Environment Agency

measuring environmental performance

Sector report for the cement industry

Version 1
November 2005

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The Environment Agency. Out there, making your environment a better place.

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1. Introduction

Cement is the major ingredient of concrete, which is the second most consumed material on the planet (Cement Sustainability Initiative, 2002). It is used to build houses and roads, protect the environment from polluting substances, and even in art. However, in common with all industrial activities, the manufacture of cement can damage the environment if it is not managed properly.

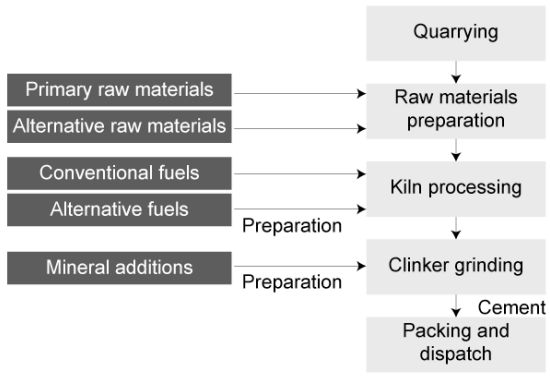
We have a statutory responsibility for protecting and enhancing the environment in England and Wales. We set conditions that the cement industry must meet if it is to be permitted to continue operating. One of the most important of these permitting mechanisms is the Pollution Prevention and Control (PPC) Regulations. We use a range of tools to monitor performance against these conditions, ensure they are met and report on environmental progress. An overview for the cement production industry is presented here.

Here, we identify the most important environmental issues facing the cement production industry in England and Wales[1] (Section 2), look at the effect these issues are having on environmental quality (Section 3) and on society (Section 4). This supports the development of a Cement Sector Plan. The Plan outlines what we, the sector and others must do to ensure that these environmental impacts are minimised and managed safely.

In summary, the main environmental challenges facing the cement manufacturing industry are:

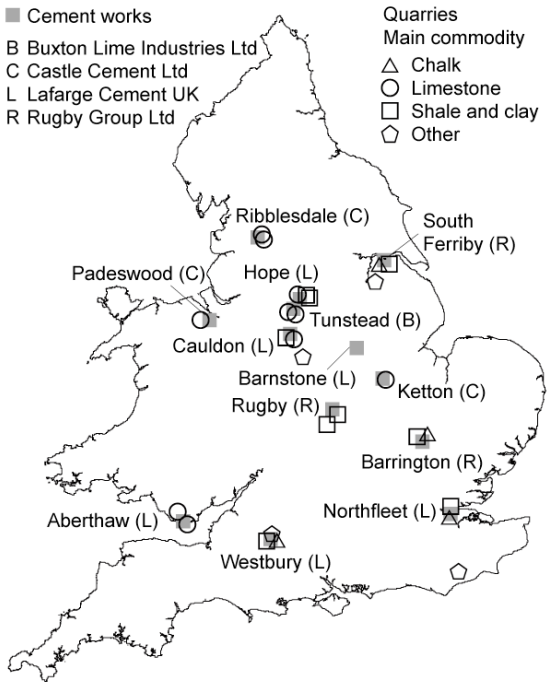
- releases to air of oxides of nitrogen, sulphur dioxide, particulates and carbon dioxide;
- use of resources, especially primary raw materials and fossil fuel;
- generation of waste.

Figure 1
Simplified cement production process



Source: Environment Agency

Figure 2
Operational cement works and associated quarries



Source: Environment Agency and Cameron et al., 2002

Description of the cement industry

There are five certified types of cement: Portland cement, Portland blast furnace cement, sulphate-resisting Portland cement, masonry cement, Portland pulverised-fuel ash cement (BSI, 2005). All but some special cements are manufactured using substantially the same process (Figure 1).

The primary raw materials used in cement manufacture are limestone or chalk, clay or shales and marl. These feedstock materials provide calcium carbonate, silica, alumina and ferric oxide which, when burned in kilns, produce cement clinker. The clinker is then ground or milled with additives

[1] Some information in this report is only available on a UK basis. UK-wide information is identified accordingly.

such as gypsum (a setting retardant) to form cement. This is stored on-site and transported either in bulk or packed in paper or plastic-lined paper bags before shipment.

Historically, cement works have been built on deposits of limestone or chalk and clay or shale to minimise the transport of heavy raw materials (Figure 2). Other raw materials, such as mineral additives and fuel, tend to be transported from greater distances. The proximity to cement markets also affects the location of new sites, as it typically becomes uneconomic for cement to travel more than 200 miles from the plant to the point of use.

Primary raw materials such as limestone are quarried by drilling and blasting, whereas chalk and clay are usually quarried in a wet state. This difference affects the choice of kiln technology, which, in turn, can affect the environmental performance of the site. Traditionally, wet materials (chalk and clay) have used wet or semi-wet kiln processes, and dry materials (limestone) have used dry or semi-dry processes. In general, wet kilns tend to require more energy and release more pollutants, but new wet kiln technologies are addressing this.

Cement manufacture in England and Wales is currently undertaken by four companies; Lafarge Cement UK, (previously Blue Circle, and sometimes still known as such), Cemex (previously Rugby Cement), Castle Cement and Buxton Lime Industries. Together, these companies produce 90 per cent of the cement used domestically. All are members of the British Cement Association (BCA).

Key facts

- Output (GVA): £750 million
- Direct employment: 3,500
- Indirect employment: 15,000
- Number of companies: 4
- Proportion of UK output: <0.1 per cent
- Main environmental drivers: Waste Incineration Directive, Climate Change Agreements, PPC, Emissions Trading Directive (EU ETS)

Source: BCA, 2005 and BCA website

Economic setting

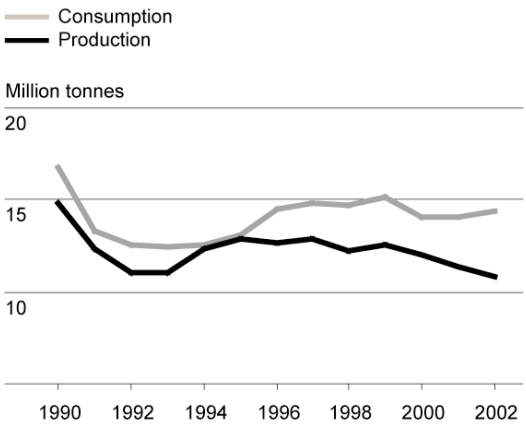
The cement sector makes up less than a tenth of one per cent of the UK's economic activity in terms of turnover, employment or number of business sites. However, its support of the construction industry, which represents 10 per cent of UK Gross Domestic Product, makes the production of cement important to the economy.

Cement is an unusual product in that it has a single major use – in construction. Most cement is sold to the ready-mix concrete industry, producers of concrete products and builders' merchants. Around 30 per cent of output is used in dwellings, 40 per cent in other buildings and 30 per cent in infrastructure (BCA, pers comm).

The consumption of cement in the UK increased since 1994 to around 14 million tonnes in 2002 (Figure 3). At about 235kg per person, this is substantially less than the European average of 616kg (ICR, 2003). Figures are not yet available for 2003, but UK consumption is likely to have grown by a further two to three per cent in response to an increase in infrastructure spending and house building.

UK cement production is less than UK consumption, and has fallen steadily over the last few years to 12 million tonnes in 2004 (Figure 3). Output is seasonal, with production levels substantially higher from March to October when construction activity is greatest. Lafarge has the greatest total production capacity (Table 1).

Figure 3
Consumption and production of cement in the UK

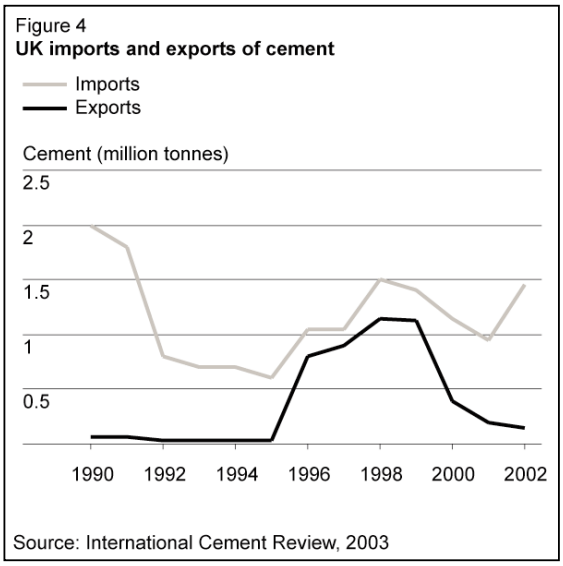


Source: International Cement Review, 2003

Table 1 Production capacity in England and Wales

Company	Number of sites	Production capacity 2004 (t/year)
Buxton Lime	1	750
Castle Cement	3	3,100
Lafarge	6	4,945
Cemex	3	2,250
TOTAL	13	11,045

Source: BCA ,2005



Relatively cheap sea transport has opened up world cement markets. After a boom in the late 1990s, UK exports have declined to about 1.5 per cent of production in the face of cheaper exports from other European countries. Imports can account for 10 to 12 per cent of domestic consumption (Figure 4) with around half of this coming from sister plants of the UK manufacturers. The major importers of cement are Seament (owned by Cemex), Titan Cement, Dragon Alfa Cement, Paragon Materials Ltd, Southern Cement and Castle Cement (ICR, 2003).

Cement manufacturing is now a global industry, dominated by a few major companies. Seventy per cent of Western Europe and all of UK production has passed into the hands of these multi-nationals in the past few years. Following their acquisition of Blue Circle Cement Lafarge has become the largest cement manufacturer in the world. Rugby Cement was acquired in 2005 by the Mexican cement producer Cemex, the third largest cement producer. Castle Cement is now owned by Heidelberg Cement, the fourth largest manufacturer. Buxton Lime Industries is part of the Anglo-American group, a global company better known for its mining activities.

If UK operations are to remain competitive they need to maximise efficiency and reduce running costs. Of the 22 currently fully operational cement kilns at 13 sites, seven are due to be closed or replaced in the next few years. Lafarge's Northfleet plant is reaching the end of its reserves and will close in 2008. Castle Cement is commissioning a new dry production line at Padeswood, which will replace three existing kilns at Padeswood and two wet kilns at Ribblesdale in 2005. A new dry kiln was commissioned at Buxton Lime's Tunstead works in 2004 to replace a wet kiln. Cemex has already completed its rationalisation, having replaced seven old kilns with a single production line at Rugby. In addition, techniques such as the substitution of raw materials and conventional fuels with wastes have significant potential to reduce long-term manufacturing costs and improve competitive advantage over rivals. This requires significant capital investment, but there is potential for this to be recouped in the long term. For example, cement companies may be able to charge a gate fee for receipt of a variety of wastes, at the same time saving on fuel and raw material costs.

Rationalisation and updating will both secure the future of cement production in the UK and create significant economic advantages for these firms and the plants operated by them. However, the industry is concerned that if there is more stringent enforcement of environmental regulations in the UK compared with many other countries, competitiveness could be affected and imports encouraged. The global nature and ownership of the cement industry means that the UK cement producers must compete with world-wide improvement projects for capital investment.

From the 1st January 2005 the cement industry has been part of the first phase of the EU emissions trading scheme (EU ETS) to reduce its CO_2 emissions. This is not expected to reduce competitiveness of UK firms because their main rivals are also subject to targets in the EU ETS.

2. Pressures on the environment

Each stage of cement production – from sourcing raw materials to the distribution and use of the final product – has some potential to exert a pressure on the environment. Here, we concentrate on the pressures caused by the on-site manufacturing of cement.

Resource use

Primary raw materials

Typically, 1.6 tonnes of raw material such as chalk, limestone or clay is used to manufacture one tonne of cement (BCA, 2004). This amounts to a UK requirement of 19 million tonnes of raw materials per year.

Information is not readily available regarding the volume (including overburden[2]) that needs to be quarried in order to obtain 1.6 tonnes of usable raw material, or about what happens to the remainder. These details will vary from site to site. The chalk at Lafarge's Westbury site, for example, contains flint and stones, which are separated out and either backfilled in the quarry or sold for construction.

Alternative raw materials

Not all materials used in cement manufacture have to be virgin raw materials. Alternative materials, such as pulverised-fuel ash (PFA) and ground granulated blast furnace slag, can also be used where product quality allows.

PFA is a waste from coal-fired power stations. It can be used to make clinker or partially supplement clinker in cement, thereby producing more cement per tonne of quarried material. PFA replaces up to 60 per cent of the clay in clinker at Lafarge's Westbury works, saving enough clay to prevent the extension of the quarry for the foreseeable future. Castle's Ketton plant uses PFA to partially replace clinker in cement, which modifies the cement recipe and allows the exploitation of different virgin raw materials.

In many cases, the industry's own waste can be used to make cement. For example, the Westbury works returns all its cement kiln dust (CKD) to the process (Lafarge, 2002), thereby reducing its requirement for virgin raw materials by about 100,000 tonnes and diverting waste from landfill (Environment Agency, 2003). Castle Cement substitutes used bricks from kiln lining and rejected concrete roof tiles for raw materials (Castle Cement, 2001).

Other substitute materials being used now or investigated include:

- broken moulds from the ceramics industry used to replace mined gypsum (Castle Cement, 2001)
- waste foundry sand and gypsum (RMC, 2002)
- mill scale (flakes of oxide coating) from steel rolling to provide iron oxide
- dried sludge from waste water treatment (Glacier ARM, 2005)

Ground granulated blastfurnace slag (from iron manufacture) and PFA can also be used to partially replace cement in concrete. For example, the concrete used for the foundations of Wembley Stadium used almost as much PFA as cement: 680 tonnes and 800 tonnes respectively. The use of granulated blast furnace slag has been estimated to reduce the environmental impact of a tonne of concrete by between four and 22 per cent (Higgins *et al*., 2002). However, the substitution of cement in concrete may pose an economic threat for the sector as the alternative materials are generally added by the concrete industry, which therefore requires less cement. In the rest of Europe, the cement industry controls this process.

[2] See glossary

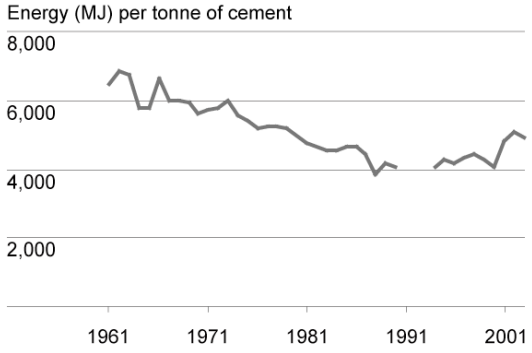
Energy use

The cement industry is energy-intensive, mainly because of the fuel requirements of kilns. Wet processes and long dry kilns tend to use more energy, the former because of the extra drying requirement. Economic incentives to improve energy efficiency include the Government's Climate Change Agreement and implementation of the UK Emissions Trading Scheme.

Kiln energy efficiency has increased substantially since the 1960s (Figure 5) as long-dry and old wet kiln processes have been replaced. While this has levelled off since 1990, the recent commissioning of new kilns is expected to restart this progress.

Conventionally, fuels such as coal and petroleum coke ('petcoke') are used in cement manufacture and account for approximately 40 per cent of production costs. The use of fossil fuels in cement manufacturing has declined since 1990 (Figure 6), partly replaced by alternative fuels. By 2003, the cement manufacturing sector accounted for around one per cent of fuel use by UK industry.

Figure 5
Energy used by cement kilns



Source: BCA pers. comm.

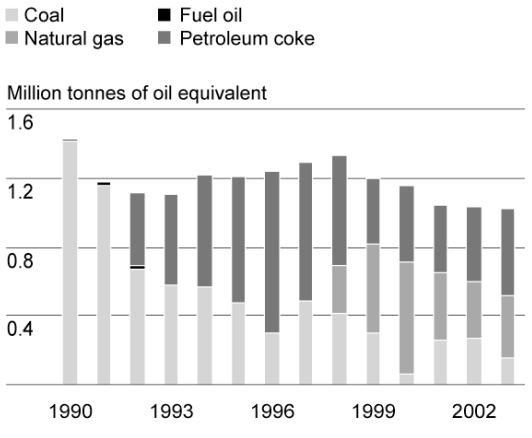
Alternative fuels

The most commonly used alternative fuels within the cement industry are waste tyres and substitute liquid fuels (SLF) made up of spent solvents. Others include packaging waste, waste oils, sewage sludge and meat and bone meal. Further alternative fuels such as waste wood, paper sludge may also be considered.

In Europe, the use of alternative fuels in cement kilns is widespread (Environment Agency, 2001). The rate of substitution in the UK is relatively low compared to other countries (Figure 7), though this masks the actual volumes used. For example, while rates of substitution are similar, Denmark's cement industry uses about 72,000 tonnes of alternative fuels (Aalborg Portland, 2004) whereas about 192,000 tonnes are used in the UK (Figure 8).

Eight sites in England and Wales already use tyres, SLF or solid waste (Table 2). Both the volume and variety of wastes used is set to expand (Table 3, Figure 8). Alternative fuels cannot be used without our permission, as part of the environmental permitting procedure. Conditions on emissions are set and monitored in order to safeguard both human health and the environment. We look at the impacts of using alternative fuels in Section 4.

Figure 6
Fossil fuels used in cement manufacturing in the UK



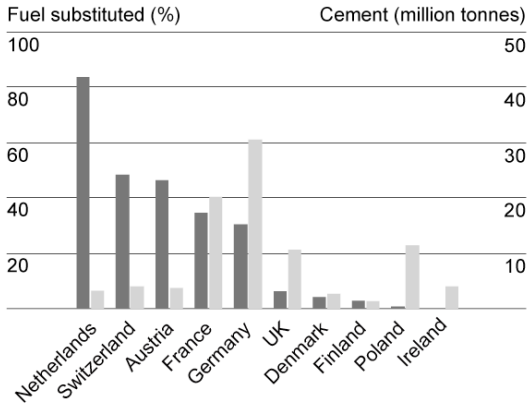
Source: Office for National Statistics, 2005

Table 2 Sites authorised to burn substitute fuels, January 2005

Company	Site name	Actual use	Planned use
Castle Cement	Ribblesdale	SLF, tyres	Meat and bone meal
	Ketton	SLF, tyres, Profuel	Meat and bone meal
	Padeswood		SLF/Profuel/tyres mix
Lafarge Cement	Cauldon	Tyres, sewage sludge	Recovered fuel oil
	Hope	Tyres	-
	Westbury	Tyres	SLF
	Aberthaw	-	Meat and bone meal, recovered fuel oil
Cemex	Barrington	SLF	Packaging waste
	Rugby	-	Tyres
	South Ferriby	SLF	

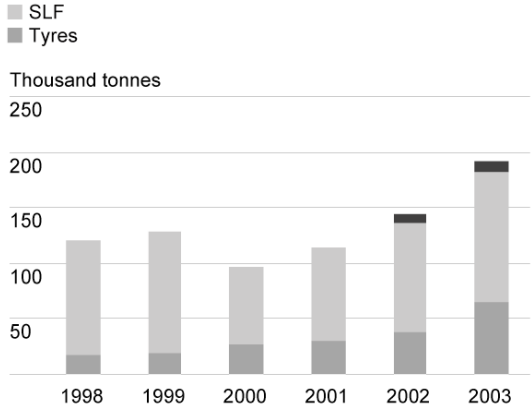
Source: Environment Agency

Figure 7
Use of alternative fuels in Europe



Source: BCA pers. comm.; ICR, 2003

Figure 8
Waste used as fuel in cement kilns



Source: Environment Agency and BCA, pers comm

Table 3 Potential use of substitute fuels by the cement industry

Fuel	Next three to five years - estimates of potential use in UK, tonnes
Waste-derived liquid fuels	200,000
Tyres	290,000
Packaging and packaging waste	500,000
Waste oils	90,000 to 345,000
Meat and bone meal	140,000
Processed sewage pellets	40,000
Maximum total	1,515,000

Source: BCA website, 2005

Case study: Sapphire Energy Recovery

Sapphire Energy Recovery (a Michelin Tyres Plc/Lafarge joint venture) sources, prepares and supplies tyres to works using or trialling the use of tyres. Based at Cauldon, the venture expects to use 2,000 tonnes of tyres a week. The 20 million tyres already used at Cauldon have saved 150,000 tonnes of coal.

(Lafarge press release, 9/5/02)

Water use

The main uses of water in cement manufacturing are in raw material preparation, cooling, dust suppression and vehicle cleaning. 'Wet' processes also use water to make the raw meal slurry that feeds the kilns. About 600kg of water is used in the manufacture of one tonne of cement[3]. Some of this is returned to the environment.

Several cement works hold licences to abstract water directly from the environment. In 2002, the industry was licensed to abstract nearly seven million litres per day (7,000 tonnes), but actually abstracted about a quarter of this. These volumes are insignificant on a national basis, representing only 0.01 per cent of that taken by the manufacturing industry as a whole.

There are opportunities to reduce abstractions or mains water use still further. Lafarge's Westbury plant, for example, uses treated wastewater from the local sewage treatment works as well as water collected in the quarry and from site drainage to supplement the plant's water supplies. Cemex's Rugby site collects rainwater from site drainage to use as cooling water and uses water from the local treatment works to produce chalk slurry.

Emissions to air

Impacts
On air quality: p14
On land quality, habitats and biodiversity: p15
On human health: p14

Emissions to air may come from quarrying, manufacture (e.g. grinding or kiln operation), from the fuel or raw materials used, or from associated activities such as transport. Of these, quarrying and the manufacture of clinker are the largest sources.

The 'key' mass[4] releases to air from cement manufacture are oxides of nitrogen (NO and NO_2 reported as NO_2), dust (including PM_{10}), mercury, cadmium and carbon monoxide. Here, we also look at sulphur dioxide (SO_2) and carbon dioxide (CO_2), as they are particularly large releases given their environmental significance and the industry's relative size[5] (Table 4).

Table 4 Selected releases to air from the cement industry in England and Wales

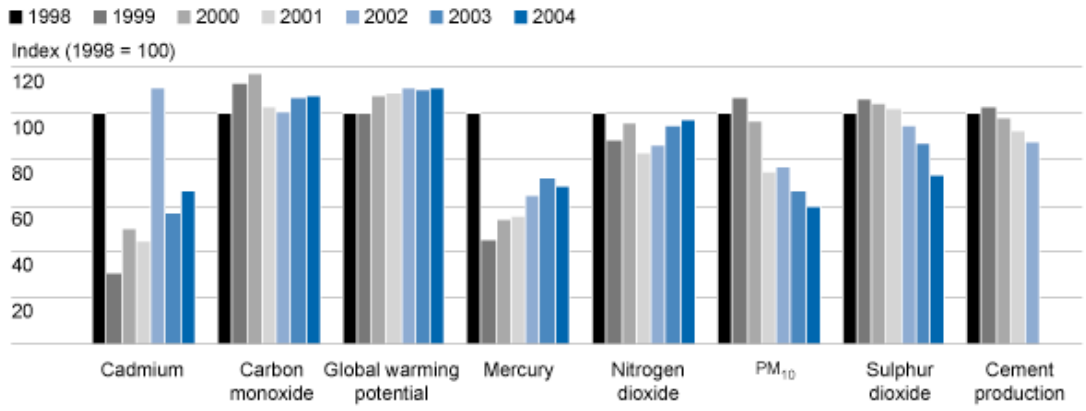
Substance	% UK emissions due to industry we regulate, 2003	% UK emissions due to the cement sector, 2003	% industrial* emissions due to the cement sector, 2004	Number of cement sites reporting, 2004**
sulphur dioxide	73	1	2	14
mercury	54	3	6	13
cadmium	22	1	6	9
greenhouse gases:				
carbon dioxide	40	2	4	13
nitrogen dioxide	25	2	7	12
carbon monoxide	17	1	5	11
PM_{10}	11	1	7	10

*Industry directly regulated by the Environment Agency
**Total number of sites in 2004 = 14. Source: Data from Environment Agency and National Air Emissions Inventory (NAEI)

[3] Calculated from data presented by Castle Cement, 2003 and Lafarge Cement, 2002
[4] Key releases are defined in the text box on page 10. This selection is made purely on a mass emissions basis and does not necessarily mean that the releases result in significant environmental impacts. To assess environmental significance, it is important to consider the local concentrations of pollutants from individual sites and how they relate to benchmarks for the protection of human health and the environment. The Sector Plan identifies the key emissions in this respect as NOx, SO_2 and particulate matter (PM_{10}).
[5] Volatile organic compounds (VOCs), heavy metals and their compounds, hydrofluoric acid and hydrochloric acid are also mentioned in reference documentation for the industry (EC, 2001). They are not described here because, where information exists, they form a small proportion of the total for England and Wales.

With the use of new kiln technologies and abatement techniques, the cement industry is gradually reducing the release of most of these substances (Figure 9). Of particular note is the long-term decline of dust releases (Figure 10).

Figure 9
Emissions to air from the cement industry



Source: Environment Agency

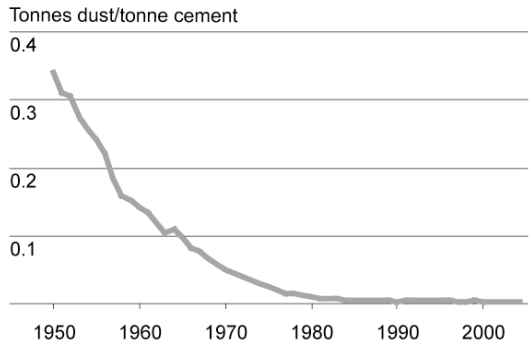
Greenhouse gases, particularly carbon dioxide released from the calcination of raw materials (about 53 per cent of CO_2 releases) and from kiln fuel (about 47 per cent), are a particular issue for the cement sector. The global industry generates about five per cent of all greenhouse gas emissions (WBCSD, 2002).

Greenhouse gases are important because of their potential to affect climate change. The warming effect of these gases depends upon the amount of each gas being emitted and its global warming potential (GWP). Cement manufacturing is responsible for about 1.3 per cent of the UK's GWP – a large proportion given the size of the industry.

Because there are so few sites in this sector, annual releases of pollutants are influenced by the performance of individual sites. For example, in 2004, a single site emitted dioxins above its permitted levels, which accounts for an unusually high level of dioxins for the whole sector.[6] We are taking enforcement action against this site.

Limestone quarrying may also release substantial amounts of PM_{10} in particular. Information is not readily available for quarries associated with cement manufacturing specifically, but quarrying as a whole contributes about 10 per cent of UK PM_{10} releases (NETCEN, pers comm).

Figure 10
Dust emissions from cement manufacture in the UK



Source: BCA

[6] Dioxins from the cement sector accounted for 38 per cent of all dioxin emissions reported to our Pollution Inventory by sites we regulate.

What does 'key releases to air' mean?

- Substances that are:
- of environmental importance i.e. are included in any of six drivers:
  1. National Air Quality Strategy (NAQS)
  2. United Nations Framework Convention on Climate Change (UNFCCC) – Kyoto Protocol
  3. United Nations Economic Commission for Europe (UNECE) Convention on Long-Range Transboundary Air Pollution (LRTAP)
  4. United Nations Environment Programme (UNEP) Ozone Depleting Substances –Montreal Protocol
  5. Heavy metals of Agency concern where sector contributes a significant proportion and/or specified under Annex 1 of the IPPC Directive
  6. Likely acidification substances: and
- released by Agency-regulated processes in quantities exceeding 10 per cent of the UK total (where this is applicable): and
- released by the cement sector in quantities greater than five per cent of all Agency regulated emissions: and
- released by the majority of sites at levels greater than the reporting threshold.

Discharges to water

Discharges to water from cement sites are generally from site run-off and vehicle washings. These can contain suspended solids and associated metals, and the effluent is likely to be alkaline. Where these could impact the environment, we will specify limits.

In reality, releases of metals are negligible (Table 5). With such small quantities released, even minor variations in the composition of raw materials and uncertainties in measurements can have an impact on the calculated yearly load, so trends are indistinguishable.

Table 5 Discharges from the cement industry to controlled water, 2004

Substance	Release (kg)	% of all industries we regulate
lead	31.1	0.11
nickel	33.3	0.05

The packaging of cement may also affect effluent discharge quality. For example, at Lafarge's paper sack factory at its Northfleet works, inks and glues have caused some exceedances of discharge limits. The company installed a filtration system in 2000 and the problem has been overcome.

Discharges of pollutants to water are low compared to other sectors, so we do not consider them to be an immediate environmental priority.

What does 'key substances discharged to water' mean?

Substances that are:

- of environmental importance i.e. are included in any of three drivers:
  1. Water Framework Directive (WFD) Priority List Substances
  2. Metals
  3. Suspected or confirmed endocrine-disrupting chemicals
- released by Agency-regulated industry in quantities that exceed five per cent of the UK total where this is applicable
- released by the cement sector in quantities greater than five per cent of all Agency regulated discharges

Waste production and management

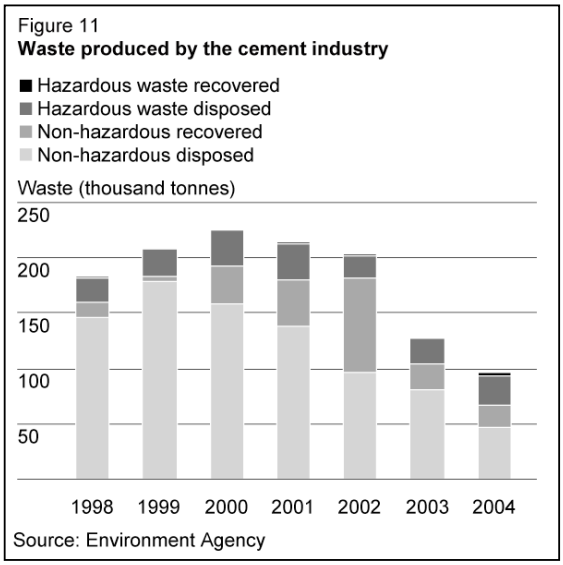
Solid wastes are produced at every stage of the cement life cycle, but mainly during quarrying and manufacture.

The industry has more than halved its production of waste from cement manufacture since 2000 (Figure 11), and is now responsible for 0.5 per cent of waste produced by the processes we regulate. Given the size of the sector, this is substantial. Up to 69 per cent of the waste produced is non-hazardous, such as cement or most cement kiln dust.

An increasing amount of waste is re-used or recovered (Figure 11), partially in response to initiatives such as Landfill Tax. The proportion of waste recovered has increased over the last five years, largely because of the increasing re-use of cement kiln dust in clinker. In 2004, 23 per cent of waste was recovered. This compares unfavourably with the average of 53 per cent for all the industries we directly regulate.

The cement sector also accepts a sizeable volume of waste from other industries to use as alternative fuels and raw materials (see above). The sector already uses more waste in its kilns than it generates: about 192,000 tonnes used as fuel compared to 127,000 tonnes in 2003. But this is a resource that could be further exploited for environmental and economic gain.

Figure 11
Waste produced by the cement industry



Source: Environment Agency

No information is available on the amount of waste (including overburden) generated by the quarrying activities of the cement sector, but it is estimated that quarrying in general generates one tonne of waste for every nine tonnes of saleable product (Defra, 2003). This means that quarrying for the UK cement industry probably produces about 1.5 million tonnes of waste.

The use of cement in construction also makes a sizeable, but unquantified, contribution to waste. In 2003, 91 million tonnes of construction, demolition and excavation waste were produced in England, 32 per cent of which was disposed of in landfill (ODPM, 2004).

Transport

Transport is an important part of the overall manufacturing process, delivering raw materials to sites and distributing final products. It needs to be minimised to reduce congestion, fossil fuel use, emissions to air, noise, vibration and accidents.
Transport of raw materials and fuel to the cement plant, and cement to customers is largely by road. It is estimated to use about 400 MJ of energy per tonne (Brodkom, 2000). Most companies are taking steps either to reduce road transport by increasing the use of pipelines and rail, or to increase efficiency. For example, Lafarge at Westbury and Northfleet and Cemex at Rugby, use pipelines to deliver slurry feed from chalk quarries to the works. Most other works are connected to bulk raw materials by rail.

Castle Cement, Lafarge and Buxton Lime Industries also use rail to distribute cement. Castle transports 200,000 tonnes by rail to its distribution site in London. Lafarge has won an award for its ‘Intermodal Transport System’, which allows road-going tankers and wagons to be carried by rail.

Pollution incidents and prosecutions

The cement industry caused four serious pollution incidents in 2004. None of these were major (category 1) incidents. This is an increase on the previous three years when it caused no serious incidents. We made no prosecutions between 2000 and 2004 but we did take some enforcement action requiring improvements to be made in this period. We issued four enforcement notices and one caution, mostly associated with emissions to air.

This is a substantial improvement since 2000, when the cement industry caused 20 serious pollution incidents (category 1 or 2), mostly affecting air. We prosecuted the industry four times, resulting in fines against Castle Cement at its Ribblesdale and Padeswood works totalling £46,500.

Noise, vibration, odour and aesthetics

Environmental nuisances – including noise, vibration, odour and visual impacts – are generally not extreme enough to impact directly on the environment or human health. They are, though, important in the context of quality of life. Noise, odour and vibration from industrial sites are within the remit of environmental legislation such as PPC. The scale of operations, including quarries, tall stacks and plumes, can cause visual disturbance. Noise and vibration can be generated from quarry blasting, heavy machinery, air flow generation and transport systems.

Complaints about nuisance may be made to us. Those that seriously affect the environment are recorded as category 1 and 2 pollution incidents; those that don't have a serious impact as category 3 and 4. Less than one per cent of all pollution incidents (category 1-4) reported to us in 2004 were caused by the cement industry. Complaints are also made to local authorities and the industry itself but this information is not available.

Standards of environmental management

We use the operator performance component of our Operator Pollution and Risk Appraisal (OPRA) scheme[7] to assess how well a site is environmentally managed. The cement sector is relatively well managed in environmental terms. In 2004, 11 sites (85%) achieved an 'excellent' band A score for operator performance, compared to 44 per cent for industry as a whole. The remaining two sites achieved band B.

We are concentrating our efforts on the most poorly performing sites. Our aim is that no more than 5.4 per cent of sites should be band D, and none in the lowest band E. With no cement sites in either band, the sector is performing better than the average for all industry.

All sites have a formal environmental management system in place. All have ISO14001 certification, and 10 are also registered to EMAS (BCA, 2005). All parent companies of cement manufacturers in England and Wales produce some form of sustainability or environmental report. Castle Cement and Lafarge make these readily available for the cement industry specifically and measure performance against environmental targets on a site-by-site basis.

[7] See glossary for full explanation

Summary

The pressures placed on the environment by cement manufacturing in England and Wales are summarised in Table 6.

Table 6 Pressures on the environment from cement manufacturing*

Pressure	Average per tonne
Raw materials use	1.6
Kiln fuel use, of which:	4930MJ
Fossil fuels	86kg
Alternative fuels	3kg
Water use	600kg
Releases to air:	
GHG	917kg
NO_2	3.0kg
SO_2	1.3kg
Dust (PM_{10})	0.1kg
Carbon monoxide	2.2kg
Mercury	0.02g
Cadmium	0.01g
Releases of heavy metals to water	0.01g
Waste produced in manufacture:	
Hazardous waste	2.9kg
Non-hazardous waste	6.4kg
Transport:	
Fuel requirements	400MJ (2000)
Miles travelled	not available
Serious pollution incidents	4 (in total)

*This is a summary of figures presented elsewhere in the review.

Of these, the most significant are: releases to air, the use of raw materials, energy use and waste production.

The manufacture of cement also has the capacity to reduce the environmental impacts of other industries. It already uses other sectors' wastes for fuel and as raw materials (see above), diverting waste from landfill and reducing its own raw material use. There is potential for this sector to use more waste materials and consequently make a significant contribution to the sustainable management of wastes in England and Wales[8].

[8] Industry is only allowed to use waste as fuel if it cannot be technically and economically recovered higher up the waste hierarchy, so the availability of wastes suitable for fuel substitution is likely to change. In other words, if markets open up for the re-use of waste in its original form (i.e. without burning it), or if recycling technologies improve to produce re-usable goods, less will be immediately available as fuel. Improving our use of waste is a desirable outcome for us all, but the cement industry's contribution to that outcome could therefore decrease. This will be a success for 'UK Plc' rather than an apparent failing of the cement industry.

3. Environmental impacts

Whether the pressures exerted by the industry actually merit action is determined by the impacts they have on the environment, society and human health.

The impact on air quality

The Government's Air Quality Strategy requires local authorities to declare an air quality management area (AQMA) if they believe that air quality objectives will not be achieved. Gravesham Borough Council has designated an AQMA for PM_{10} around Northfleet Industrial Area, including Northfleet cement works. Lafarge is steadily reducing emissions from this site. We are also concerned about levels of sulphur dioxide around Lafarge's cement plant at Barnstone, but this plant will close in 2006. No other cement manufacturing sites have been identified as major contributors to local air quality exceedances.

Of the cement industry's key releases, carbon monoxide, NO_2, SO_2 and dust (PM_{10}) are covered by the Government's Air Quality Strategy.

The cement industry also releases substantial quantities of greenhouse gases, and specifically carbon dioxide, implicated in climate change (see 'Releases to air'). The cement industry is responsible for about two per cent of the UK's CO_2 and about four per cent of industrial releases. This is substantial considering the small size of the sector. The release of greenhouse gases (as GWP) from the cement industry has increased since 1998. From January 2005 the cement industry became subject to the Greenhouse Gas Emissions Trading Regulations - the UK interpretation of the first phase of the EU-wide emissions trading scheme (EU ETS).[9] The carbon dioxide allocation (allowance) for existing cement operations is seven per cent less than current emissions, although some headroom has been provided for new or updated processes (Defra, 2005).

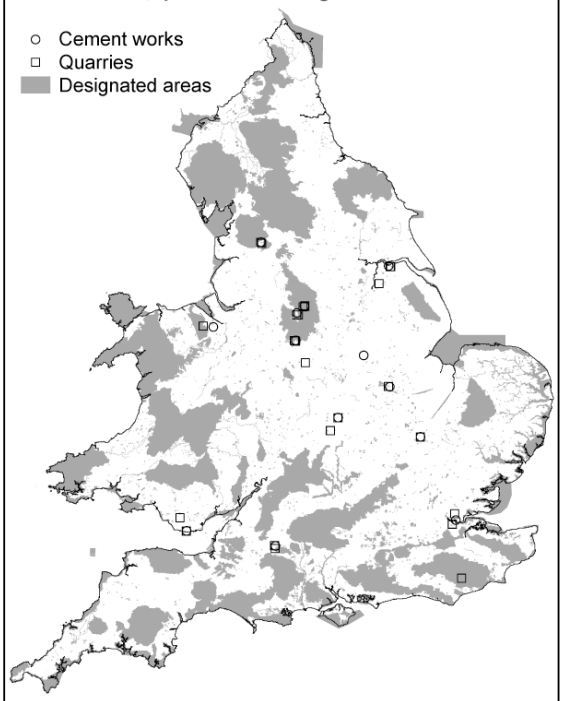
The impact on land quality, habitats and biodiversity

The main impact of cement manufacturing upon land quality comes from quarrying, the disposal of wastes, storage (of fuel, raw material and finished product) and atmospheric deposition.

One of the most visible impacts on land is quarrying. The actual area of land and habitats excavated will depend on both the depth and purity of the raw material, about which information is not currently available. Quarries also affect the amenity value of countryside, as access is inevitably restricted for safety reasons.

Up to 28,355ha of land in England may have been contaminated by cement, ceramics and asphalt manufacturing in the past (Environment Agency, 2002); around 13 per cent of total contaminated land identified. Potential contaminants include calcium oxide, heavy metals, dioxins and hydrocarbons. Local authorities are identifying and remediating contaminated land in England as part

Figure 12
Cement works, quarries and designated areas



Source: English Nature, Countryside Council for Wales, Countryside Agency, Ordnance Survey, Farming and Rural Conservation Agency

[9] See glossary

of their contaminated land strategies. None so far are related to cement manufacturing.

The effects of cement works on habitats are difficult to quantify, but the potential for harm is inevitably greater in more vulnerable areas. The geographical location of cement works is primarily determined by the location of suitable geological deposits. About half the quarries associated with cement manufacture lie within or on the edge of designated areas and most quarries are within two kilometres of such sites. Two operational cement works are located on the edge of National Parks, Ramsar sites or SSSIs, with a further 10 (i.e. the majority) within two kilometres of similarly designated areas (Figure 12).

The industry's view is that both the manufacturing process and the product itself can have beneficial impacts on land quality. Cement manufacture can divert significant quantities of waste from landfill (see above) and concrete is regularly used in environmental protection structures such as flood defences and in pollution prevention.

4. Social and health impacts of cement manufacturing

Only three cement works are located within urban areas, but all are within two kilometres of villages or towns. The relationship between cement works and local communities is therefore important.

Most sites hold regular liaison meetings and record the complaints they receive directly or that are passed on from other stakeholders, although information on these complaints is not always made readily available.

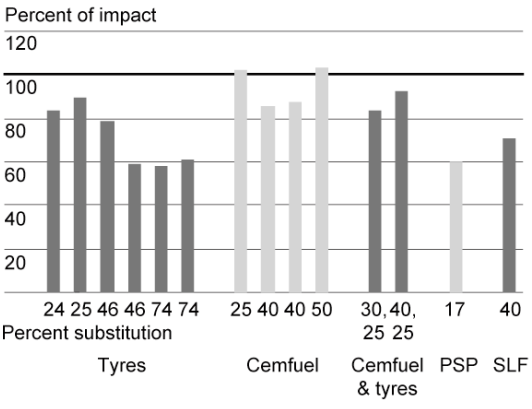
Many substances released by the cement industry may affect human health at elevated concentrations. Environmental assessments as part of our PPC permitting at each site must satisfy us that releases will be below levels which could cause harm to human health or the environment. The Food Standards Agency, Primary Care Trusts (England) and Local Health Boards (Wales) are statutory consultees in this process.

The use of alternative fuels has caused some public concern about potential health risks. Sites will not be permitted to use such fuels unless they can satisfy us that human health will not be significantly affected.

The Health Protection Agency (HPA) has also produced a position statement on the public health consequences of the use of substitute fuels in cement kilns (HPA, 2004). The statement concludes that the HPA is "*unaware of any evidence that burning substitute fuel has caused adverse health effects*." The HPA will be referring this issue to the Committee on Medical Effects of Air Pollutants (COMEAP) for detailed consideration and advice.

We will continue to monitor the performance of kilns and ensure their safe operation. We would also welcome further long-term health studies near cement kilns.

Figure 13
The Impact of substitute fuels (shown as a percentage of fossil fuel impact)



Source: Environment Agency

5. Taking action

The environmental impacts of cement manufacturing will be addressed in a joint approach between ourselves, the cement industry and key stakeholders, working together to improve the sector's environmental performance.

Nationally, the main environmental impacts of the cement manufacturing industry are:

- releases to air of oxides of nitrogen (NO + NO_2 expressed as NO_2),sulphur dioxide (SO_2), particulates and carbon dioxide (CO_2);
- use of resources, especially primary raw materials and fossil fuel;
- generation of waste

We have worked with the sector to produce a Cement Sector Plan to address these challenges. The Plan sets out the environmental and management targets for the Sector for the next five to 15 years. It shows how the sector proposes to achieve these targets, and how progress against the targets will be measured and reported. The Plan builds on regulatory compliance and contains agreed, voluntary actions that will improve environmental performance.

6. Sources of further information

Further copies of this report are available from our enquiries unit, tel: 08708 506 506, or email: enquiries@environment-agency.gov.uk.

Visit our website for:

- information specific to the cement industry, including the Sector Plan and Substitute Fuels Protocol: www.environment-agency.gov.uk/business/444304/444385/
- Delivering for the environment (our approach to regulation for the 21st Century): www.environment-agency.gov.uk/business/444217/444661/571853/
- information on our work with businesses: www.environment-agency.gov.uk/business
- environmental information on your local cement manufacturer: www.environment-agency.gov.uk/yourenv
- the pollution inventory: www.environment-agency.gov.uk/pi/
- OPRA scores: www.environment-agency.gov.uk/opra/
- Spotlight on business environmental performance: www.environment-agency.gov.uk/spotlight

Cement industry websites:

- Overview of the cement industry: www.cementindustry.co.uk
- The British Cement Association: www.bca.org.uk
- ConCemSus: www.concemsus.info
- Cement Sustainability Initiative: www.wbcsdcement.org
- The Concrete Centre: www.concretecentre.com/main.asp?page=0
- Lafarge Cement UK: www.cement.bluecircle.co.uk
- Castle Cement: www.castlecement.co.uk
- Cemex: www.cemex.co.uk
- Buxton Lime Industries: www.buxtonlime.co.uk

See also:
Department for Environment, Food and Rural Affairs: www.defra.gov.uk
Department of Trade and Industry: www.dti.gov.uk
Department of Health: www.doh.gov.uk

References

Aalborg Portland 2004 *Environmental Report 2003.* Aalborg Portland, Denmark. 29pp.

British Cement Association (BCA) 2005 *Performance: a corporate responsibility report from the UK cement industry*. BCA, 15pp

British Cement Association (BCA) 2004 *Performance: a corporate responsibility report from the UK cement industry*. BCA, 15pp

British Standards Institute (BSI) 2005. From their website: http://www.bsi-global.com/Construction/ConcreteMasonry/index.xalter

Brodkom, F. 2000 *Good environmental practice in the European extractive industry: a reference guide*. Centre Terre & Pierre – Tournai, Belgium, 97pp.

Cameron, D.G., Bartlett, E.L., Coats, J.S., Highley, D.E., Lott, G.K., Flight, D., Hillier, J.A. and Harrison, J. 2002 *Directory of Mines and Quarries: 6th edition*. British Geological Survey.

Castle Cement 2003 *Sustainability Review*. Castle Cement, 25pp.

Castle Cement 2001 *Environmental Review.* Castle Cement, 27pp.

Cement Sustainability Initiative 2002 *Our Agenda for Action: Executive Summary*. World Business Council for Sustainable Development (WBCSD).

Department for the Environment, Food and Rural Affairs (Defra) 2003 *e-Digest of Environmental Statistics.* From their website: www.defra.gov.uk/environment/statistics/waste/download/xls/wrtb09.xls

Department for the Environment, Food and Rural Affairs (Defra) 2005 *EU Emissions Trading Scheme UK national allocation plan: revised list of installations and allocations.* Defra, 55pp.

Environment Agency 2003 *Using waste in cement-making: A brief guide*. Environment Agency, 16 pp.

Environment Agency 2002 *Dealing with contaminated land in England.* Environment Agency, 40pp.

Environment Agency 2001 *Solid waste derived fuels for use in cement and lime kilns – an international perspective.* R&D Technical Report P4-087/TR/1. Environment Agency, 142pp.

European Commission 2001 *Integrated Pollution Prevention and Control (IPPC) Reference Document on Best Available Techniques in the Cement and Lime Manufacturing Industries*. 111pp.

Glacier ARM 2005 www.glacierarm.com/index.htm

Higgins, D., Parrott, L. and Sear, L. 2002 *Effects of ground granulated blast furnace slag and pulverised-fuel ash upon the environmental impacts of concrete*. Available from ConCemSus Website at http://www.concemsus.info

Health Protection Agency (HPA) 2004 *Position Statement – Substitute fuels in Cement Kilns.* Available at www.hpa.org.uk

International Cement Review (ICR) 2003 *Global Cement Report, 5th Edition*. ICR, 342 pp.

Lafarge Cement UK 2002 *Environmental Statement 2001*. Lafarge Cement UK, 43pp.

Office of the Deputy Prime Minister (ODPM), 2004 *Survey of arisings and use of construction, demolition and excavation waste as aggregate in England in 2003*. ODPM, 125pp.

Office for National Statistics 2005 *Environmental Accounts.*
http://www.statistics.gov.uk/statbase/Expodata/Spreadsheets/D4295.xls

RMC (UK) 2002 *UK Sustainable development report 2001: results, resources and relationships*. 25pp

World Business Council for Sustainable Development (WBCSD) 2002 *Towards a Sustainable Cement Industry*. WBCSD.

Glossary

Agency-regulated industry
Processes we regulate under IPC and PPC and which report to the Pollution Inventory

AQMA
Air Quality Management Areas are designated by local authorities where air quality objectives are not likely to be achieved. The objectives are part of Air Quality Strategy.

Air Quality Strategy
The national framework for air pollution management. Includes objectives for benzene, 1,3-butadiene, carbon monoxide, lead, nitrogen dioxide, ozone, fine particles (PM_{10}) and sulphur dioxide.

BCA
British Cement Association

Calcination
The method of obtaining calcium oxide from limestone or chalk by heating it to drive off carbon dioxide

CCA
Climate Change Agreement. A negotiated reduction in the Climate Change Levy in return for improvements in energy efficiency

CKD
Cement kiln dust

Clinker
The intermediate product in cement manufacture i.e. the product of heating the main raw materials

Designated areas
In this report, this refers to Sites of Special Scientific Interest (SSSIs), National Parks, National Nature Reserves, Areas of Outstanding Natural Beauty (AONBs), Special Areas of Conservation (SACs), Special Protection Areas (SPAs), Environmentally Sensitive Areas and Ramsar sites.

EMAS
Eco-Management and Audit Scheme. A voluntary European initiative designed to improve companies' environmental performance.

EU ETS
EU Emissions Trading Scheme. A new mechanism to encourage a reduction in GHG releases. We will run this scheme in England and Wales and the ETS registry for the whole UK. The first tranche of this is aimed at the big emitters of CO_2, many of which we already regulate but also including hospitals and universities. See www.environment-agency.gov.uk/business/444217/590750/590838/1009544/

GHG
Greenhouse gas. A gas that contributes to the heat retention of the atmosphere and thus the warming of the earth, known as the greenhouse effect.

Hazardous waste
Waste that has hazardous properties (e.g. explosive or harmful). Includes waste oils and lubricants and batteries. Kiln dust has the potential to be considered hazardous waste if the calcium oxide content is greater than 10 per cent.

ISO 14001
The International Standard Organisation's environmental management system specification.

NO_2
Nitrogen dioxide. In this report, NO_2 includes all nitrogen oxides except N_2O.

OPRA
Operator and Pollution Risk Appraisal, a tool for assessing the environmental risk of processes on a site

Overburden
The overlying material that has to be removed so that target materials (e.g. limestone or chalk) can be quarried.

Petcoke
Petroleum coke is a by-product of the fractionation of gasoline

PFA
Pulverised-fuel ash, a waste from coal-fired electricity generation

PM_{10}
Very fine particles that can affect human health

Pollution incidents
Pollution incidents are classified as category 1-4. The most serious are category 1 (major impact on the environment) and category 2 (significant impact)

PPC
Pollution Prevention and Control. For details, see the 'Taking Action' section of main report

SLF
Substitute liquid fuel, one of several alternative fuels made up of spent solvents

SO_2
Sulphur dioxide. In this report, all sulphur oxides (SO_x) are grouped together and expressed as SO_2

Urban areas
Areas with a population density of more than 1,000 people per km^2

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