Communities and Local Government

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Mineral Planning Factsheet

Cement

This factsheet provides an overview of the raw materials that are used in the manufacture of cement in the UK. It is one of a series on economically important minerals that are extracted in the UK and is primarily intended to inform the land-use planning process.

March 2014.

Cement is a manufactured product consisting essentially of a mixture of calcium silicates and calcium aluminates. These compounds react with water and in so doing cause the cement to set. The requirement for calcium is supplied by limestone, or chalk, and clay/mudstone is the source of most of the silica and alumina. Cement is produced by firing a carefully controlled mixture of limestone and clayey raw material at sufficiently high temperatures to produce **cement clinker**. The finished cement is produced by finely grinding together about 95% cement clinker and 5% gypsum/anhydrite; the latter helps to retard the setting time of the cement. This factsheet considers the principal raw materials used in cement manufacture, notably **limestone** (calcium carbonate, $CaCO_3$), including **chalk**, and also **mudstone** (clay/shale). (See also Factsheet on **Gypsum/anhydrite**).

There are a number of different types of cement, standardised under BS EN 197-1 into five categories (Table 1). Portland cement (previously called 'Ordinary Portland Cement' or OPC), also known as CEM I, is the most widely produced type both in the UK and elsewhere. Blended or composite cements, for example CEM II, are becoming more important. In the UK these are generally produced by fine grinding cement clinker with either pulverised fuel ash (also known as fly ash) from coal-fired power stations, granulated slag from the iron industry or limestone fines, together with gypsum or anhydrite. The term 'Portland' Cement was so named by its inventor in 1824 because of the resemblance of the set material to Portland Stone, the well-known natural building stone.

Cement kiln.

Demand

Cement is an essential constituent of concrete, which is a mixture of cement, coarse and fine aggregate, and water. Once the water has been added, this material can be placed *in situ* or cast in moulds. It is a highly versatile building material valued for its high compressive strength, fire resistance, mouldability, impermeability and durability. Mortar (a mixture of cement, fine aggregate and water) is used for joining structural block and brickwork, plastering, rendering and as a floor screed (top layer of a floor). Both concrete and mortar are vital, and essentially irreplaceable, construction materials for the building and civil engineering industries. They are widely used in all construction sectors, including housing, road construction, bridges and dams, and in other infrastructure projects, such as railways, airport facilities, hospitals, schools, new offices and shops. Demand for cement is a function of economic activity as a whole, but construction activity in particular, which can be highly cyclical.

Supply

The cement industry in Great Britain consumed some 9.3 million tonnes of limestone and chalk and about 1.4 million tonnes of clay/mudstone in 2012, together with about 0.3 million tonnes of gypsum/anhydrite and much smaller quantities of ancillary materials, including silica sand, pulverised fuel ash (PFA) and iron oxides. Cement plants have clinker capacities

Category	Description	Proportion of cement clinker	Proportion of other constituents
CEM I	Portland cement	95–100%	0–5%
CEM II	Blended cements (sub-divided depending on the material used, e.g. 'Portland fly ash cement', 'Portland slag cement', 'Portland limestone cement', etc.	65–94%	6–35%
CEM III	Blastfurnace cement (incorporating ground granulated blastfurnace slag or G.G.B.S.)	5–64%	35–95%
CEM IV	Pozzolanic cement (incorporating natural or synthetic pozzolanic material, e.g. volcanic ash)	45–89%	11–55%
CEM V	Composite cement (incorporating both G.G.B.S. and pozzolanic material)	20–64%	18–50% G.G.B.S 18–50% Pozzolanic material

Table 1 Categories of cement materials under BS EN 197-1.

of between 0.48 Mt/y to 1.5 Mt/y. They are, therefore, major consumers of mineral raw materials with, approximately 1.6 tonnes of dry raw materials being required for each tonne of clinker produced. However, the total quantity of raw material will vary depending on local circumstances and the proportions of the different cement categories used.

The cement industry had its origins in South-east England, in the mid 19th Century, where it was based on chalk. This was because of the ease with which chalk and clay could be converted to a uniform slurry with the equipment then available. The industry became concentrated along the Thames, east of London, and in the Medway valley of Kent. The later introduction of more efficient grinding mills made the use of harder limestone and mudstone possible without the need to add water for mixing and homogeneity. In addition, rising energy prices favoured the use of the dry process based on limestone instead of chalk using the wet process. Consequently, there has been a declining use of chalk relative to limestone in an overall declining market (Figure 1). In 2012, limestone accounted for about 79% of the total requirement for calcareous raw material. This represents a notable increase from the equivalent figure for 2006 of 62% and this is probably due to the closure of the cement plants at Northfleet and Westbury which previously used chalk.

For many years up to 2007, UK cement clinker production has been in the range 10 Mt/y to 15 Mt/y, albeit with a generally declining trend.

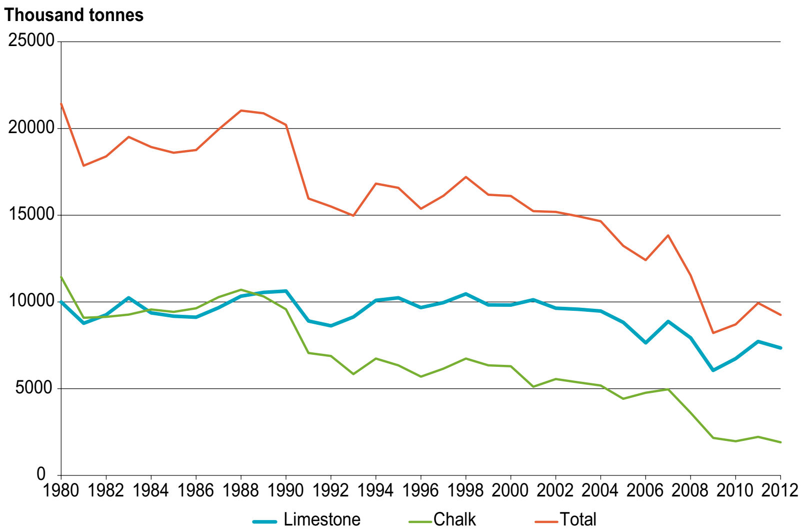

Figure 1 Great Britain: Production of limestone and chalk for cement manufacture, 1980–2012.
Source: United Kingdom Minerals Yearbook, BGS.

Cement

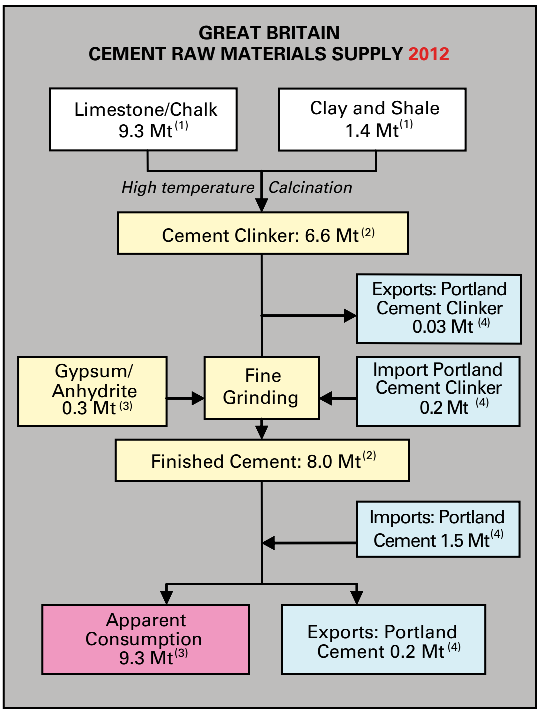

Figure 2 Cement raw materials[5] supply chain, 2012.

1 Annual Minerals Raised Inquiry, Office for National Statistics
2 Monthly Statistics, Building Materials and Components, Department for Business Innovation and Skills
3 BGS estimate
4 HM Revenue & Customs
5 For simplicity, this figure ignores the recycled material used as fuel for cement plants. Part of this material may be chemically incorporated into the cement clinker during the process

However, the recession that began in 2008 has caused UK cement clinker production to fall below 10 Mt/y. Clinker production in Great Britain was some 6.6 Mt in 2012, figures for Northern Ireland are not available. Output is seasonal, with production levels substantially higher from March to October when construction activity is greatest. The supply chain for cement raw materials is shown in Figure 2.

Trade

In the late 1970s and very early 1980s, the UK was a significant exporter (>1 Mt/y) of cement. However, increasing competition in overseas markets has led to a decline in exports and from 1987 onwards, the UK has become a net importer (Table 2). UK imports of cement (clinker and Portland cement) were valued at about £113 million in 2012 compared with £48 million for exports. Cement imports can be cyclical and affected by excess availability in exporting countries where, in periods of low domestic demand, producers are forced to export to maintain volumes to cover high fixed costs.

Consumption

UK consumption of cement includes cement made from indigenously produced cement clinker, cement made from imported clinker and imports of finished cement (see Figure 2). Total UK consumption of cement in 2012 was 9.3 million tonnes, of which 86% was supplied by the UK industry and the remainder was imported. Total consumption of cementitious material (including blended cement) was 10.5 million tonnes in 2012.

Economic importance

The value of UK sales of Portland cement, including blended cements, was £656 million in 2011. Some 2500 people are directly employed in the industry, with a further 15 000 jobs supported indirectly. Cement is an essential material for the UK construction industry, which is a major sector of the economy. In 2012 the total value of the work completed in the construction sector in Great Britain was £116.0 billion: £71.4 billion of new work and £44.6 billion of repair and maintenance.

Structure of the industry

There are five producers of cement in the UK, although only four are currently operating. These are (with their approximate share of capacity in 2014): Lafarge Tarmac (36%), Hanson Cement (27%), CEMEX UK Cement (21%), Hope Construction Materials (12%) and Aventas Group (5%). In addition to the sites with cement clinker capacity, a number of other locations exist where the grinding and/or blending of cement are carried out. These locations are listed in Table 3 and shown on Figure 4. The Mineral Products Association is the trade association for the industry.

Lafarge Tarmac is a joint venture company formed in January 2013 and owned jointly

Thousand Tonnes	Cement clinker		Portland cement	
	Exports	Imports	Exports	Imports
2003	61	506	216	1 715
2004	83	377	214	2 034
2005	135	406	321	1 645
2006	91	517	522	1 397
2007	28	837	548	1 561
2008	15	367	324	1 760
2009	5	207	144	1 749
2010	6	201	191	1 852
2011	16	209	184	1 847
2012	31	206	195	1 461

Table 2 UK: Imports and exports of cement clinker and Portland cement, 2003–2012.
Source: HM Revenue & Customs.

by the Lafarge Group of France (the world's largest cement producer) and Anglo American plc (who acquired the Tarmac business in 2000). The amalgamation of the assets of Lafarge Cement UK and Tarmac was reviewed by the Competition Commission in 2011/12 and it was concluded that a number of assets should be divested before the merger could proceed in order to avoid the potential loss of competition in certain specified markets. As a consequence, assets worth a total of £285 million and including the cement plant at Hope in Derbyshire were sold in November 2012 to Mittal Investments.

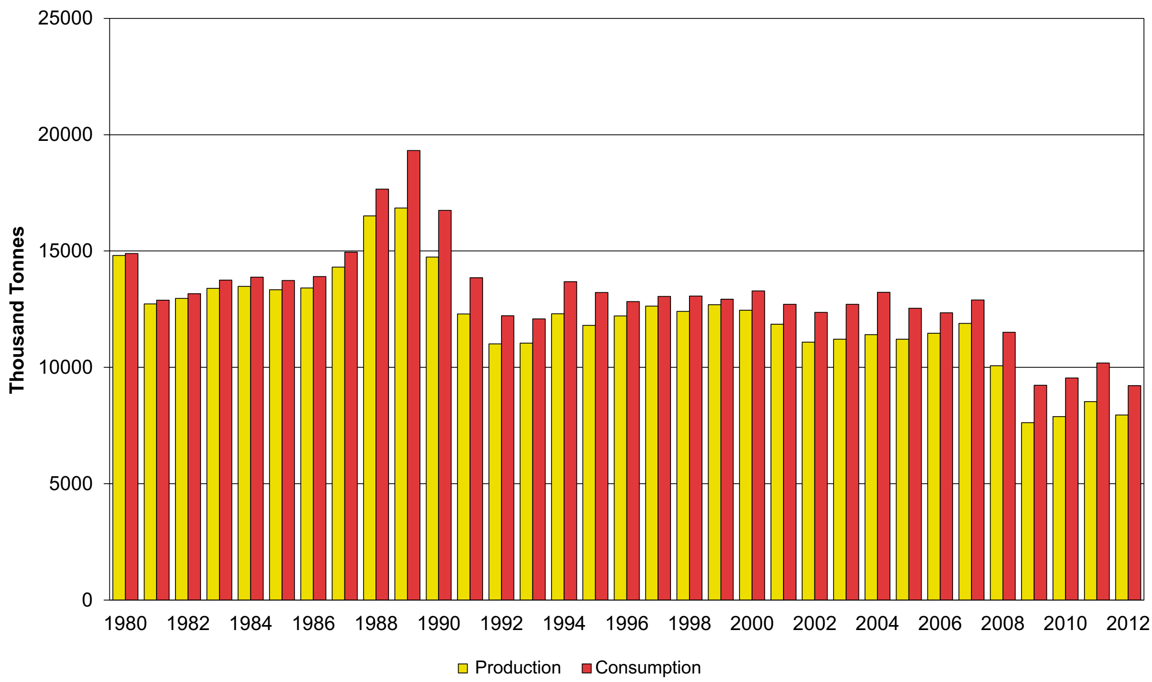

Figure 3 Production and apparent consumption of cement: UK 1980–2001, GB 2002–2012.
Source: Monthly Statistics, Building Materials and Components, DBIS (and predecessors).

Company	MPA	Plant	Cement clinker capacity (Thousand tonnes/year)	Process	Raw materials	Transport
Lafarge Tarmac	Staffordshire	Cauldon	900	Dry	Carboniferous limestone/ mudstone	Road
	Vale of Glamorgan (South Wales)	Aberthaw	500	Dry	Jurassic limestone/ mudstone and Carboniferous limestone	Road
	East Lothian (Scotland)	Dunbar	900	Dry	Carboniferous limestone/ mudstone	Road/Rail
	Tyrone (Northern Ireland)	Cookstown	480	Semi-dry	Carboniferous limestone/ mudstone	Road
	Derbyshire	Tunstead	1095	Dry	Carboniferous limestone/ mudstone	Road/Rail
	Kent	Northfleet		Grinding and Blending		Road/Rail
	Nottingham-shire	Barnstone		Grinding and Blending		
	Northern Ireland	Belfast		Blending		
	Fife (Scotland)	Scot Ash		Blending		
	County Durham	Seaham		Blending		
	Essex	West Thurrock		Blending		
Hanson Cement	Rutland	Ketton	1390	Dry	Jurassic limestone and mudstone	Road/Rail
	Lancashire	Ribblesdale	750	Dry	Carboniferous limestone/ mudstone	Road/Rail
	Flintshire (North Wales)	Padeswood	820	Dry	Carboniferous limestone and colliery spoil	Road
CEMEX UK Cement	North Lincolnshire	South Ferriby	750	Semi-dry	Chalk and Kimmeridge Clay	Road
	Warwickshire/ Bedforshire	Rugby	1500	Semi-wet	Chalk and Jurassic mudstone	Road
	Essex	Tilbury		Grinding and Blending		
Hope Construction Materials	Peak District National Park	Hope	1300	Dry	Carboniferous limestone/ mudstone	Road/Rail
Aventas Group (Formerly Quinn Group)	Fermanagh (Northern Ireland)	Derrylin (mothballed)	500	Dry	Carboniferous limestone/ mudstone	Road

Table 3 UK cement plants with details of their clinker capacity, raw materials and transport, together with other locations used only for the grinding and/or blending of cement.
Source: Mineral Products Association and BGS.

These assets are now operated as Hope Construction Materials.

Hanson Cement is a subsidiary of the Heidelberg Cement Group of Germany, which acquired the UK-based Castle Cement in 2007. CEMEX UK Cement is part of the CEMEX Group of Mexico, who acquired Rugby Cement through its takeover of the RMC group in 2005. The Quinn group was formed by the Quinn family in 1973 and subsequently expanded to include a range of different markets, including cement. The group has experienced financial problems in recent years resulting in the ownership transferring to its former creditors. The group was renamed Aventas in November 2013, but the cement plant at Derrylin is currently mothballed.

In 2011 the Office of Fair Trading referred the aggregates, cement and readymix concrete markets to the Competition Commission because it considered that the market contained features that could "prevent, restrict or distort competition". In 2013, the Competition Commission reported that it did not find any problems with the aggregates or readymix markets, but it had concerns surrounding the structure of the cement industry. It was considered to be "highly concentrated" with "only four cement producers" and that each of the producers "know too much about each other's businesses and have concentrated on retaining their respective market shares rather than competing to the full." The Competition Commission's proposed remedies were published in January 2014. The documents relating to the Competition Commission's investigation, including their final report with details of the proposed remedies, are available online at: http://www.competition-commission.org.uk/our-work/directory-of-all-inquiries/aggregates-cement-ready-mix-concrete. At the time of writing, appeals had been lodged with the Competition Appeal Tribunal.

Resources

The availability of suitable raw materials is normally the determining factor in the location of a cement works. The manufacture of Portland cement requires raw materials that contain four main components; lime, silica, alumina and iron oxides. Limestone, or chalk, is the main source of lime (CaO) and typically accounts for 80–90% of the raw mix. Clay or mudstone accounts for some 10–15% and provides most of the silica, alumina and iron oxides. However, limestone, depending on its purity, may also contribute some of these constituents. Depending on the raw materials used, it may also be necessary to introduce sources of silica, alumina and iron oxides to optimise the mix. The quality of the cement clinker is directly related to the chemistry of the raw materials used. Elements such as magnesium (Mg), sodium (Na), potassium (K) and sulphur (S) are acceptable if kept within certain limits. However, cement with excessive amounts of magnesium (>5% MgO) would not meet specification and the cement would suffer from expansion. An excess of alkalis (K_2O and Na_2O) would also be unacceptable because of durability problems with the concrete (the alkali-silica reaction). However, a high alkali cement is desirable for certain markets due to its reactivity with slag or PFA, helping with early strength. An excess of sulphur can cause operational problems. Thus the raw materials used in cement manufacture must meet relatively stringent quality requirements and, most importantly, be carefully controlled.

Limestones of various geological ages are widely distributed in the UK (Figure 4). They vary considerably in their chemistry and thickness and thus their suitability for cement manufacture on a large scale. Dolomites and magnesian limestones are unsuitable for cement manufacture, because of their high magnesia (MgO) contents. Limestone should contain less than 3% MgO. This precludes the use of limestones (dolomites) of Permian age in England.

Cement manufacture is based primarily on Carboniferous limestones and on the Cretaceous chalk. The former is the most important (see Figure 1). Carboniferous limestones are relatively extensive and occur as thick deposits that are easy to work and which are generally of relatively high purity. The Peak District of Derbyshire has extensive resources and the limestones are

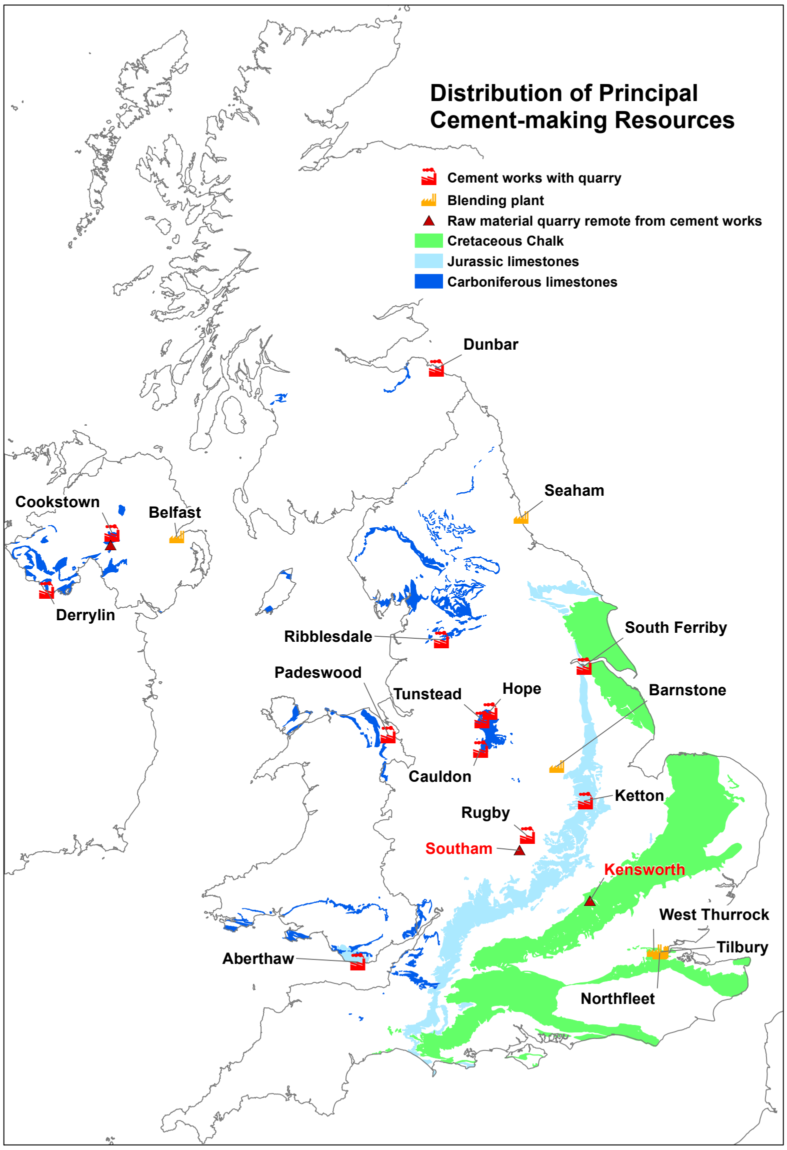

Figure 4 Distribution of the main limestone resources in the UK and the location of cement plants.

characteristically flat-lying and are noted for their uniformity over wide areas. Large areas of the northern Pennines and the fringes of the Lake District are also underlain by Carboniferous limestones, some of which are relatively thick, pure and consistent in quality. Elsewhere, Carboniferous limestones occur mainly in the Mendips, although here they do not exhibit the same degree of purity.

Limestones of Jurassic age occur in a belt extending from the Dorset coast, north-eastwards through central England to the Yorkshire coast. The limestones of Middle Jurassic age are the most extensive, although individual beds are comparatively thin. Currently Jurassic limestone (Lincolnshire Limestone) is worked at only one site in England, at Ketton, in Rutland. As limestones generally have low porosities, and thus low moisture contents, the dry process is used in cement manufacture from these resources. Limestone of Devonian age, which have a restricted distribution in Devon, were formerly worked for cement manufacture at Plymstock, near Plymouth, but this small works closed in 1999.

The Cretaceous Chalk is a soft, fine-grained, white limestone and occurs extensively in eastern and southern England. It is composed of the calcareous debris of planktonic algae, largely in micron-sized plates. It is generally of high purity with a uniform composition. Small quantities (1%) of clay are present throughout the Chalk, and centimetre thick beds of calcareous mudstones also occur. However, the lowest 25–60 m of the Chalk has a higher clay content and it is this material that was formerly extensively worked as a natural cement mix. The chalk is up to several hundred metres in thickness. It is generally highly porous and has a high moisture content. Consequently wet or semi-wet manufacturing processes are normally used to make cement from chalk.

Resources of clay and mudstone suitable for cement manufacture are widespread and normally obtained from quarries adjacent to cement plants. The only exception to this is the Rugby cement plant in Warwickshire where chalk is transported from Kensworth Quarry in Bedfordshire by pipeline and Jurassic mudstones are brought in from Southam Quarry in Warwickshire by road.

In contrast to the rest of the UK, Scotland has few limestone resources. Carboniferous limestone occurs to a limited extent in the Midland Valley of Scotland and is most thickly developed in the east. Dunbar, the only cement plant in Scotland, is based on local Carboniferous limestone. Mudstones from the same quarry provide the necessary clay. Extensive outcrops of Carboniferous limestone occur in North and South Wales and Northern Ireland.

Lower Carboniferous rocks in Northern Ireland include two thick limestone formations separated by fine-grained clayey material. Carboniferous limestone crops out mainly in a broad belt in the south-west of the province and in areas near Cookstown and Armagh. The largest quarry at Cookstown produces material for the local cement plant. In the south-west of Northern Ireland Carboniferous limestone is worked at Derrylin for cement manufacture. Cretaceous chalk occurs in Northern Ireland where it is locally known as the White Limestone, it is some 50 m thick and extensively overlain by Tertiary lavas.

In South Wales Carboniferous limestones crop out around the flanks of the South Wales Coalfield. Jurassic limestones with interbedded mudstones occur to the south of the coalfield and are worked for cement manufacture at the Aberthaw plant. However, Carboniferous limestones provide the main calcareous feedstock to the plant. In North Wales Carboniferous limestones occur in three main areas: on the western flank of the North Wales Coalfield, the west side of the Vale of Clwyd and on Anglesey. Carboniferous limestone is worked at the Cefn Mawr Quarry, near Mold in Flintshire for cement manufacture at Padeswood. The quarry is some 8.5 km from the plant.

Reserves

Cement plants are highly capital intensive. The construction of a new plant costs about £250 million. Ongoing capital investment at individual plants can also typically amount to several million pounds a year.

Cement raw materials must be available in sufficiently large quantities to justify these large capital investments. Current policy in the National Planning Policy Framework (NPPF) is that the stock of permitted reserves should provide at least 25 years supply for a new plant or new kiln. Elsewhere the stock of permitted reserves should be maintained at least at 15 years.

MPA	Plant	Cement clinker capacity (Thousand tonnes/year)	Reserve Life (Years)
Staffordshire	Cauldon	900	> 40 years
Vale of Glamorgan (South Wales)	Aberthaw	500	> 30 but < 40 years
East Lothian (Scotland)	Dunbar	900	> 30 but < 40 years
Tyrone (Northern Ireland)	Cookstown	480	> 40 years
Derbyshire	Tunstead	1095	> 30 but < 40 years
Rutland	Ketton	1390	> 10 but < 20 years
Lancashire	Ribblesdale	750	> 20 but < 30 years
Flintshire (North Wales)	Padeswood	820	> 30 but < 40 years
North Lincolnshire	South Ferriby	750	> 40 years
Warwickshire/Bedfordshire	Rugby	1500	Southam Quarry > 30 but < 40 years Kensworth Quarry > 20 but < 30 years
Peak District National Park	Hope	1300	> 20 but < 30 years
Fermanagh (Northern Ireland) Mothballed	Derrylin	500	

Table 4 UK: Reserve life of quarries supplying cement plants.
Source: Mineral Products Association and industry contacts.

Actual figures for permitted reserves at quarries supplying the UK's cement plants are typically confidential. However, Table 4 has been compiled, with the assistance of the industry, to provide an indication of the reserve life remaining at these quarries. Existing permissions for these quarries are time limited to 2042 or before.

Relationship to environmental designations

The Carboniferous limestone and Cretaceous Chalk are the two principal resources on which cement production is based in the UK. These two resources give rise to some of the UK's most attractive scenery and consequently extensive areas are covered by national landscape designations. In addition, these calcareous rocks give rise to areas of nature conservation interest, both geological and biological. Nature conservation designations and landscape designations are not mutually exclusive. The approximate proportion of the outcrop covered by two of these designations in the UK is shown in Table 5 and on Figure 5.

Extraction and processing

The raw materials used in cement manufacture are extracted in large quarries with outputs of up to 2.5 Mt/y. Consequently, large reserves of feedstock, particularly limestone/chalk, are required to provide security of supply and

	% National Park	% Areas of Outstanding Natural Beauty (National Scenic Areas in Scotland)
Chalk	5	25
Jurassic Limestone	4	25
Carboniferous Limestone	27	13

Table 5 Proportion of limestone and chalk resources covered by National Parks and AONB/ NSA in the UK.
Source: BGS

these are normally quarried in close proximity to the works. Clay/mudstone may be worked in the same, or an adjacent quarry, or transported from more distant sites.

Cement clinker is manufactured by heating a carefully controlled and homogenised mixture of finely ground calcareous and clayey raw materials to partial fusion (typically at 1400°–1500°C) in a rotary kiln. Small amounts of other materials, such as silica sand, may be added to optimise the mix. These raw materials supply the lime (CaO), silica (SiO_2), alumina (Al_2O_3) and iron oxides (Fe_2O_3) necessary for the formation of the calcium silicates and smaller quantities of calcium aluminates that constitute cement clinker. The clinker is cooled and then finely ground, typically with 5% gypsum/anhydrite, to form the final cement. Gypsum/anhydrite is introduced to control the initial rate of reaction with water and to allow concrete to be placed and compacted before setting commences.

Depending on how the material is handled prior to being fed into the cement kiln there are three basic types of process; the dry, semi-wet/semi-dry and wet processes. The moisture content of the raw material (3% for hard limestone and over 12–16% for chalk) is the main criterion governing the process used. In the dry process the feed material is in powdered form. It is either preheated by the kiln hot exit gases prior to entering the kiln (preheater kiln) or, if fuel is added in a special combustion chamber, the calcination process can almost be completed before the feed enters the kiln (precalciner kiln). In the wet process the feed is made by wet grinding and the resulting slurry is fed directly into the kiln. In the semi-dry/semi-wet processes water is either added to the feed or removed by filter pressing. Over the decades there has been a move away from the wet process to the more energy efficient dry process.

Energy costs have risen to 40 per cent of the Gross Value Added for the sector. This is despite significant investment in the use of alternative fuels to replace coal and other fossil fuels. The proportion of the cost relating to electricity is increasing despite efficiency improvements of around 30 per cent between 2005 and 2011. The finished cement is transported in bulk or in bags to the market.

Cement manufacture results in the emission of large amounts of carbon dioxide, mainly through the calcination of limestone/chalk to produce calcium oxide and also by the fuel burn required for this energy intensive process.

By-products

Quarries extracting limestone/chalk and clay/mudstone for cement manufacture do not normally sell these materials for any other use. However, small amounts of associated minerals are produced at some sites.

At Hope Quarry in the Peak District National Park, the limestone is cut by mineral veins, which carry fluorspar-barytes-lead mineralisation. Fluorine is a deleterious impurity in cement manufacture and has to be kept below specified levels. An independent company works the veins and the partially processed ore is sold for the production of acid-grade fluorspar at the nearby Cavendish Mill.

Depending on the specific horizons in the Chalk being worked, flints can be common in some of the quarries working chalk as feedstock. In the past washed flints have been supplied for processing into specialised aggregates or for fill.

Alternatives/recycling

The principal objective of using alternative raw materials in cement manufacture is to optimise the mix to make best use of available materials. Other than limestone/chalk, there are no calcium-bearing sources that occur on a sufficiently large scale to be used as alternatives. Clay/mudstone is the main source of silica, alumina and iron oxides because of its availability and low cost. However, clay/mudstone may not supply the correct chemical balance of constituents and bought in supplements are often required. These may include silica sand, pulverised fuel ash (PFA), and iron oxides. PFA has a higher alumina to silica ratio than most mudstones, and also lower alkalis (depending on the coal used). It is used at some cement plants to add alumina so that higher silica limestone can also be utilised.

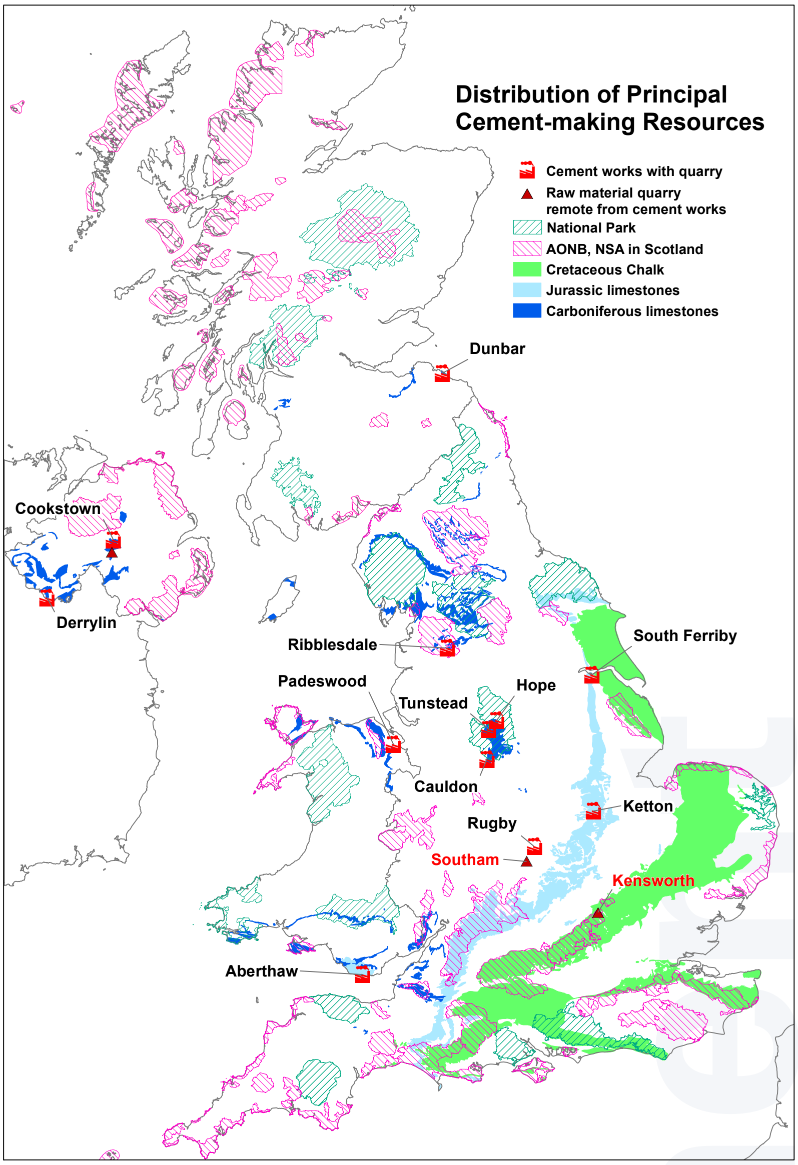

Figure 5 Distribution of the main limestone resources in the UK and their relationship to National Parks, Areas of Outstanding Natural Beauty and National Scenic Areas (Scotland).

This has extended reserves. It is also used to reduce alkalis in the clinker. Ash from the fuel burn also contributes to the overall chemistry, particularly the alkali content of the cement feed. Increasingly blended alternatives are being used to replace mudstone/clay or the more expensive bought in materials such as sand and iron oxides.

Cement manufacture is energy intensive. Fuel and electricity represent some 40 per cent of variable costs. Imported coal was traditionally used as the main source of fuel. Alternative fuels are increasingly being used and include: waste solvents from printing and cleaning processes, waste oils, tyres, packaging and refuse derived waste, sewage pellets, meat and bone meal and waste wood. All these fuels have to meet strict specifications laid down by legislation. Co-processing in cement manufacture is a combination of recycling elemental content into cement product and energy recovery to drive the reaction. It thus provides a valuable outlet for materials beyond their useful life which minimises the material going to landfill. The use of these alternatives fuels can also reduce emissions. The cement industry replaces over 40 per cent of fossil fuels with waste, which is equivalent to approximately 380,000 tonnes of coal.

The production of blended and composite cements is increasing. These may contain for instance, singly or in combination, a proportion of pulverised fuel ash (a by-product of coal-fired power stations), blastfurnace slag (a by-product of iron making) and limestone. The use of these secondary constituents both reduces the amount of cement clinker used per unit of concrete produced and imparts additional technical properties as both PFA and slag, in combination with clinker of CEM I cement, have cementitious properties that improve the long-term strength and durability of concrete. In the production of blended and composite cements the amount of cement clinker, and thus the amount of primary feedstock required, is reduced by the proportion of the PFA, slag or limestone used. Indirectly, therefore, these additions also reduce the environmental impact of clinker production per unit of concrete produced.

Effects of economic instruments

Limestone, including chalk, and clay/mudstone used in cement manufacture are not included within the scope of the Aggregates Levy.

The UK Government introduced the Climate Change Levy (CCL) on the 1st April 2001, which applies to fuels used by energy intensive sectors, including the cement industry. In 2001 UK cement manufacturers signed a Climate Change Agreement with government to deliver an overall energy efficiency improvement across their sector of 26.8 per cent by 2010 against a base year of 1990. The industry achieved this in 2008 recording a reduction of 33.7 per cent improvement in energy efficiency by a combination of replacing older plant, introducing alternative fuels and the use of PFA, slag and limestone to manufacture blended cements. In the Budget of 2014 the Chancellor announced an exemption from CCL for mineralogical processes, including cement manufacture.

The industry has published a Carbon Reduction Strategy which sets out how emissions of carbon dioxide can be reduced by up to 81 per cent by 2050 compared to 1990 levels (the reductions were 55 per cent in 2012). This could be achieved by an increased use of waste-derived and lower carbon fuels, low carbon transport options, lower carbon cements and carbon capture and storage.

The cement industry has been included in the European Union's Emissions Trading Scheme (ETS) since its inception on 1 January 2005. In this scheme cement plants are allocated a number of allowances and if emissions exceed this, further allowances must be purchased. This requires cement plants to monitor all carbon emissions to ensure compliance with the scheme. The scheme is now in phase 3 which runs from the beginning of 2013 until the end of 2020. Phase 3 has imposed benchmarks on cement production based on the top 10 per cent most efficient plants in Europe to encourage the replacement of older plants that have higher emissions. The cement industry has lobbied against this arguing that it could encourage investment in production outside the EU where fewer emissions controls exist. Phase 4 of the scheme is planned to run from 2021 onwards.

As well as the direct costs of ETS and CCL, cement manufacturers face a number of indirect carbon related costs which are passed on by power generators. This includes the Carbon Price Floor (CPF), which came into effect on 1 April 2013.

Hope Cement Works, Peak District.

There is concern that these additional economic instruments, with the worthy aim of reducing environmental impacts, are resulting in unequal production costs between Europe and the rest of the world. There are also inequalities within Europe as different EU Member States implement climate policies in different ways. This could be contributing to the UK becoming a net importer of cement.

Transport issues

The principal raw materials used in cement manufacture are usually supplied from adjacent quarries in order to avoid the high costs of transporting large tonnages of low cost raw materials. In England the only major exception is the Rugby works in Warwickshire, where both the calcareous and clay raw materials are transported into the plant. The cement industry in Warwickshire was originally based on local impure Jurassic limestones, but these are unsuitable for modern cement making. Since 1965 a slurry pipeline from Kensworth Quarry in Bedfordshire has been the source of chalk into the county. Clay is also transported by road to Rugby from Southam. A pipeline was also used to transport clay from Essex beneath the Thames to the Northfleet cement works before it closed in 2008. It is unlikely that pipelines will be used in the future to transport raw materials, because of their high cost and the economic disadvantages of the wet or semi-wet process.

Six cement works in the UK currently use rail transport (see Table 2).

Planning issues

Modern cement operations tend to be large-scale and long-lived. The economies of scale required in order to make individual operations profitable mean that production has tended to concentrate at larger processing plants with more extensive quarries, both of which are likely to be more visually intrusive because of their size.

Cement manufacture requires complex plant, which is expensive to install and requires ongoing capital investment to maintain. As a consequence, operators require security of

Cement

supply of both limestone and clay/mudstone over relatively long periods of time. Individual extraction and processing sites can, therefore, be long lived relative to other mineral operations. Whilst the reserve life figures provided in Table 3 indicate that the planning system has been largely successful in achieving this, long periods of time taken for planning applications would cause concern as they result in uncertainty.

The domestic cement industry has contracted in recent years and the UK is a modest net importer from elsewhere in Europe. However, it is not considered to be prudent to rely on imports for cost, quality and security of supply reasons.

Environmental issues relating to emissions and air quality are not mineral planning issues. However, major investment is required to meet strict environmental standards laid down by EU legislation, transposed into UK law and implemented in the UK by the Environment Agency. This further reinforces security of supply issues and the need for long-term reserves to justify this investment.

A number of cement works remain entirely reliant on road transport.

Sustainability is also a key issue facing the cement industry. Through the World Business Council for Sustainable Development, ten industry leaders have developed The Cement Sustainability Initiative. The UK industry is 100 per cent committed to the initiative as outlined in the Carbon Reduction Strategy mentioned previously.

In England, the NPPF has replaced MPG 10: *Provision of Raw Materials for the Cement Industry* (1991) as the relevant policy document for cement. The relevant planning guidance in Wales is *Minerals Planning Policy Wales* and in Scotland *Scottish Planning Policy,* which supersedes *Scottish Planning Policy 4: Mineral Working.*

Further information

National Planning Policy Framework. Department for Communities and Local Government. (London: HMSO, 2012). Available online at: https://www.gov.uk/government/organisations/department-for-communities-and-local-government

Carbon Reduction Strategy. Mineral Products Association. 2013. http://cement.mineralproducts.org/current_issues/climate_change/carbon_strategy.php

The cement Sustainability Initiative, 10 years of progress — moving on to the next decade. Executive summary. 2012. World Business Council for Sustainable Development. www.wbcsdcement.org.

Authorship and acknowledgements

This factsheet was produced by the British Geological Survey for the Department for Communities and Local Govenment as part of the research project 'DCLG-BGS Joint Minerals Programme.'

It was updated by Teresa Brown and Tom Bide (British Geological Survey), from an original compiled by David Highley, Paul Lusty and Don Cameron (BGS) and Richard Bate (Green Balance Planning and Environmental Services), with the assistance of Deborah Rayner (BGS).

The advice and assistance of the DCLG, the cement manufacturers and the Mineral Products Association is gratefully acknowledged.

Mineral Planning Factsheets for a range of other minerals produced in Britain are available for download from www.mineralsUK.com