrocarbon resources prove economically viable to extract.

The deployment of commercial scale CCS technology has widespread political support and could be used for coal and gas-fired stations, as well as perhaps some industrial processes, notably cement manufacture. There remain large problems with regard to scale, efficiency and cost, but evaluation is being carried out in the UK and elsewhere. If solutions could be

[12] See http://og.decc.gov.uk/en/olgs/cms/licences/lic_rounds/timing_of_the_/timing_of_the_.aspx. Two exploration wells for shale gas have been commenced by Cuadrilla under licences in the West Lancashire Basin and in the Weald Basin (compared to an average of 26 wells per year for conventional sources).

[13] National Infrastructure Plan, 2013. HM Treasury.

[14] Construction 2025. Industrial Strategy: government and industry in partnership. Department of Business, Innovation and Skills. July 2013.

found that were capable of implementation at acceptable economic and environmental cost there could be implications for future demand for coal. Whether that could be supplied from UK mines would depend on projected costs being competitive against the international coal market.

New technology can also create new uses for minerals as well as new sources of supply. A good example, in this case driven by environmental policy, is flue gas desulphurisation at coal-fired power stations to remove sulphur dioxide emissions. First used in the UK in 1994, this created both a substantial new market for high-purity limestone, and the increasing availability of the by-product desulphogypsum, which has mainly replaced natural gypsum in the manufacture of plasterboard. Despite its current availability, however, desulphogypsum it is not viewed as a long term source of supply, unless coal also has a future through CCS technology. If not, future supply of gypsum will have to come from either increased imports or expansion of output at existing or new operations.

4.5 ENVIRONMENT

Minerals consumed in the UK are obtained from the natural environment whether at home or overseas. Mineral extraction will always have environmental impacts, such as noise, dust, visual intrusion, and additionally whilst only a temporary use of the land, some operations can continue for decades. Although mineral extraction is a relatively minor use of land, resources are unevenly distributed throughout the country and the sources of supply may not correspond with the areas of greatest demand. Consequently minerals extraction may be highly concentrated in limited areas, with associated environmental impacts, while the minerals are used nationally or even internationally. However, much extraction of construction minerals, such as aggregates, is still focused on meeting local demand. Smaller scale quarrying of building stone meets local as well as wider national needs.

The UK has a policy framework which attempts to balance the economic benefits of mineral extraction with the associated environmental and social costs. Each case has to be treated on its merits in the light of current planning policy. The greater the adverse environmental impacts, the greater the justification for working the mineral has to be.

The geological diversity that has provided the UK with a wealth of mineral resources has also produced varied and distinctive landscapes which in turn provide a wide-range of habitats; for example durable rock, such as limestone, suitable for aggregates, cement manufacture, industrial uses and building stone, also forms attractive upland scenery.

A very high degree of protection against development is afforded to many of these areas of scarce habitats and highly-valued landscapes. Clearly, whilst minerals can only be worked where they occur they cannot be worked everywhere they occur. A particular issue is that some minerals are concentrated in National Parks and Areas of Outstanding Natural Beauty. These areas contribute significantly to national well-being, through protection of the landscape, wildlife and key environmental resources like water and carbon storage. Another issue is potential impact on internationally designated nature conservation sites, including Natura 2000 sites and national SSSIs.

The difficulty of finding environmentally acceptable mineral sites to work occurs nationwide. For minerals that are relatively widespread there may be a wider range of alternative options for extraction. However, if the mineral is nationally scarce or geographically localised, then options may be very limited. If the same area is also subject to extensive international and national landscape, heritage and nature conservation designations it will be more difficult, or even impossible, to identify acceptable sites for mineral working unless there are to be

exceptions for reasons of overriding national importance. These issues apply to a number of industrial minerals worked in the UK, notably potash and fluorspar.

The UK minerals industry generally has a good reputation for high-quality restoration and an ability to recreate new landscapes and wildlife habitats from former mineral sites, with additional benefits for biodiversity and the historic environment. Restored sites at the same time can provide attractive, new public amenities. High working and restoration standards will continue to be essential to maintain the mineral industry's 'licence to operate' and further innovation in restoration practice will help keep pace with rising public expectations of corporate responsibility.

There is, however, a global dimension that also needs to be considered. Imports of minerals and minerals-based products transfer the environmental impacts of extraction and processing onto other countries, whilst increasing global carbon emissions as a consequence of transportation. Therefore, a further environmental consideration is the net balance of greenhouse gas emissions between locally-sourced and imported minerals.

The UK is aiming for a low carbon economy, and has a statutory target to reduce greenhouse gas emissions by at least 80% below the 1990 baseline by 2050. We can help achieve our carbon reduction objectives by making the best use of our domestic mineral resources, where economically and environmentally feasible to do so. Carbon mitigation measures – renewable energy, CCS, waste minimisation, recycling and greater resource and energy efficiency - are crucial elements in limiting increased demand for new primary minerals. Facilitating the retention of efficient yet still energy intensive processes in the UK rather than importing the resultant products from less regulated countries may also yield a net global benefit in terms of carbon emissions.

4.6 SOCIETY

The UK is facing major challenges about the future use and development of land, above all for housing and new transport infrastructure. This is already leading to rising tension over any proposals for development. These challenges are being driven by demographic change in our society and the rising demand for housing, schools, hospitals and commercial development. They are also boosted by the consequent need for improved infrastructure and the constraints of climate change and flood risk. Whilst mineral working is a relatively minor use of land area nationally (0.51% in England, compared with 10-11% that is built on[15]), extraction is often concentrated because of the uneven distribution of mineral resources, which can result in cumulative effects sometimes in limited areas. Public and local political opposition can be a substantial obstacle to proposals for new mineral workings.

Mineral extraction and processing does not in itself support large employment, although the jobs available require a wide range of skills, are relatively well paid and non-seasonal. Importantly, they are mainly located in rural areas, where reliance on lower paid, lower skill jobs in agriculture and tourism is an issue for local people. However, the minerals industry directly supports large numbers of jobs in construction and downstream manufacturing[16].

The economic well-being and quality of life of our society is heavily dependent on the availability of a wide range of minerals and minerals-based products. This position will not

[15] Land worked for minerals but not reclaimed in 2000. Arup Economics and Planning, 2002. *Survey of Land for Mineral Working in England.* Classified as 'Built-up Area'. National Ecosystem Assessment.

[16] The mineral products industry's contribution to the economy and our quality of life. Mineral Products Association, 2012. http://www.mineralproducts.org/documents/MPA_MTL_Document.pdf

change significantly under any future scenario. It is important, therefore, that the essential contribution that minerals (and secondary materials) make to society is recognised.

4.7 POLITICAL

The policy framework within which the minerals industry operates will continue to be of crucial importance in maintaining supplies of minerals in the coming decades. There are two primary aspects of this;

- planning and regulatory policy; and
- energy policy and carbon/renewables pricing.

The national planning policies of each of the UK administrations recognise the importance of minerals to the economy. They support the delivery of the supply of minerals that all parts of the country need for growth through minerals development which balance the three pillars of sustainable development (economic, social and environmental). This national policy approach is implemented through a plan-led system which requires national coverage of up to date minerals or local development plans that implement national policy consistently at the local level, while remaining locally distinctive, and which are regularly reviewed. Achieving this will ensure more confidence in the ability of the plan-led system to deliver sustainable minerals development, which combines balancing the economic, social and environmental factors in each case, with the speed and consistency of decision making required to secure continuity of minerals supply.

Currently, however, the minerals industry has expressed concerns about the coverage of up to date plans, inconsistency between plans, along with the complexity, time and cost of planning applications. All these factors are affecting investment decisions.

In addition, having appropriate skills and expertise in the minerals planning sector (both the public and private sector) are of crucial importance. There is currently concern that a shortage of people with the required skills may prejudice the delivery of an adequate supply of minerals needed for economy if this is not addressed[17].

There are a number of other specific issues that could impact on future continuity of supply. It remains crucially important that mineral resources, and particularly those that are geologically scarce, together with the facilities for transporting minerals (and secondary materials) by rail, sea and inland waterways, are safeguarded against non-mineral development.

Mineral workings with a planning permission granted prior to 1981 have a deemed cessation date of 2042[18], unless a revised permission has granted a different date. Sites with sufficient reserves and a life expectancy beyond 2042 will, therefore, need a new permission to continue. At this stage it is not known what tonnage of mineral reserves or production could be affected if companies do not renew relevant permissions, but this is an issue that will require consideration in the future by Government and the onshore mineral industries.

National climate change and Government policies aimed at mitigation and adaptation cannot be divorced from any discussion of future minerals supply. The impact of policy on the fuels used in electricity generation and on carbon reduction targets can undermine the

[17] In response to an earlier UKMF Working Group Report in 2011, the Institute of Quarrying is currently developing and testing an introductory distance learning unit for planning staff new to the specialised aspects of minerals work. In Scotland funding has been secured for a training programme in association with local authorities.

[18] The Town and Country Planning (Minerals) Act 1981 requires all planning permissions for mineral working granted since 1981 to have an end date.

competiveness of many energy-intensive industries. The cumulative energy tax regime in the UK and, for example, the Carbon Floor Price applied only in the UK, is proving very challenging. Ceramics, glass, chemicals, cement, lime and plaster products are consumers of minerals principally sourced in the UK, but are potentially at an energy cost disadvantage which may threaten their international competiveness and ultimately their ability to continue to supply UK markets.

5 Future minerals scenarios

There are many issues that are likely to affect access to minerals in the future. The principal ones are summarised above. In order to understand how these issues or 'drivers' might affect future minerals supply in the UK they were used by the Working Group to develop, explore and analyse impacts resulting from three future scenarios. Scenarios are not predictions or forecasts, instead they provide a means by which people can explore alternative futures to identify what's in their control, what isn't and what needs to change to ensure future success. Scenarios are designed in such a manner that they provoke and encourage debate about alternative futures thus supporting strategic thinking and decision-making[19]. They are a useful mechanism for looking beyond current 'long-term' policy making, the majority of which only looks forward to 2020 or 2030.

5.1 WORKING GROUP SCENARIOS

To assist in the scenario development process the World Economic Forum (WEF) Mining and Metals scenarios[20] were used as the basis for presenting three alternative futures for the UK. The principal drivers of change affecting minerals supply in the UK informed the modification of the WEF scenarios making them specific to a future UK. Each of the resulting scenarios (Green Britain, Britain Powering Growth and Insular Britain) was based on differing influences from the geo-economic landscape, the geopolitical landscape, the economic outlook and the environmental outlook and are summarised in Table 2.

The scenarios were presented at a one-day workshop. Participants, drawn from national and local policy-makers, the minerals industry, NGOs and academia were provided with an opportunity to explore how demand, sourcing and supply of minerals in the UK might vary in the future under each scenario in order to improve understanding of the long-term impact of their key characteristics on the minerals sector. Exploration of the scenarios provided an opportunity to also identify the risks and rewards facing industry, citizens and Government[21].

Assessment by workshop participants of each scenario on what it would mean for the UK in terms of how people live, work and consume provided an indication of the expected impact of the scenario on the general sourcing and supply of minerals in the UK (Table 3).

[19] Alternative future scenarios for marine ecosystems. Cefas - http://www.cefas.co.uk/Publications/techrep/afmec_techrep.pdf

[20] The World Economic Forum mining and metal scenarios to 2030 - http://www.weforum.org/pdf/scenarios/MetalsMiningScenarios.pdf

[21] Future Minerals Scenarios for the UK. Report from the scenarios workshop. November 2013. *Waverley Management Consultants Ltd.* http://www.bgs.ac.uk/ukmf/home.html

Table 2. The UK in 2050 - scenario summaries

Green Britain	Britain Powering Growth	Insular Britain
Low cyclical growth with some stagnation.	Free markets and open borders in the EU generate strong cyclical growth in the UK.	Economic stagnation and volatility.
Push for free markets and open borders - but some political instability.	The UK economy is strong and the largest in Europe.	Geopolitically unstable, with controlled markets and closed borders.
A decisive and ambitious approach to tackling environmental challenges.	Geopolitically stable.	Resource security in the UK overrides other issues and the state maximizes use of domestic resources.
Environmental issues are of overriding importance to the UK.	Short termism is prevalent and there is a reactive and incremental approach to environmental issues.	Reactive and incremental approach to the environment.

Table 3. Impact of the different scenarios on UK sourcing and supply of minerals

Green Britain	Britain Powering Growth	Insular Britain
Requires the UK to maximise self-sufficiency in minerals.	Demand for minerals would increase.	Requires the UK to maximise self-sufficiency in minerals.
Environmental stance means that efficiency and amount of recycling needs to be maximised in order to lower consumption of primary minerals.	Whilst recycling of minerals would be undertaken there would be less of a drive towards recycling.	Controlled markets means that that efficiency and amount of recycling of minerals and in particular metals needs to be maximised. Innovation required to find ways of replacing imported products.
Careful and strategic management required to ensure mineral supply.	Supply of minerals would be market driven, with cheapest price being the overarching consideration (including imports). Security of mineral supply would be fragile.	Policy and regulation would be required to optimise production of indigenous minerals (which is of overriding concern). Security of mineral supply would be fragile.
Focussed policy and regulation would be required to drive change towards Green Britain.	No strategy or plan for UK mineral/energy supply.	Government is likely to be under resourced and fire-fighting. There is no public participation in planning development.
Energy intensive industries decline.	Energy intensive industries stabilise or grow.	Energy intensive industries may stabilise or decline (fewer exports).

In addition to assessing the impact of the scenarios, participants at the workshop also identified different risks and rewards for three stakeholder groups: the minerals industry, Government and UK citizens. These are summarised in Table 4.

Perceptions of those participating in the workshop across a range of factors indicated that looking forward to 2050:

- *Britain Powering Growth* is the most plausible scenario and is the one which is closest to now, suggesting they believe the *status quo* is likely to remain in place.
- *Britain Powering Growth* is also closest to the future that the majority of workshop participants believe that current Government policy is creating.
- *Green Britain*, however, is closest to what the future participants' organisations are planning for, but is one that requires the biggest change within the minerals sector to achieve.
- *Green Britain* is also closest to the future the majority of participants personally aspire to.

Scenario analysis provides a useful way of assessing implications arising from an uncertain future. Information gathered during the scenario development process and subsequent workshop reflect the key concerns surrounding future minerals supply in the UK.

The backwards trends analysis, identification of key issues affecting future UK minerals supply and the results from the scenarios workshop, have together informed the conclusions and recommendations made by the Working Group.

Table 4. Risks and rewards facing stakeholders

	Green Britain		Britain Powering Growth		Insular Britain	
	Risks	**Rewards**	**Risks**	**Rewards**	**Risks**	**Rewards**
Industry	Costs will increase. Competition will increase. UK production decreasing. Imports increase of minerals and finished products containing minerals. Need long term strategy to manage supply. Energy generation capacity gap/blackouts.	Export opportunities in some areas will increase. Sustainable business growth offers potential.	Barriers to production will increase. Business will be more competitive. Infrastructure will be weaker. Public opinion will be unfavourable. Political challenges will increase.	Strong demand means big rewards.	Investment is reduced. Demand declines. Production is compromised. Exports decrease.	Markets may be more predictable. Opportunities for increased production.
Government	The transition will be difficult domestically. Societal divisions could be reinforced. Different approaches may cause global instability.	Societal well-being will increase.	Some big challenges to maintaining the *status quo.*	Plenty of funding available to build a stronger society.	UK will be politically and economically isolated. Social unrest. Demographics are a challenge.	Government has greater control over resources.
Citizens	Cost of living will increase. Choice will reduce. Central Government will take more control. Citizens will need to retain a global focus.	Society will have a sense of shared purpose. Change will create new opportunities.	Environmental risks will increase. Individualism will increase. Societal tensions will increase.	Rewards will be unevenly distributed.	Quality of life will fall. Insecurity will rise. UK will be marginalized.	Communities might feel more empowered. UK will need to be more self-reliant.

6 Conclusions

A steady and resilient supply of minerals is essential, not optional, for the UK economy, and hence the life and well-being of our population. Some key facts are:

- minerals are the largest materials flow in the economy with some 290 million tonnes produced in 2012, of which 193 million tonnes was from onshore;
- UK onshore and offshore mineral production in 2012 was valued at £34.5 billion about 2% of GDP;
- over 80% by tonnage (167 million tonnes) of onshore and marine-dredged minerals were used in construction in 2012 – the essentials of cement, concrete, road construction, bricks, tiles, mortar, plaster products and groundwork engineering. UK construction output accounted for £83,736 million representing 5.5% of UK GDP in 2012;
- production of industrial minerals such as salt, potash, kaolin, ball clay, silica sand, industrial carbonates and fluorspar were valued at approximately £1 billion in 2012; in addition they support downstream, valued-added industries and some important export markets;
- the UK's energy minerals (onshore and offshore) supplied 46% of our total primary energy demand in 2012.

Clearly the expansion of renewable energy, recycling, waste minimisation, and resource and energy efficiency should all be vigorously pursued. However, under any future scenario the UK will still need to access and use newly-extracted minerals.

Looking ahead to 2050, globally the UK faces increasing competition for raw materials. Mineral demand is being driven by expanding populations, and rising incomes and expectations, particularly in emerging economies. In the present global economy imported mineral supplies cannot be guaranteed.

Future access to supplies is likely to become more challenging through growing geopolitical uncertainty and the risk of supply disruption, not least because of a high concentration of production of key minerals in specific countries, notably China. Closer to home, there is uncertainty about the future make-up of the UK and its relationship with the EU. This could impact on mineral prices and availability. Uncertainty in turn may well affect future investment in the domestic minerals supply chain, particularly as the UK's minerals sector is now largely foreign owned and free to divert investment elsewhere.

The UK is not self-sufficient in a number of key minerals, notably metals and increasingly in oil, gas and economically viable coal. The future potential to access unconventional fuels in the UK, notably shale gas, is unknown and requires significant further investigation.

On a more positive note, the UK has adequate resources to sustain the economic production of many non-energy minerals, particularly for construction use, to 2050 and beyond. If the UK is to achieve sustainable economic growth and rebalance its economy towards production and manufacturing, long-term access to domestic supplies of these minerals is of crucial importance.

The UK's current population and household growth, together with climate change mitigation measures, are already major drivers for:

- more homes;
- new and improved infrastructure (including essential increases in road and rail capacity);
- enhanced flood and coastal protection; and
- low and zero carbon power generation.

These factors and others point to a continuing and potentially increased demand for a wide range of minerals (particularly construction minerals) sourced in the UK. Responding to these drivers will be a matter of national urgency over the 35 years to 2050.

The need to access minerals in the UK has, of course, to be balanced against the adverse impacts of mineral working on valued and sensitive landscapes, habitats and heritage assets. These have intrinsic merit in their contribution to the nation's identity and sense of well-being. Over the decades since 1945 a comprehensive system of protection for the nation's environmental and cultural assets has been developed. The currently accepted balance provided by national environmental and spatial planning policies affords those assets an appropriately high degree of protection.

In the case of interests designated under European Directives, this protection can only be set aside to allow development to proceed if there are reasons of overriding national importance. So far the UK has generally been able to maintain adequate and steady supplies of the minerals needed by its economy and society within this highly protective environmental framework. It is hoped that this will continue to be the case over the period towards 2050.

Taking all these factors into account, this Group considers there are several key challenges with clear potential to affect the UK's minerals supply to 2050:

Key challenges

- **Understanding that increasing geopolitical uncertainty is having, and will continue to have, major impacts on the supply of energy and other vital minerals**, and the need to frame effective responses;

- **Resolving the apparent conflict between a 50% target cut in the trade gap in construction products and materials by 2025 and carbon and energy pricing policies** that discourage domestic production and send jobs abroad;

- **Balancing environmental factors with the economic and social factors driving demand for minerals**, and that environmental regulation and controls are proportionate to the significance of proposed mineral sites and their settings; and

- **Managing uncertain operator commitment**: extensive foreign ownership of the UK's non-energy minerals industry risks investment seeking higher returns in countries with faster and more predictable regulation and taxation.

A number of other related challenges flow from these:

- **Delivering an adequate supply of UK-won construction materials to meet the needs of the nation's growing population** for housing, other employment-generating development, renewed infrastructure after decades of under-investment, building lower and zero carbon energy generation and substantially increased flood and coastal defence.
- **Getting the balance right in responding to climate change:**
    - recognising that unrealistic carbon reduction targets and excessive taxes undermine the competitiveness of energy-intensive mineral processing industries;
    - shifting from the mistaken focus on production-based greenhouse gas emissions to concentrate on consumption emissions. The former potentially forces energy-intensive mineral processing overseas, only to add embodied manufacturing and transport emissions to the imported products consumed in the UK;
    - promoting energy efficiency within the minerals supply chain.
- **Overcoming the lack of public and political recognition that UK-won minerals are central to much major downstream manufacturing**, enhancing security of supply, creating wealth and providing employment.
- **Securing regulatory certainty through**:
    - stable, realistic national planning policy;
    - efficient and consistent policy implementation to ensure continuity and adequacy of minerals supply;
    - sound and up to date local mineral plans;
    - wider public and local political acceptance of the need for mineral working and better local understanding that as minerals are not evenly distributed they may be extracted in one place but used elsewhere.
- **Maintaining mineral industry performance and innovation by:**
    - adapting to change and embedding continually improving technology;
    - improving working and restoration standards that lead rather than react to public expectations and regulatory standards.
- **Improving resource efficiency:** making best use of the UK's domestic minerals where economically and environmentally feasible, and by promoting recycling, re-use and waste minimisation.
- **Responding to increasing energy costs, supply insecurity, and diminished resilience** as the UK increasingly relies on oil, gas and coal imports recognising:
    - increased gas prices damages the competiveness of energy intensive industries;
    - inadequate gas storage capacity increases UK vulnerability to supply disruption.
- **Clarifying whether the UK's unconventional hydrocarbon resources – primarily shale gas/oil - can realise their potential** to become a major energy supply at acceptable economic, political and environmental cost.
- **Responding in the medium and longer term to possible near-term constitutional changes** after the 2014 Scottish referendum[22] and if the UK decides to leave the EU.

[22] On 18 September 2014 the Scottish independence referendum took place and Scotland voted to stay part of the United Kingdom.

7 Recommendations

Taking into account the conclusions from the Future Scenarios Workshop and its wider discussions with stakeholders the Working Group therefore recommends:

1. **Creating a national long term vision and strategy for UK minerals supply as an integral part of Britain's future industrial strategy.**

   The minerals industry should work alongside policymakers and other interested stakeholders to develop a shared long-term vision and strategy that has wide political support. As a working concept this should take the form of a UK minerals strategy. Any such project must acknowledge future risk and uncertainty, accept and define the strategic role of future minerals supply, and set a broad framework to guide future policy.

2. **Concerted action to help policymakers understand the importance of minerals supply to the UK economy and society, and its challenges**.

   That will help develop effective policy and legislation that responds to social, environmental and economic change through enabling the long term production and supply of necessary minerals.

3. **Building public acceptance that we must plan realistically for the essential contribution of minerals to living**.

   Many people accept 'in principle' that we must renew our infrastructure, build more homes, and respond to climate change (for example by developing lower-carbon energy generation and – topically – improving our flood and coastal defences). However, the public seems less willing to accept this requires a supply of indigenous minerals supply which in turn necessitates the working of land[23]. And few people realise that high quality restoration of some quarry sites can create valuable biodiversity habitats and public recreation facilities, and may cut flooding by increasing floodplain capacity and carbon storage.

4. **Effective review and monitoring by all parties of progress in delivering an agreed minerals strategy, and adjusting it in response to emerging events to keep it on track**.

   A possible UK Minerals Strategy based on a shared vision is not a sufficient condition for success; the delivery of any such Strategy must be effectively managed. Government as the policy-maker, the statutory regulators and the minerals industry must all be able to monitor progress, evaluate the evidence in collaboration, and if necessary adjust the path as events intervene and new trends emerge.

5. **Continued discussion and collaboration between Government and industry to deliver the vision in any Minerals Strategy that might be developed.**

   Industry stands ready to do its part. Government in turn must ensure it has capacity and expertise to understand the essential characteristics and needs of onshore

[23] The Coalition Government has very recently completed its overhaul of planning policy and supporting guidance. The delivery of this structure in securing the future supply of essential UK land-won minerals must now be carefully monitored against these priority requirements. Other regulatory issues remain to be worked through, for example including the management of water on minerals sites.

mineral working in the UK, and respond with sustained data collection, monitoring and, where necessary, adjustments of regulation, taxation and other policies.

6. **Boost the resilience of the UK minerals industry**

   The Strategy and subsequent policy framework needs to enhance and support the industry's resilience to adapt and survive. Developing a shared vision will help, but delivery requires realistic policies and an appropriate regulatory framework that allows the sector to adapt where necessary in continuing to meet the UK's strategic needs

7. **Develop capability and foresight to anticipate future changes**

   It would be vital in framing and implementing the proposed UK Minerals Strategy to monitor and analyse emerging trends and developments impacting on the UK minerals industry, and understand the implications for future demand and supply. All the organisations involved with the minerals sector will need to be fully engaged in this work. However, it is especially important that national Government and its agencies have access to high quality and impartial information, and staff with the skills and experience to understand it, if they are to frame the necessary policy changes and any adjustments of regulation.

Annex A: Summary of UK mineral resources

Energy minerals	**Markets**	**Resources (a)**
Conventional onshore oil	Fuel.	Limited resources, a fraction of offshore resources, and declining production. Principal oilfield in Dorset.
Conventional onshore gas	Electricity generation and domestic/industrial fuel.	Limited resources, a fraction of offshore resources, and declining production.
Shale gas	Potentially electricity generation and domestic/industrial fuel. Chemical feedstock.	Very large resources but evaluation at a very early stage and yield and economic viability as yet unknown.
Shale oil	Fuel.	Requires commercial evaluation.
Coalbed methane (CBM)	Electricity generation and domestic/industrial fuel.	Potential recovery from unworked coal seams depends not only on methane content but, importantly, coal permeability. UK coals have low permeability which limits their potential for CBM. Evaluation ongoing.
Underground coal gasification	Electricity generation and domestic/industrial fuel.	UK resource potential largely unknown. Unlikely to be acceptable onshore but near shore prospects exist. Requires demonstration project.
Shallow coal	Primarily electricity generation.	Identified resources about 800 Mt. Economic viability depends on future coal price and planning access for surface mining. Access increasingly constrained by competing surface development.
Deep coal	Primarily electricity generation.	Large resources but at current and foreseeable coal prices, and EU/UK environmental policies, deep mine development unlikely. (The necessary very large investment would require long-term price guarantees linked to future coal-fired generation with CCS).
Construction minerals		
Land sand & gravel	Concrete & concrete products; mortar & asphalting sand.	Relative importance as a source of construction aggregate has declined. Resources widely distributed and closer to centres of demand, but superficial deposits thin and bedrock resources mainly comprise sand. Over 10 years to 2012 only 43% of sand and gravel reserves with planning permission have been replenished. Increasingly constrained by competing surface

		development.
Marine-dredged sand & gravel	Concrete & concrete products; construction fill, beach nourishment & exports. Important source of supply for London & South East. Ability to supply large volumes close to the point of demand.	Significant resources present across the UK Continental Shelf sufficient to sustain current output for >50 years with the potential to respond to future demands. Sand more abundant than gravel. Environmental constraints and competition from other marine area users.
Crushed rock (limestone, igneous rock, sandstone)	Asphalt, roadstone, concrete, concrete products, railway ballast, armour stone, construction fill.	Large resources, but unevenly distributed. Resources mainly in north & west (SE England almost totally devoid of resources) but also forms attractive upland scenery and heavily constrained by range of environmental designations. Crucial issue is where the next generation of strategic rail-linked, hard rock quarries capable of supplying London & the SE will be located.
Limestone, chalk	Cement manufacture.	Very large resources but extensively constrained by environmental designations. Cement manufacture is energy intensive and future UK production may depend on carbon pricing policies. Wide range of waste products, including tyres, used as alternative fuels and raw materials, helping to reduce carbon emissions as well as providing an energy efficient and controlled disposal of waste.
Brick clay	Primarily manufacture of building bricks but also clay tiles & pipes.	Large & diverse resources providing a wide range of distinctive bricks. However, the 'Etruria Marl,' the premier brick clay resource, has restricted occurrence and is extensively sterilised by urban development. As with cement, high energy costs may deter future investment in UK clay product manufacturing. Current shortage of finished product supply and brick imports increasing.
Fireclay	Light-firing building bricks.	Associated with coal seams and mainly a by-product of surface coal mines. Future availability largely dependent on future of surface coal mining.
Gypsum ($CaSO_4.2H_2O$)	Plasterboard, plaster & cement manufacture, some speciality uses.	Mainly produced by mining at several locations in England. Resources are restricted to relatively small, near surface deposits (typically <150 m); developing future mines will be challenging in terms

		of identifying workable deposits and the time needed to obtain planning approval and capital investment required. Desulphogypsum from some coal-fired power stations is an important supplement to supply for plasterboard but its longer term availability is not assured.
Industrial minerals		
Salt (NaCl)	Basic chemical feedstock, white salt & for road de-icing.	Huge resources mainly confined to England, more limited resources in Northern Ireland. Principal resources in Cheshire Basin. Salt solution caverns important for natural gas storage.
Potash (potassium-bearing minerals – sylvine (KCl and polyhalite – complex K,Ca, Mg sulphate)	Principally fertilizers - Potassium is an essential plant nutrient.	Large resources, notably of polyhalite, underlie at depth (>1200m) extensive parts of east Yorkshire, mainly within the North York Moors NP. Resources and workings extend offshore. Existing and proposed new mine are within the National Park. Polyhalite is a new product not extracted elsewhere and for which a market is being developed.
Silica sand	Glass manufacture (containers, flat & speciality), foundry sand, & range of industrial, agric/horticultural and sports uses, including in oil and gas development.	Silica sands differ markedly in purity & grain size depending on particular use. Silica sand resources for colourless glass are limited in England, although more extensive in Scotland. For some speciality uses requiring specific grain-size distributions resources are limited.
Industrial carbonates (Limestone, chalk –$CaCO_3$- and dolomite – $CaMg(CO_3)_2$)	Wide range of industrial applications, including manufacture of lime and dolime; used in steel and glass manufacture; agricultural and environmental uses.	Very large resources of chemically pure limestone & chalk but heavily constrained by environmental designations. Resources of dolomite more restricted and of lower chemical purity.
Kaolin (china clay)	Papermaking, ceramics, fillers in paints, rubber, plastics. UK's leading non-energy mineral export.	World class resources in terms of quality and size in Cornwall and Devon sufficient to maintain production well beyond 2050.
Ball clay	Principally ceramic whiteware (sanitaryware, tableware and tiles). Leading world producer of high quality ball clay, output mainly exported.	Geographically and geologically restricted resources in south and north Devon, and Dorset. Large reserves (>100 years) of high quality clay in Devon. Dorset deposits more restricted and heavily constrained by landscape and habitat designations.
Fluorspar (CaF_2)	Most important and only UK source of fluorine.	Fluorspar production resumed in 2013 from operations in the Peak District NP,

	Used mainly in the manufacture of a wide range of UK-produced fluorochemicals (e.g. refrigerants, specialty plastics, electronics, solar panels, Li-ion batteries, anaesthetics); and a flux in steel and aluminium production.	historically the most important UK source of supply. Deposits typically of small size and resources principally restricted to Peak District NP. The Milldam Mine at Great Hucklow is the principal source but surface ore also required. An EU-recognised critical raw material.
Barytes ($BaSO_4$)	Principally used in drilling fluids for oil and gas exploration; some specialised filler applications for the car and paint industries, and for LCD glass and dielectrics manufacture.	Modest output from a mine near Aberfeldy in Scotland (20 years reserves) and as a by-product of fluorspar in Peak District. World class deposit (7 Mt high-quality barytes) defined at Duntanlich, near Aberfeldy in Scotland. Proposed mine that could have supplied UK demand for many decades refused planning approval after an appeal in 1996. This major deposit may never be worked.
Metallic minerals		
Wolframite & cassiterite	Principal sources of tungsten and tin.	World class tungsten deposit at Hemerdon, near Plymouth in Devon currently being developed for production in 2015; expected output of about 3,500 t/y tungsten concentrate and 450 t/y tin-in-concentrate.
Gold	Gold	Minor production in Northern Ireland. One mine at Cononish in Scotland is fully permitted and will likely be developed when the gold price recovers. Other prospects being explored, some with associated copper mineralisation, in Scotland.

(a) Mineral resources are natural concentrations of minerals, or bodies of rock (or fluids such as oil and gas) occurring in sufficient quantity and with physical and/or chemical properties of intrinsic value that are, or may become, of potential economic interest for the extraction of a mineral product.

Reserves are that part of a **mineral resource** that may be commercially worked after consideration of all technical, economic and legal factors, including planning permission. In the UK without a valid planning consent no mineral working can take place.

Annex B. Summary statistics

MINERALS PRODUCED IN THE UNITED KINGDOM, 2012

	Thousand tonnes
ENERGY MINERALS	
Coal: Deep-mined	6 153
Coal: Surface-mined	10 188
Coal: Other (a)	760
Oil: Onshore (incl. natural gas liquids)	883
Oil: Offshore (incl. Natural gas liquids)	43 677
Gas: Onshore (oil equivalent) (incl. colliery methane)	76
Gas: Offshore (oil equivalent)	38 858
CONSTRUCTION MINERALS	
Aggregates:	149 477
of which: Land-won sand & gravel	*41 800*
of which: Marine-dredged sand & gravel	*14 227*
of which: Crushed rock	*93 450*
Clay & shale for construction	491
Cement raw materials (limestone, chalk, clay & shale) (GB only)	10 670
Clay & shale and Fireclay (mainly for bricks)	3 665
Gypsum, natural	1 200
Slate	701
Building (dimension) stone (GB)	1 017
INDUSTRIAL, AGRICULTURAL AND HORTICULTURAL	
Limestone / Dolomite / Chalk (Industrial use) (GB only)	7 557
Limestone / Dolomite / Chalk (Agricultural use) (GB only)	1 580
Salt (in brine & brine salt) & rock salt	6 100
Potash (refined potassium chloride) (b)	900
Silica (Industrial) sands	3 888
Kaolin (china clay) (b)	1 150
Ball clay (b)	748
Fluorspar (c)	0
Barytes	31
Peat (d)	428
Other minerals (e)	4
UK Landmass	**193 439**
UK Continental Shelf	**96 762**
TOTAL	**290 201**

(a) Slurry etc. recovered from dumps, ponds, rivers.
(b) BGS estimate.
(c) Fluorspar production resumed in 2013.
(d) Converted from thousand m^3.
(e) Other minerals: calcspar, china stone, talc, gold, silver, chert and flint.
GB: Figures for Great Britain only.

Sources: MineralsUK.com: UK Minerals Yearbook, British Geological Survey; Office for National Statistics; Department for Business, Innovation and Skills.

USE OF SELECTED SECONDARY MATERIALS IN THE UNITED KINGDOM, 2012

	Thousand tonnes
RECYCLED AND SECONDARY MATERIALS (a)	
Recycled aggregates	49 200
of which: - construction, demolition & excavation waste	43 000
- *asphalt planings*	5 000
- *railway ballast*	1 200
Secondary aggregates	11 170
of which: kaolin & ball clay (sand and rock)	3 000
colliery spoil	800
furnace bottom ash	800
incinerator ash	1 000
pulverised fuel ash (pfa)	500
iron & steel slag	1 000
slate waste	660
glass	500
clay & shale	560
other/unallocated	2 250
OTHER SECONDARY MATERIALS	
Cementitious materials: Pulverised fuel ash & blast furnace slag (a)	2 000
Desulphogypsum (b)	1 500
Glass cullet (remelted for glass making) (c)	764
Iron and steel scrap (UK consumption) (d)	3 674.5
Aluminium (secondary production) (e)	148.8
Lead (secondary refined production) (e)	155
Copper (direct scrap used by manufacturers) (e)	120

Sources:
(a) Mineral Products Association
(b) UK Minerals Yearbook, BGS
(c) Environment Agency National Packaging Waste Database
(d) Iron and Steel Statistics Bureau
(e) World Bureau of Metal Statistics

TRENDS IN UK MINERALS PRODUCTION

	Production		**Peak production**	**Self sufficiency**	
	Thousand tonnes			***%***	
	1970	**2012**		**1970**	**2012**
Crude oil (a)	156	44 560	137 760	1	65
Natural gas (oil equiv.)	9 720	38 934	110 926	92	53
Coal	144 571	17 101	147 144	94	27
Aggregates (GB)	208 000	133 000	300 000	100	100
Bricks (millions)	5 515	1 371	6 315	100	93
Cement	17 171	8 529	17 781	100	82
Kaolin	2 369	1 150	2 785	100	100
Ball clay	732	748	1 020	100	100
Salt	9 029	6 100	9 029	100	82
Gypsum, natural & synthetic	2 796	2 745	3 700	96	84
Potash	0	900	1 040	0	100
Silica sand	5 782	3 888	6 775	100	94
Fluorspar (b)	199	30	235	100	40
Barytes	22	31	41	26	27
Fuller’s earth	176	0	216	84	0
Iron ore	12 000	0	12 000	37	0
Tin-in-concentrate (c)	1.7	0	5.2	9	0

(a) Including natural gas liquids
(b) 2013. Fluorspar production resumed in 2013
(c) Minor tin output will resume in 2015 when the Hemerdon tungsten operation starts production.

Annex C: Working Group membership

Joseph Mankelow	Chairman, British Geological Survey
David Highley	Secretary, Independent
Andrew Bloodworth	British Geological Survey
Bob Brown	Campaign to Protect Rural England
Lauren Darby	British Ceramic Confederation*
Jim Davies	Environment Agency
Bob Fenton	MAUK/MIRO/CBI Minerals Group
Peter Huxtable	British Aggregates Association/CBI Minerals Group
Ken Hobden	Mineral Products Association
Jeremy Lake	English Heritage
Bob LeClerc	Executive Secretary, CBI Minerals Group
Jerry McLaughlin	Mineral Products Association
Mark North	Kier Minerals/CBI Minerals Group
Ian Selby	The Crown Estate/CBI Minerals Group
Michelle Spence	Derbyshire County Council/Planning Officers Society

* *Corresponding member*