Science at the Environment Agency

Science underpins the work of the Environment Agency. It provides an up-to-date understanding of the world about us and helps us to develop monitoring tools and techniques to manage our environment as efficiently and effectively as possible.

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The science programme focuses on five main areas of activity:

- **Setting the agenda,** by identifying where strategic science can inform our evidence-based policies, advisory and regulatory roles;
- **Funding science,** by supporting programmes, projects and people in response to long-term strategic needs, medium-term policy priorities and shorter-term operational requirements;
- **Managing science,** by ensuring that our programmes and projects are fit for purpose and executed according to international scientific standards**;**
- **Carrying out science**, by undertaking research – either by contracting it out to research organisations and consultancies or by doing it ourselves;
- **Delivering information, advice, tools and techniques,** by making appropriate products available to our policy and operations staff.

Steve Killeen

Steve Killeen

Head of Science

Executive Summary

In 2001, the Environment Agency for England and Wales published a report (prepared by Entec UK) on the international use of solid waste derived fuels in the cement sector. The aim of this current study is to update the previous report. Changes in typical practice and international legislation have been investigated, including information on the amount, substitution rate and types of solid waste derived fuels being burned in cement kilns in Europe and the USA, and information on the legal framework for permitting solid fuels to be burned in cement kilns. The previous study was very extensive, both in terms of content and resources available. As such, this report should be considered in conjunction with the previous report. The data collation process involved consultation with regulatory authorities, cement associations and cement manufacturers, as well as a literature review. The scope of this project is much reduced compared to that of the previous study and simply represents an update based on information available within the time and resources available for the work.

This study found that, since the previous report, the overall proportion of waste fuel used within the European cement industry has increased, and it currently represents over 12%, according to Cembureau. This is predicted to increase to around 20% in 2015 and 25% in 2030. However, these substitution rates are not uniform, as some countries have higher rates than others do (e.g., Austria 48%, France 32%, Germany 38%, Norway 29% and Switzerland 50%). The major cement manufacturers report substitution rates and sometimes waste composition as part of their annual sustainability reports.

Typical compositions of waste derived fuels are reported for selected countries and companies. Tyres remain an important source of solid waste derived fuel. A number of countries reported an increase in meat and bone meal (MBM), following the bovine spongiform encephalopathy (BSE) crisis. This is a direct result of measures adopted by the European Commission (EC) to prohibit the reuse of animal waste (i.e., MBM) into animal feed (Decision 2000/766/EC and Regulation 999/2001). This led to large amounts of MBM entering the market as ‘cheap’ secondary fuels, much of which has been taken up by the cement industry.

Legislation in most European Union Member States reflects the implementation of the Waste Incineration Directive (WID). However, in a limited number of cases, national requirements for some emission limit values are more stringent than those set out in the WID.

Introduction

1.1 Background

The cement industry worldwide is very energy-intensive, with fuel costs typically accounting for 30-40% of operating costs. The use of solid waste derived fuels can significantly reduce the operating costs of cement kilns, while at the same time offer an alternative waste disposal route under sustainable waste management strategies. In 2001, the Environment Agency for England and Wales published a report (prepared by Entec UK) on the international use of solid waste derived fuels in the cement sector. The impact of using solid wastes as alternative fuels in the cement and lime sectors was investigated to determine an international perspective on environmental performance, best practices and regulatory standards relevant at the points of combustion, sourcing, transport and storage.
The report concluded that the use of alternative fuels in cement kilns is widespread across Europe and the USA, with some use in other parts of the world. It was found that in Europe at least 85 plants in at least 15 countries regularly use solid waste derived fuels from a wide range of sources, including tyres, plastics, paper, refuse derived fuel (RDF), dried sewage sludge, meat and bone meal (MBM) and a variety of other waste streams. The use of solid waste derived fuels in the USA was also shown to be widespread, although the range of waste types was more limited, with about 33 plants using tyres and only a small number using any other type of solid waste derived fuels. For other parts of the world, it was more difficult to obtain information, although it is known that some cement plants use solid waste derived fuel.
The waste fuels used in cement kilns are prepared either off-site by the supplier and in a form suitable for use direct in the kiln, or are prepared or treated on-site by the cement company. The types of solid waste fuels used are generally homogeneous in nature, as fuel consistency is crucial to the process when directly firing solid waste fuels. The solid waste derived fuels are burned at different places in the kiln, with various fuel injection systems used. The system used for each kiln is site-specific and tailored to the requirements and details of that kiln.

The report found that, in general, emissions were not noticeably affected or reduced, although nitrogen oxides (NO_x) were observed to decrease in many cases when using alternative fuels in substitution for conventional fuels.
Regulatory controls over cement plants in different countries were found to vary significantly, with the regulatory bodies in some countries requiring much lower emission levels of certain pollutants than did those in other countries.

1.2 Objectives

The aim of this report is to update the work previously undertaken by Entec for the Environment Agency on ‘Solid Waste Derived Fuels for Use in Cement and Lime Kilns – An International Perspective’, completed in 2001. Changes in international legislation and typical practice have been investigated, including information on the amount, substitution rate and types of solid fuels being burned in cement kilns in Europe and the USA, and information on the legal framework for permitting solid fuels to be burned in cement kilns.

The previous study was very extensive, both in terms of content and resources available. The scope of this project is much reduced and simply represents an update based on information available within the time and resources available for the work.

1.3 Structure of Report

The structure of this report is as follows:

- Section 2 describes the data collation process;
- Section 3 outlines the key updates since the previous report;
- Section 4 lists the references.

2. Data collection process

2.1 Introduction

In updating the previous report the data collation process involved:

- consultation with regulatory authorities, cement associations and cement manufacturers;
- a literature review.

A description of these approaches is provided below.

2.2 Consultation

The consultation process began by using the contacts in the 2001 report to identify the most relevant person within each organisation and industry. They were informed by telephone about the project to be undertaken and an enquiry was made to see if they were willing to be contacted further and provide information. The literature review process also updated contacts. Additionally, individual cement associations were identified and also contacted over the phone.

Regulatory authorities and individual cement associations were surveyed to obtain information on types and amounts of solid waste being used in cement kilns, on substitution rates being achieved and on any changes in the legal framework. An information request was developed and is presented in Appendix A. Additionally, regulatory authorities were provided with a copy of the annex for their country from the previous report, and asked to comment on whether the data were still valid.

Information required from cement manufacturers was slightly different. It was targeted at more detailed information on types and amounts of solid waste used in cement kilns, substitution rates and control measures, as well as on operational and technical details A short questionnaire was developed, which is also presented in Appendix A.

For most contacts, a follow-up telephone call was made to ensure that the request for information was received and to determine whether a reply should be expected.

Tables 2.1-2.3 demonstrate from where information has been obtained. A list of the organisations that were contacted but no reply received is presented in Appendix B.

Table 2.1 Regulatory authorities that provided information for this study.

Country	*Organisation*	*Information received*
Austria	Federal Ministry of Agriculture, Forestry, Environment and Water Management	Publications and information received on legislation
Austria	Umweltbundesamt – Federal Environment Agency	Comments received on previous annex
Belgium	Direction générale des Ressources naturelles et de l'Environnement	Contact details received for the association
Germany	Federal Environmental Agency	Received information on legislation and contact details in the association
Italy	ENEA	Contact details received for the Italcementi Group
Netherlands	Ministry of the Environment	Information received on the kiln of ENCI (part of Heidelberg) in Maastricht

Table 2.2 Cement associations that provided information for this study.

Country	*Association*	*Information received*
Europe	CEMBUREAU – The European cement association	Information received on the use of solid waste
Czech Republic	Czech Cement Association	Information received on legislation and publications on line
Germany	German Cement Association - Verein Deutscher Zementwerke (VDZ)	Publications and information received on legislation
Portugal	Associacao Tecnica da Industria de Cimento	Contact details received of members
Switzerland	Cemsuisse – Association of the Swiss cement Industry	Information received on legislation and publications
USA	Portland Cement Association	Received information on legislation, publications and contact details of case studies

Table 2.3 Cement manufacturers that provided information for this study.

Country	*Company*	*Information received*
Switzerland	Holcim	Information received on legislation and the use of solid waste
Iceland	Iceland Cement Ltd	Information on the use of solid waste
Sweden	Cementa AB	Information received on the use of solid waste and operational details
Norway	Norcem A.S.	Information received on the use of solid waste, operational details and regulations.
USA	Texas Lehigh Cement Company LP	Information received on the use of solid waste, operational details and regulations
USA	Ash Grove Cement Company	Information received on regulations, publications and general use of use of solid waste
Finland	Finnsementti Oy	Information received on the use of solid waste, operational details and regulations

2.3 Literature Review

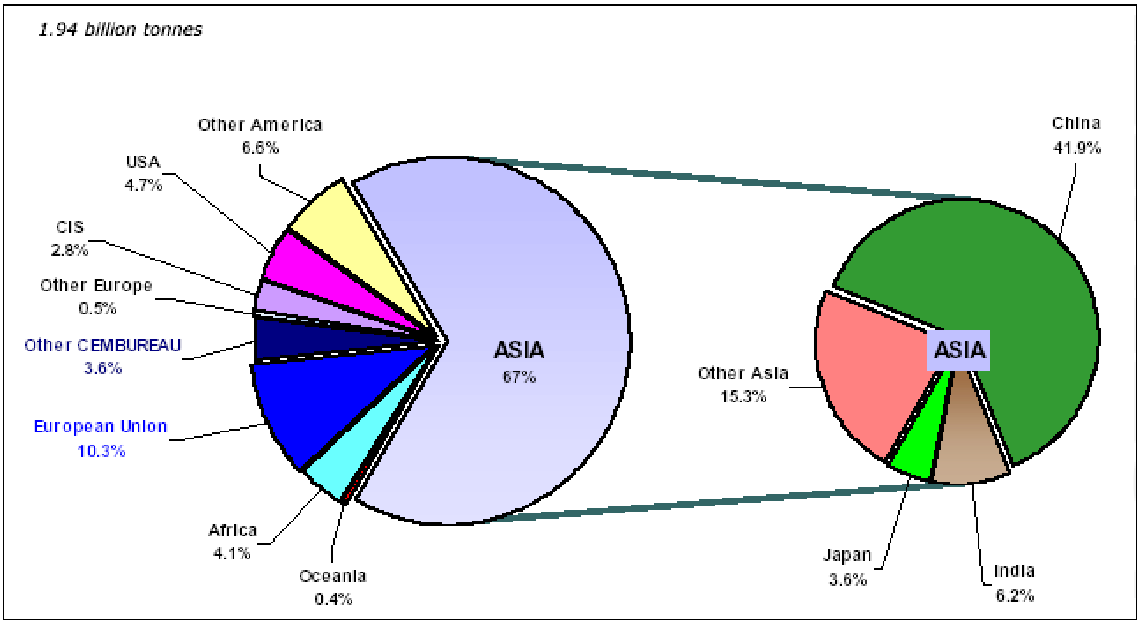
A literature review has also been conducted, which included information gained from contacts made during the survey of regulatory authorities and cement associations, as well as wider information obtained from web-based searches. The literature sources are included within the references in Section 4.

3. Updates since the previous report

3.1 Developments in the Cement Industry

Total cement production in the European Union (EU) 15 Member States has risen from 170 Mt in 1995 to 194 Mt in 2002, at the same time as a fall in the number of installations from 252 to 233 (European Commission, 2004). In 2003, world cement production reached 1.94 billion tonnes, with the EU15 Member States accounting for around 10% of this (*figure 3.1*; CEMBUREAU, 2004b).

Figure 3.1World cement production in 2003 (CEMBUREAU, 2004b).



Patterns of production and consumption in Europe and the USA have been varied since 2000. A summary of the key trends for individual countries is presented in Appendix C. Production in most countries has remained consistent. However, the survey conducted as part of this study found that German clinker production has fallen significantly since the previous report, from 27.5 Mt in 1998 to 21.5 Mt in 2003 (Verein Deutscher Zementwerke e.V., 2004). Additionally, contact with the Dutch Ministry of Environment revealed that the only cement plant in the Netherlands, the ENCI kiln (part of Heidelberg) in Maastricht, is due to close at the end of 2005 (Ministry of the Environment, 2005).

3.2 Cement Kilns Using Solid Waste

3.2.1 European Overview

Provisional information from CEMBUREAU (2004a) indicates that the proportion of waste fuel used within the European cement industry has increased since 2001 and will continue to do so with the full implementation of the Landfill Directive

(1999/31/EC) and the End-of Life Vehicles Directive (2000/53/EC). Furthermore, the implementation of the EU Emission Trading Scheme (ETS) may encourage the additional use of biofuels in cement kilns, as CO_2 emissions from biofuels are not included in the EU Emission Trading System (ETS).
The use of alternative fuels in Europe is shown in *Table 3.1* On average a substitution of 12.2% is currently achieved, of which 20% is from the use of liquid fuels and 80% is from the use of solid fuels (CEMBUREAU, 2005).

Table 3.1. Use of alternative fuels in Europe (CEMBUREAU, 2005).

Fuel type	*Quantity (KT)*	*Energy (TJ)*	*Substitution rate (%)*
Animal meal, bone meal, animal fat	890	17203	2.29
Tyres	554	14980	2.00
Plastics	210	5026	0.67
Paper, ,cardboard, wood	180	2802	0.37
Impregnated sawdust	167	1931	0.26
Coal slurries, distillation residues	112	1654	0.22
Sludges (paper fibre, sewage)	107	1032	0.14
Fines, anodes, chemical cokes	89	1603	0.21
Refuse derived fuels (RDF)	41	531	0.07
Shales, oil shales	14	130	0.02
Packaging waste	12	264	0.04
Agricultural and organic waste	11	170	0.02
Others, non-hazardous	788	15035	2.00
Others, hazardous	357	6545	0.87
Waste oil and oiled water	402	14331	1.91
Solvents and others	266	4081	0.54
Other hazardous liquid fuels	173	4398	0.59
Total alternative fuels	4373	91716	12.22

The future use of alternative fuels in the cement sector has been examined under the European Commission's Clean Air For Europe Programme (CAFE) during a study contract to investigate the air emissions impact of emerging technologies (DFIU/IFARE, 2004). It was noted that the use of wastes for alternative fuels in cement plants has increased over recent years. For example in Austria the substitution rate has increased to a current level of 43%, with an increase of up to 75% before 2010 predicted. On average, for the EU the substitution rate is predicted to increase from currently 12% on average (with large local differences) to 20% on average in 2015 and 25% on average in 2030 (again, with large local differences). Reasons for the relatively moderate increase were cited as:

- limited availability of suitable selected wastes as alternative fuel;
- gradual build-up of technical know-how and experience on how to use waste-derived fuels without jeopardising process and product quality;

- decreasing production rate of the kiln when low calorific waste is used (DFIU/IFARE, 2004).

3.2.2 National Perspectives

The following sections of the report update information collated from a number of countries. Owing to the time and budget constraints of the project, the list is not exhaustive and reflects information collated from responses to information requests (see Section 0).

Austria

The previous report provided data for 1998 on the use of solid waste in cement kilns in Austria. Mauschitz (2004) summarises the operating data and emissions from the nine Austrian cement works from 1998 to 2003. This is presented in *Figure 3.2* and *Table 3.2*. It is evident that there have been significant changes since the publication of the previous report. The proportion of waste used as fuel has increased from around 25% in 1998 to 50% in 2003. This change has mainly been through an increase in the use of plastic wastes and 'other waste', which includes MBM, sewage sludge and sawdust (Austrian Federal Environment Agency, 2005).

Figure 3.2 Changes in fuel composition between 1998 and 2003.

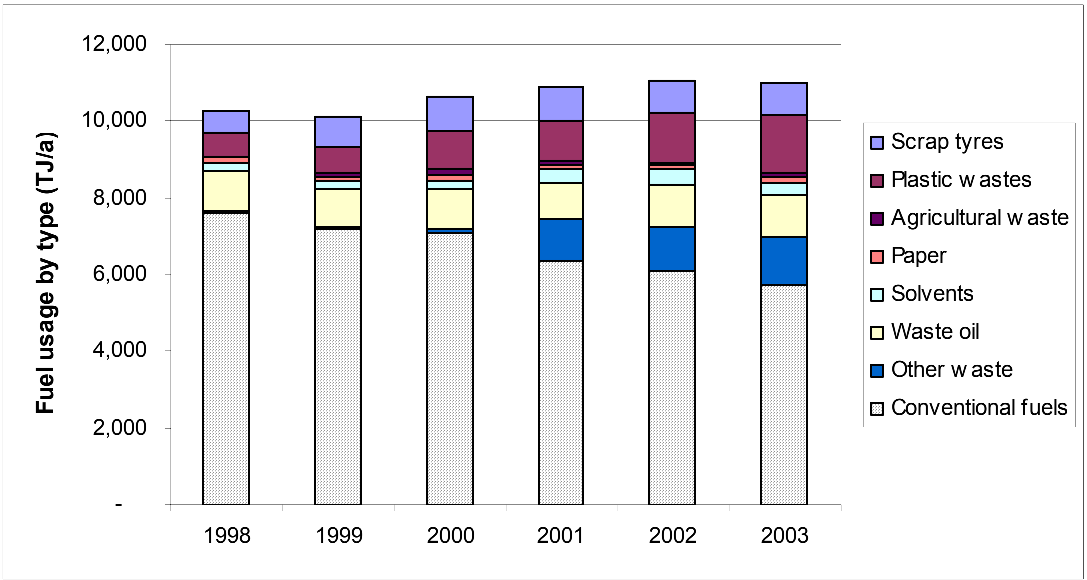


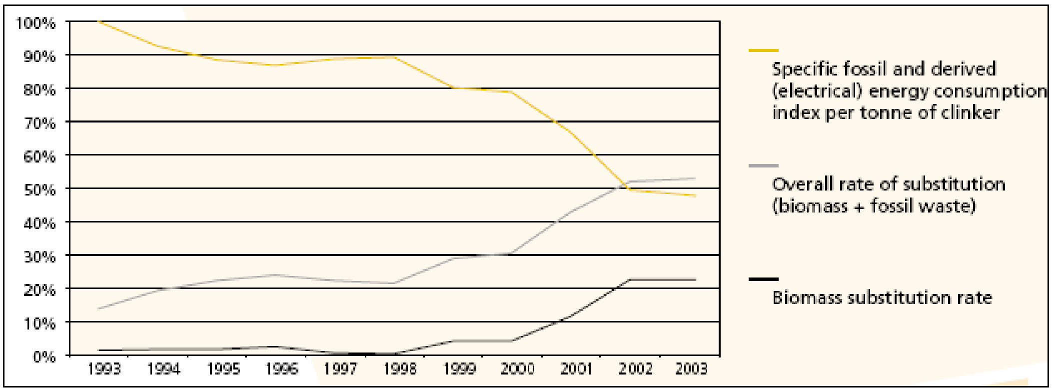
Table 3.2 Fuel usage in 2003 (Mauschitz, 2004).

Fuel type	*Tonnes per annum*	*GJ per annum*	*Percentage of thermal input*
Hard coal	70,523	2,101,234	19
Brown coal	56,805	1,244,945	11
Fuel oil (0.2% S)	546	22,588	0
Fuel oil (0.6% S)	–	–	0
Fuel oil (1.0-3.5% S)	11,528	–	4
Natural gas	8,615	312,746	3
Petroleum	50,089	1,580,439	14
Other conventional fuels	82	3,495	0
Scrap tyres	32,060	848,467	8
Plastic wastes	57,416	1,508,036	14
Waste oil	30,057	1,103,025	10
Solvents	12,459	312,978	3
Agricultural waste	8,684	142,744	1
Paper	42,368	122,867	1
Other waste fuels	72,766	1,266,944	11
Total conventional fuels	**195,700**	**5,727,424**	**52**
Total waste fuels	**255,810**	**5,305,061**	**48**

Belgium

Belgium has been described as one of the leading countries in the use of alternative kiln fuels, both in terms of the quantity of usage and in terms of the range of materials available and authorised for burning (Cemnet, 2005). The 2003 environmental report for CBR (2004), the leading cement producer in Belgium and a subsidiary of HeidelbergCement, demonstrates the significant increase in substitution rates since 2000 (Figure 3.3) In 2003, substitution rates were 53% for the company's three kilns. At the Antoing plant, a substitution rate of 72% has been reported.

Figure 3.3 Reductions in fossil fuels (CBR, 2004).



Finland

The survey conducted as part of this project obtained a response from Finnsementti Oy, the only cement company in Finland. For solid waste, substitution rates of 20% for total fuel used and 10-15% of total thermal input are achieved. The amount of waste used as a fuel is:

- 200 tonnes/year of tyres, which represents 2% of total thermal input;
- 10,000 tonnes/year of MBM, which represents 8% of total thermal input;
- 1500 tonnes/year of paper, plastic and aluminium foil, which have just been introduced in the kiln and represent 5% of total thermal input.

The use of plastic solid recovered fuel and sewage sludge is currently being investigated for future applications (Finnsementti Oy, 2005).

France

The literature review found that substitution rates in France had increased from 24% in 1998 to 34% in 2002 and 32% in 2003, based on the total energy for combustion in cement plants (Syndicate Française de l'Industrie Cimentière, 2003).

Germany

The previous report stated that in 1999, 23% of the fuel used in German cement kilns comprised alternative fuels. By 2003, this proportion had increased to about 40% of the total thermal input *(Table 3.3).* The composition of the waste fuel used has also changed (*Figure 3.4*), with a much greater contribution from 'other' types of waste, including industrial fractions (e.g., cellulose, paper and pasteboard, plastic, packing and textile waste), MBM and sewage sludge.

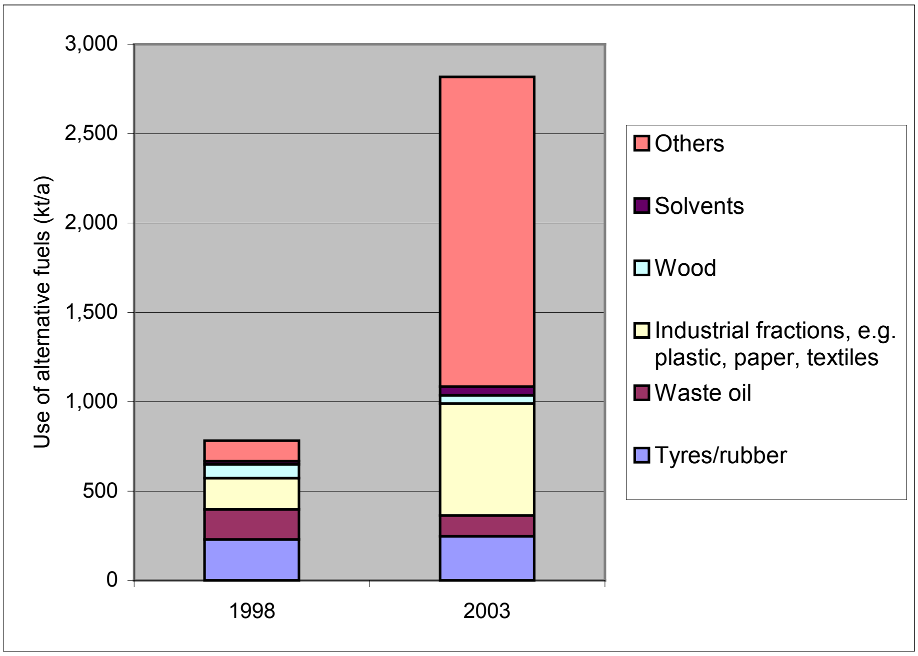
Table 3.3 Fuel usage in 2003 (Verein Deutscher Zementwerke e.V., 2004).

Fuel type	*Tonnes per annum**	*GJ per annum*	*Percentage of thermal input*
Hard coal	n.i.	19,100,000	20.9
Brown coal	n.i.	27,400,000	30.0
Petroleum	n.i.	5,700,000	6.2
Fuel oil	n.i.	3,100,000	3.4
Natural gas and other gases	n.i.	300,000	0.3
Other fossil fuels	n.i.	800,000	0.9
Tyres	247,000	6,422,000	7.0
Waste oil	116,000	3,480,000	3.8
Cellulose, paper and pasteboard	156,000	2,964,000	3.2
Plastic	177,000	3,717,000	4.1
Packing	9,000	225,000	0.2
Wastes from the textile industry	15,000	315,000	0.3
Other industrial and trade waste	269,000	5,918,000	6.5
Meat and bone meal	452,000	8,136,000	8.9
Prepared settlement wastes	155,000	2,635,000	2.9
Mature timber	48,000	624,000	0.7
Solvents	48,000	1,200,000	1.3
Bentonit	20,000	240,000	0.3
Sewage sludge	4,000	44,000	0.05
Others	17,000	306,000	0.3
Total fossil fuels		**56,400,000**	**61.8**
Total waste fuels	**1,733,000**	**34,900,000**	**38.2**

Notes:

*n.i, no information.

Figure 3.4 Changes in fuel composition between 1998 and 2003.



Iceland

In Iceland, the situation has not changed since the previous report. There is only one cement plant in Iceland, run by Iceland Cement Ltd, which does not burn solid waste derived fuels (Iceland Cement, 2005).

Norway

The survey conducted as part of this project obtained a response from Norcem A.S,, which owns and operates the two plants in Norway. The substitution rate is currently 29%, as a percentage of total fuel used, which is higher than the target of 25% in 2000. The composition of the waste fuel used is shown in *Table 3.4* (Norcem, 2005).

Table 3.4 Fuel usage (Norcem, 2005).

Fuel type	*Tonnes per annum*	*Percentage of thermal input*
Tyres	10,000	15
Municipal solid waste (RDF)	35,000	15
Animal waste	10,000	10
Hazardous waste (solid)	16,000	8

Switzerland

The previous report cited substitution rates of around 30% in most Swiss cement kilns (1997 figures). This increased to about 50% in 2004 (Holcim, 2005a), mainly through a five-fold increase in the use of animal fats and animal waste in cement kilns in 2001. In certain plants the rate of substitution is over 80% (Swiss Agency for the Environment, Forests and Landscape, 2002). The average composition of fuel used is presented in *Figure 3.5* and *Figure 3.6*.

Figure 3.5 Fuel usage in Switzerland by mass (Holcim, 2005a).

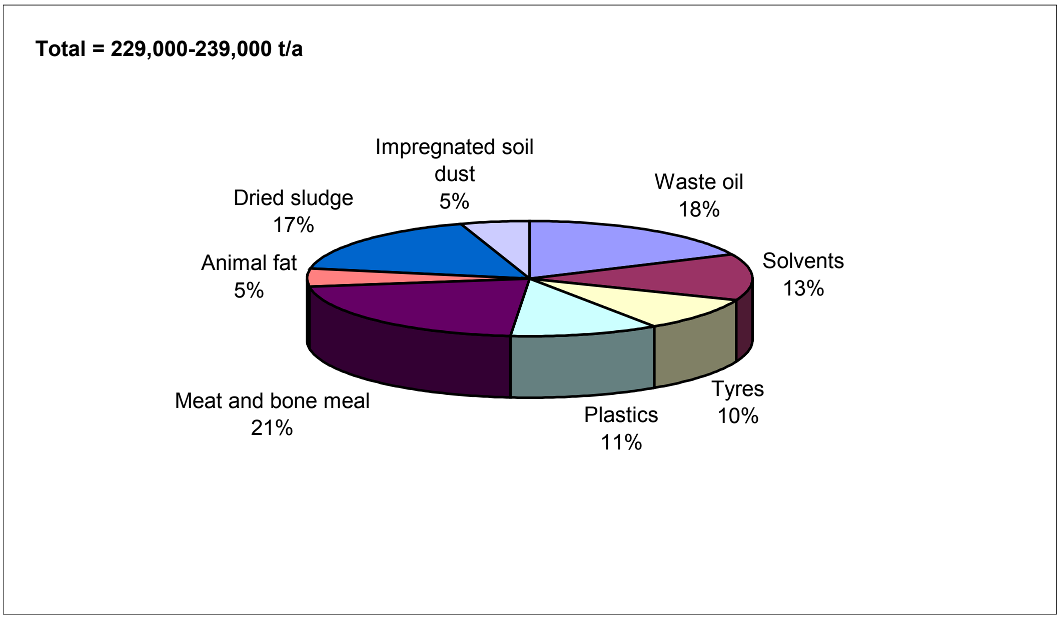
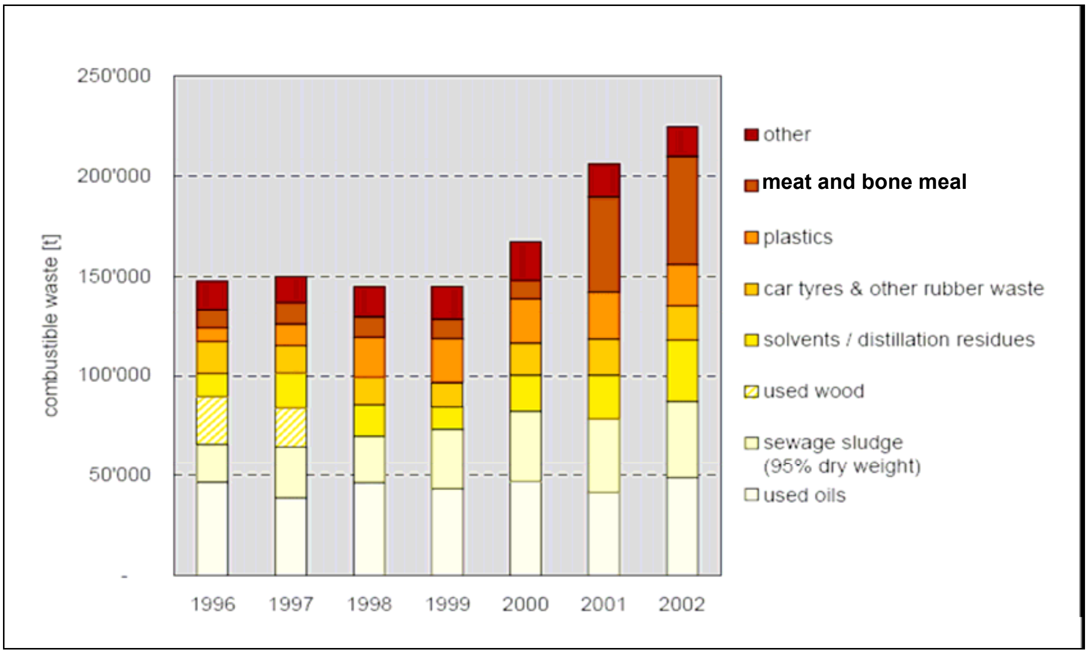


Figure 3.6 Fuel usage in Switzerland from 1996 to 2002 (Swiss Agency for the Environment, Forests and Landscape (b), 2005).

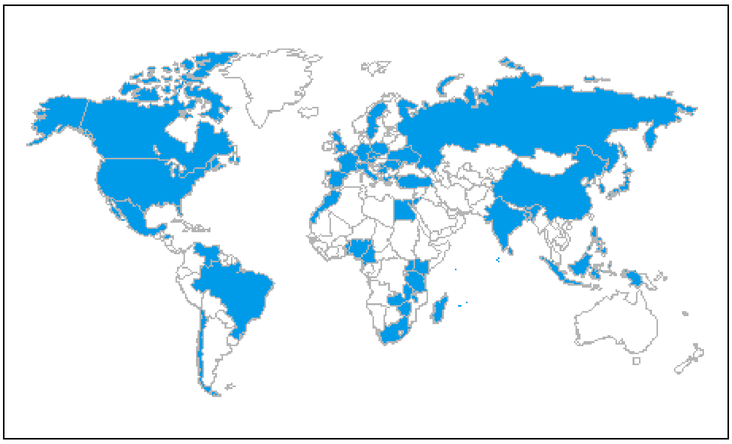


3.2.3 International Cement Manufacturers

Lafarge

Lafarge operates cement works in 43 countries worldwide, including Europe and North America (*Figure 3.7*). Since the publication of the previous report, Lafarge has acquired Blue Circle Industries, which operates cement works in the UK, Greece, Malaysia, Chile and Nigeria (Lafarge, 2003).

Figure 3.7 Coverage of Lafarge Cement Works (Lafarge, 2005)



Lafarge's 2003 sustainability report demonstrates a 45% increase in the use of alternative fuels between 2001 and 2003 across the group (*Figure 3.8* and *Figure 3.9* Lafarge, 2004).

Figure 3.8 Fossil fuel net savings in Lafarge cement works as a result of both energy efficiency improvements and the use of alternative fuels (Lafarge, 2004).

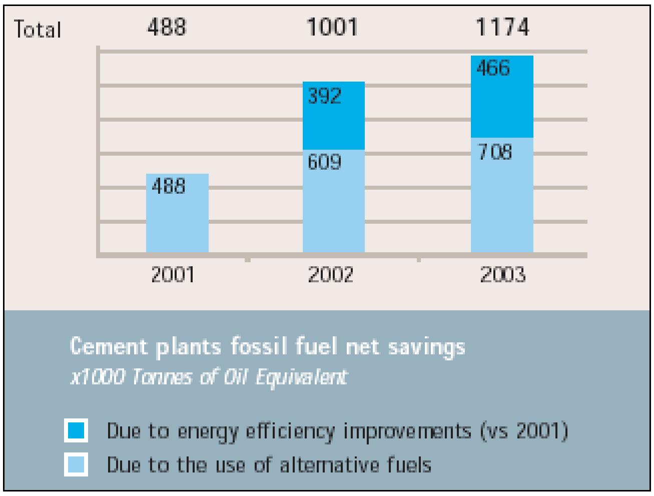
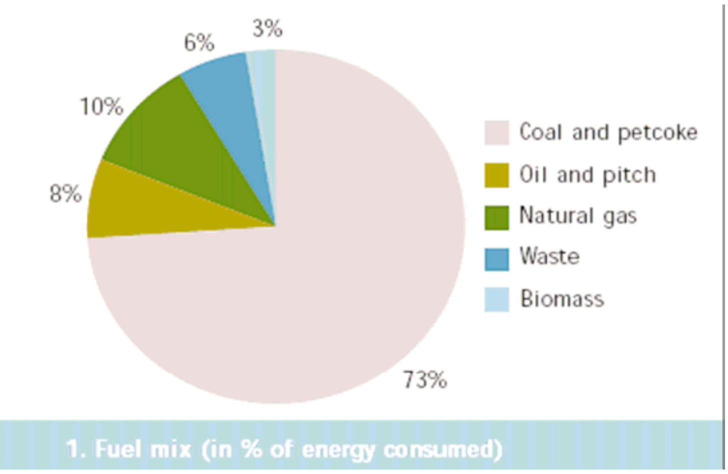


Figure 3.9 Fuel mix (Lafarge, 2004)



Dyckerhoff

Dyckerhoff, who operate in Germany, Luxembourg, the Czech Republic, Poland, the Ukraine, Russia and the USA, reported that in 2003:

- alternative fuels replaced approximately 25% of fossil fuels in Germany (using tyres, used oils, liquid refuse, residual carpet, plastic and MBM) – notably, the Deuna and Göllheim plants met around 40% of their fuel energy requirements with secondary fuels;
- alternative fuels accounted for 23% of heat requirements at the Intermoselle plant in Luxembourg, using tyres and sewage sludge;
- the Czech plant in Hranice began to burn MBM, increasing the substitution rate to around 26%;
- in Poland the Nowiny plant uses tyres as secondary fuels, to a substitution rate of approximately 10% of primary energy.

Dyckerhoff are aiming to continue to increase the use of secondary fuels in all plants and to expand the range of secondary fuels used (Dyckerhoff, 2005).

Holcim

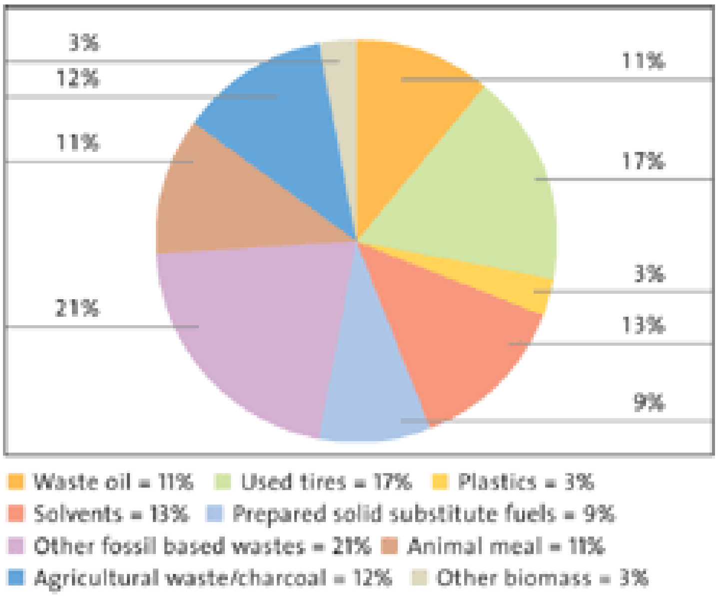
Holcim is a Swiss-based cement company that operates in a large number of countries across the world, including Europe and North America (Figure 3.10).

Figure 3.10 Coverage of Holcim cement works (Holcim, 2005b).

Holcim has developed an alternative fuels and raw materials policy, which governs the co-processing of waste-derived materials at Holcim cement plants and also covers Holcim facilities at which selected waste streams are pre-treated for recovery in cement kilns. Holcim has also formed a public–private partnership with the German Technical Cooperation (GTZ) to develop guidelines for the use of wastes in cement production. The substitution rates achieved by Holcim cement works increased slightly between 2000 and 2003 (*Figure3.11*). The use of alternative fuels is most established in Western Europe and North America, at 32% and 17%, respectively. However, Holcim works in Latin America significantly increased their rates in the past 2 years from 10% to 14%. *Figure 3.12* shows the types of wastes used.

Figure 3.11. Thermal substitution rate by alternative fuels (%) (Holcim, 2005b).

Figure 3.12 Waste types used as alternative fuels (Holcim, 2005)



Italcementi

Italcementi operates in 19 countries in Europe, Asia, Africa and North America. The Group's 2003 sustainability report (Italcementi, 2004) notes that alternative fuels comprise more than 7% of the Group's total energy consumption, and in France, Belgium and the USA they represent a substantial part of the energy used. The substitution rates for the individual group sections are presented in *Figure 3.13*, with the composition presented in *Figure 3.14*.

Figure 3.13 Substitution rates for the Italcementi Group in 2003 (Italcementi, 2004).

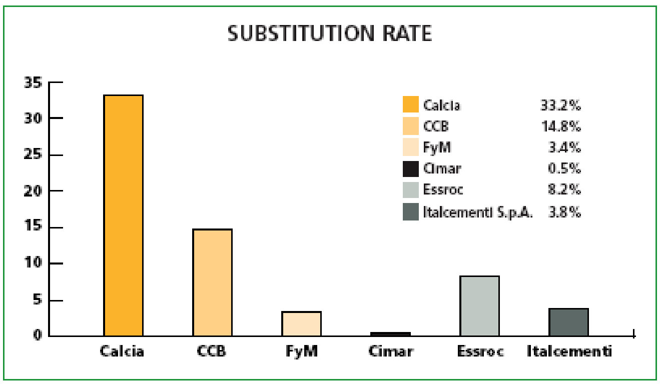
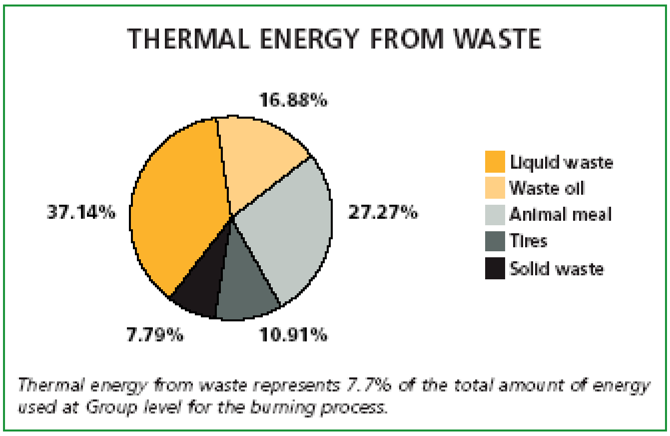


Figure 3.14 Waste composition for alternative fuels used by Italcementi Group in 2003 (Italcementi, 2004).



Ciments Français are part of the Italcementi Group. Their 2003 annual report noted that their share of alternative fuels is dependent on the quantity of waste available. For example, in 2003 in France and Belgium, MBM was not as predominant in waste streams as in previous years in France and Belgium. In Spain, Turkey and Greece, national plans for the incineration of waste are being gradually implemented, in co-operation with local authorities.

3.3 Case Studies

The following sections of this report update information collated from contacts made during the survey. As such, the list is not exhaustive.

Czech Republic

Two Ceskomoravsky cement (CMC) plants (part of HeidelbergCement) in the Czech Republic have begun to use biomass as an alternative fuel (HeidelbergCement, 2004). Use of MBM in the Mokra plant started in August 2003, with 2450 tonnes of MBM utilised by early 2004. The Radotin plant began using MBM 4 months later. Heidelberg report both positive and negative experiences from these plants (HeidelbergCement, 2004). The use of MBM has reduced CO_2 emissions, reduced overall fuel expenditures and also slightly improved clinker quality. However, they have found the utilisation of MBM to be demanding, as it requires special attention to feeding the fuel into a kiln without clogging the fuel tubes. Furthermore, supplies of MBM are sometimes limited, and the plants could successfully utilise more of the material. Careful logistics and on-time delivery is therefore required.
However, Heidelberg does note that many of these negative factors are being resolved. The meal is being mixed with a paper-based solid alternative fuel, which helps the fuel mix travel more smoothly to the kiln. Additionally, a second space for unloading the 15-ton containers of MBM is being built to address the logistic and storage conditions (HeidelbergCement, 2004).

Denmark

The survey conducted as part of this project obtained a response from Aalborg Portland in Denmark. A substitution rate of 13% was achieved in 2003 (as a percentage of total fuel used, 8% as a percentage of total thermal input) by burning mainly municipal solid waste and animal fats and animal meal, but also sewage sludge (Aalborg Portland, 2005). In 2003 the input of CemMiljø fuel was increased and the use of MBM was introduced to increase the use of alternative fuels at Aalborg Portland. Also, a new chlorine bypass for kiln 87 was designed and installed to enable a better use of alternative fuels for kiln firing. *Table 3.5* shows the development in consumption for the different fuel types (Aalborg Portland, 2003).

Table 3.5 Waste products used as fuels for Aalborg Portland (Aalborg Portland, 2003).

Year	*Tonnes wet*	*kg wet/tTCE*
2001	70915	26.4
2002	84382	31.5
2003	71331	28.6

The use of municipal solid waste increased in 2004 to 58 kt (Aalborg Portland, 2005).

Romania

HeidelbergCement (2004) presents the development of alternative fuels in Romania. The goal is to reach an initial alternative fuel substitution rate of 10%. The project began with governmental authorities granting the cement plants in Moldocim Bicaz and Casial Deva permits to collect and transport waste oils, old tyres and waste wood. The two plants also received the environmental permits for recovery of these wastes as alternative fuels. The first tests were made in November 2003, and 5 tons have since been used. Both plants have been preparing to use tyres in their kilns for several years. Special storage facilities were organised at each plant in 2002. By late 2003, over 4400 tons of old tyres had been collected. The plants will be prepared following implementation of the end-of-life vehicles directive, which will create the financial mechanisms to move old tyres from the countryside and into collection centres before being used in a cement plant.

Sweden

Three cement plants are owned by Cementa AB in Sweden. Data have been supplied for one of the plants, at which 30-40% of the total thermal input is achieved by burning approximately 34,000 tonnes of tyres, 16,000 tonnes of plastics and 7000 tonnes of animal waste. An increase in the use of solid waste is planned, mainly through burning biomass, to achieve 50% of thermal input by 2007. The possibility of the use of sewage sludge as a fuel is also under consideration (Cementa AB, 2005)

Switzerland

The survey conducted as part of this project obtained a response from Holcim (Schweiz) AG. In 2003 the company used approximately 15,000 tonnes of plastic, 10,000 tonnes of tyres, 30,000 tonnes of MBM, 30,000 tonnes of dried sludge and 12,000 tonnes impregnated soil dust. The substitution rate being achieved is 45% for waste fuels. There are no plans to increase the use of solid waste in the future.

USA
The survey conducted as part of this project obtained a response from the Ash Grove Cement Company, which operates a cement plant in Chanute, Kansas, that burns hazardous waste and tyres. The plant is a new source under the HWCNESHAP (Hazardous Waste Combustion NESHAP) regulations. In 2004, Ash Grove substituted 22.1% of its required energy input with alternative fuels (hazardous waste, tyres, landfill gas, and coke; Ash Grove, 2005).
A questionnaire response was also obtained from Texas Lehigh Cement Company LP, which burns 200 tonnes/year of tyres, and achieves a substitution rate of 16% of total thermal input.

3.4 Changes in the Legislative Framework

3.4.1 European Legislation

The Directive on Integrated Pollution Prevention and Control (IPPC; 96/61/EC) and the Waste Incineration Directive (WID; 2000/76/EC) are both described in the previous report. The WID introduces emission limits for the co-incineration of waste in cement kilns. Other waste management legislation influences the utilisation of waste as fuel by requiring Member States to move waste away from landfill, such as the Framework Directive on Waste (75/442/EEC, as amended) and the Landfill Directive (1999/31/EC).
Following the outbreak of bovine spongiform encephalopathy (BSE), the EC adopted measures to prohibit the reuse of animal waste (i.e., MBM) into animal feed (Decision 2000/766/EC (CD 2000b) and Regulation 999/2001(ECR 2001)). As a result, large amounts of MBMs entered the market as ‘cheap’ secondary fuels, much of which has been taken up by the cement industry (EC, 2003), as reflected in the waste composition data presented in Section 3.2.

3.4.2 National Legislation

Legislation in most EU Member States reflects the implementation of the WID. However, in a limited number of cases, national requirements for some emission limit values (ELVs) are more stringent than those set out in the WID. These are noted in the sections below. In the USA, there have been no significant changes in the legislative framework since 2001, except for corrections and amendments to the HWCNESHAP regulations.

Austria
The legislative framework has changed significantly since 2000, following the implementation of the WID in 2002 with the Waste Incineration Ordinance ‘Abfallverbrennungsverordnung’. The requirements were issued by the Federal Ministry for Agriculture, Forestry, Environment and Water Management and the Federal Ministry for Economics and Labour. The Waste Incineration Ordinance will replace the previous ordinance concerning hazardous waste from 28 December 2005 (Lebensministerium, 2005). Existing plants that insert waste have to meet the limit values of the Ordinance on waste incineration from 28 December 2005. There are exemptions for some limit values until 31 October 2007. This ordinance places more

stringent requirements than the ELVs set out in the WID for some emissions. The differences are presented in *Table 3.6.*

Table 3.6 Comparison of WID ELVs with Austrian Waste Incineration Ordinance.

Pollutant	*WID (Annex II.1)*	*Austrian ELVs*
Averaging period	Daily average values for continuous measurements – half-hourly average values shall only be needed in view of calculating the daily average values	As WID, but also with half-hour averages for total dust
Conditions	The results of the measurements made to verify compliance with the emission limit values shall be standardised at the following conditions: temperature 273 K, pressure 101.3 kPa, 10% oxygen, dry gas	As WID
Total dust*	30 mg/m^3	30 mg/m^3 as a half-hour average; 20 mg/m^3 as a daily average
HCl	10 mg/m^3	As WID
HF	1 mg/m^3	0.7 mg/m^3
NO_X (existing plants)†	800 mg/m^3	500 mg/m^3 for existing plants, starting from 31 October 2007
NO_X (new plants)	500 mg/m^3	As WID
Cd and Ti	0.05 mg/m^3	As WID
Hg	0.05 mg/m^3	As WID
Sb, As, Pb, Cr, Co, Cu, Mn, Ni and V	0.5 mg/m^3	As WID
Dioxins and furans	0.1 ng/m^3	As WID
SO_2	50 mg/m^3	As WID
TOC	10 mg/m^3	As WID
CO	No specific ELV given; emission limit values for CO can be set by the competent authority	As WID

Notes:
1.* Until 1/1/ January 2008, exemptions for particulates may be authorised by the competent authorities for cement kilns which that burn less than 3 tonnes of waste per hour, provided that total particulates emissions do not exceed 50 mg/Nm^3.
†2. Until 1/1/ January 2008, exemptions for NO_X may be authorised by the competent authorities for existing wet process cement kilns or cement kilns which that burn less than 3 tonnes of waste per hour, provided that the total NO_X emissions do not exceed 1,200 mg/Nm[33].

Germany

As highlighted in the previous report, the two key pieces of legislation for cement plants in Germany are the Technische Anleitung Luft (TA-Luft), or Technical Instruction on Air Quality Control, and the 17th BImSchG, a regulation made under the Bundes-Immissions-Schutz-Gesetz (BImsSchG; the Federal Immission Protection Act).
TA-Luft applies to cement plants that burn conventional fuels. The 17th BImSchG applies when burning wastes. Nearly all cement plants in Germany use some type of waste and have limits imposed by the local authority, which are based on a mixture of requirements in the two laws above. Different authorities interpret the limits

differently, so all plants have different limits. There are very few differences between this legislation and the WID *(Table 3.7).*

Table 3.7 Comparison of WID ELVs with German Federal Emission Control Law.

Pollutant	*WID (Annex II.1)*	*German ELVs*
Averaging period	Daily average values for continuous measurements – half-hourly average values shall only be needed in view of calculating the daily average values	As WID, but also with half-hour averages for HCl, HF, SO_2 and mercury
Conditions	The results of the measurements made to verify compliance with the emission limit values shall be standardised at the following conditions: temperature 273 K, pressure 101.3 kPa, 10% oxygen, dry gas	As WID
Total dust*	30 mg/m^3	20 mg/m^3
HCl	10 mg/m^3	As WID
HF	1 mg/m^3	As WID
NO_X (existing plants)†	800 mg/m^3	500 mg/m^3 for existing plants, starting from 31 October 2007
NO_X (new plants)	500 mg/m^3	As WID
Cd and Ti	0.05 mg/m^3	As WID
Hg	0.05 mg/m^3	0.03 mg/m^3 ‡
Sb, As, Pb, Cr, Co, Cu, Mn, Ni and V	0.5 mg/m^3	As WID
Dioxins and furans	0.1 ng/m^3	As WID
SO_2	50 mg/m^3	As WID
TOC	10 mg/m^3	As WID
CO	No specific ELV given; emission limit values for CO can be set by the competent authority	As WID

Notes:
1. *Until 1/1/ January 2008, exemptions for particulates may be authorised by the competent authorities for cement kilns which that burn less than 3 tonnes of waste per hour, provided that total particulates emissions do not exceed 50 mg/Nm^3.
†2. Until 1/1/ January 2008, exemptions for NO_X may be authorised by the competent authorities for existing wet process cement kilns or cement kilns which that burn less than 3 tonnes of waste per hour, provided that total NO_X emissions do not exceed 1,200 mg/Nm^3.
‡3. The responsible authorities can approve a daily average of up to 0.05 mg/m^{3}³ upon the request of the operator if an excess of the daily average of 0.03 mg/m^{3}³ is due to the mercury content of the raw materials.

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Appendix A

Environment Agency for England and Wales

The use of solid waste derived fuels in cement kilns request for information

The cement industry worldwide is very energy-intensive, with fuel costs typically accounting for 30-40% of operating costs. The use of solid waste derived fuels can significantly reduce the operating costs of cement kilns, whilst at the same time offering an alternative waste disposal route under sustainable waste management strategies.

In 2001, the Environment Agency for England and Wales compiled a report on the international use of solid waste derived fuels in the cement sector. This report is now being updated, to take account of any changes in international legislation and typical practice. We would very much appreciate your input into this process of knowledge exchange.

The attached word document comprises the annex for your country, used in the 2001 report. We would be very grateful if you could provide your comments on this annex, indicating where information needs to be updated.
We are particularly interested in gaining additional information in the following areas:

1. PUBLISHED INFORMATION

- Please could you forward details of any published reports on current and/or future use of solid waste derived fuels in cement kilns.

2. USE OF SOLID WASTE IN YOUR COUNTRY

- How much solid waste is being used as fuel?
- What substitution rates are achieved?
- What types of solid waste are currently used – composition as a % of total thermal input?

3. REGULATION

- What are the emission limit values (if different from the Waste Incineration Directive) – with details of averaging periods and reference conditions?
- Has the legal framework for permitting solid fuels burning in cement kilns changed since 2000? If so, how?

4. CASE STUDIES

- Please could you provide contact details for cement manufacturers in your country that we could contact and use as case studies for good environmental practice in the use of solid waste derived fuels?

5. OTHER COMMENTS

- Are there any other comments that you would like to make regarding the use of solid waste derived fuel in cement kilns?

MANY THANKS FOR YOUR CO-OPERATION

We would be grateful if you could reply to this information request by **25th February –** electronically, by post or fax to Andriana Stavrakaki (contact details given above). **Please clearly identify any information that could be classified as confidential.**

Environment Agency for England and Wales

The use of solid waste derived fuels in cement kilns
Request for information

The cement industry worldwide is very energy-intensive, with fuel costs typically accounting for 30-40% of operating costs. The use of solid waste derived fuels can significantly reduce the operating costs of cement kilns, whilst at the same time offering an alternative waste disposal route under sustainable waste management strategies.

In 2001, the Environment Agency for England and Wales compiled a report on the international use of solid waste derived fuels in the cement sector. This report is now being updated. As a major cement manufacturer, we would very much appreciate your input to this investigation.

We would be grateful if you could complete this questionnaire and return it to Andriana Stavrakaki by **25th February** (electronically, post or fax – contact details given above). Please feel free to expand your answers on further pages if required. **Please clearly identify any information that could be classified as confidential.**

1.	COMPANY DETAILS

1.1	Company name and address:

1.2	Contact name and telephone number:

1.3	Annual cement production (tonnes clinker per year)

1.4	Number, location and type of kilns using solid waste derived fuel:

2. SOLID WASTE DETAILS

2.1 What substitution rates are being achieved?

As a percentage of total fuel used: ____________________________________

As a percentage of total thermal input: ____________________________________

2.2 What types of solid waste are currently used? Please complete the table below.

	Amount of waste used as fuel	
Waste type	**Tonnes per year**	**As % of total thermal input**
Tyres		
Plastics		
Paper		
Municipal Solid Waste		
Sewage Sludge		
Animal Waste		
Other waste (please specify)		
____________________		
____________________		
____________________		

2.3 Are there any plans to increase the use of solid waste in the future, or to use different types of solid waste? If so, please provide details.

3. OPERATIONAL / TECHNICAL DETAILS

3.1	How are the waste fuels stored and handled on site?

3.2	How is the waste checked, if applicable (e.g. for contaminants)?

3.3	Does the waste require processing on site prior to use (e.g. shredding)?

3.4	How are waste fuels introduced to the kiln?

4. CONTROL MEASURES

4.1	What combustion control measures are in place (or planned) to minimise air emissions (e.g. combustion control)?

4.2	What abatement measures are in place (or planned) to minimise air emissions?

5. REGULATION

5.1	What are the emission limit values (if different from the Waste Incineration Directive) and what emission monitoring is carried out? Please complete the table below

Pollutant	**ELV if different from WID (mg/Nm^3)**	**Averaging period**	**Reference values**			**Spot samples? (tick)**	**Continuous monitoring? (tick)**
			% oxygen	**Temp. (°C)**	**Pressure (mbar)**		
Particulates						☐	☐
TOC						☐	☐
HCl						☐	☐
HF						☐	☐
SO_2						☐	☐
NO_X						☐	☐
CO						☐	☐
Cd						☐	☐
Ti						☐	☐
Hg						☐	☐
Other metals						☐	☐
Dioxins						☐	☐
Other (please specify) ________						☐	☐
________						☐	☐
________						☐	☐

5.2	Has the legal framework for permitting solid fuels burning in cement kilns changed since 2000? If so, how?

6.	OTHER COMMENTS

6.1	Are there any other comments that you would like to make regarding the use of solid waste derived fuel in cement kilns?

MANY THANKS FOR YOUR CO-OPERATION

Please forward your completed survey form to:

Andriana Stavrakaki
ENTEC UK LTD
17 Angel Gate
City Road
London
EC1V 2SH
UK
Tel: +44 (0) 20 7843 1416
Fax: +44 (0) 20 7843 1410
E-mail: stava@entecuk.co.uk

Appendix B List of organisations contacted

Regulatory Authorities
Federal Environment Agency, Austria
Bundesministerium Umwelt, Austria
Ministry of the Walloon Region, Belgium
Directorate General Protection of Public Health: Environment, Belgium

Environment Protection Agency, Ministry of Environment & Energy, Denmark
DPPR (Environment Ministry) Service de l'Environnement Industriel Ministere de l'ecologie et du developpement durable, France
Ministry of Environment, France
Finnish Environment, Finland
Federal Environment Agency, Germany
Federal Ministry of Environment, Germany
Ministry for Environment and Water, Hungary
Environment and Food Agency, Iceland
ENEA, Italy
Administration de l'Environnement air division, Luxembourg

Ministry of Environment, Netherlands
Ministerio de Medio Ambiente, Spain
Environment Protection Agency, Sweden

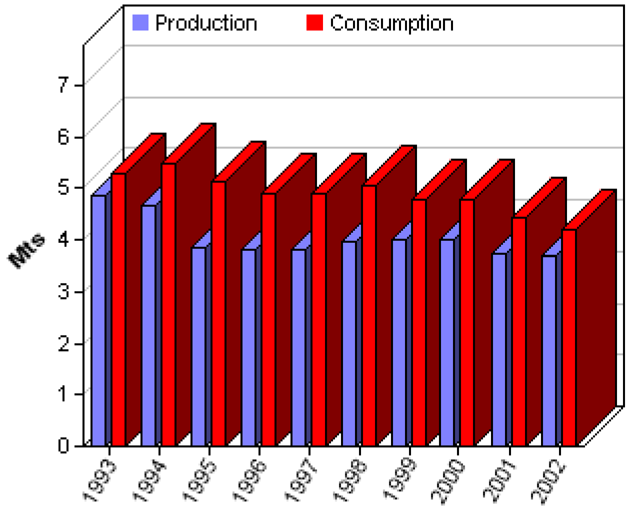
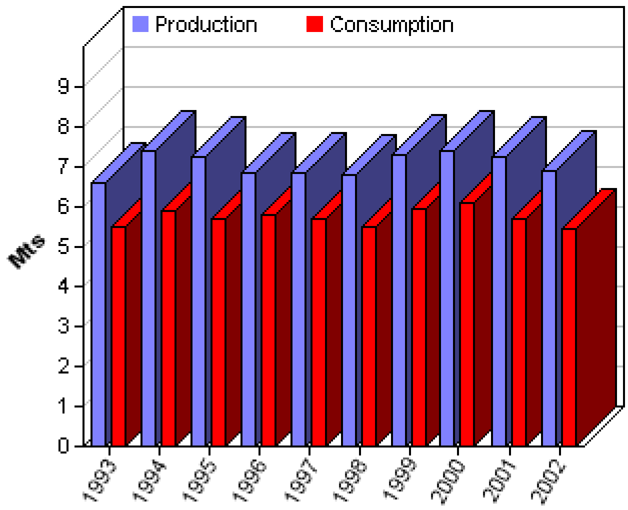
Cement Manufacturers
PMT – Zyklontechnik GmbH, Austria
Compagnie des Ciments Belges, Italcementi Group, Belgium
Holderbank, Belgium
S.A. Cimenteries CBR, Belgium
Aalborg Portland AS, Denmark
Nordjyllands Amt, Denmark (local office that authorises the permit for Aalborg Portland)
Finnsementti Oy, Finland
Lafarge International
Lafarge, France
RZG Rüdersdorf, Germany
Heidelberg Zement Group, Germany
Sementsverksmidjan Hf, Iceland (Iceland Cement Ltd.)
ITALCEMENTI Group, Italy
Ciments Luxembourgeois S.A., Dycherhoff, Luxembourg
VNC, Vereniging Nederlandse Cementindustrie, Netherlands
Norcem A.S., Norway
CIMPOR, Indústria de Cimentos, S.A., Portugal
SECIL, Companhia Geral de Cal e Cimento, S.A., Portugal
Cementa AB, HeidelbergCement Group, Sweden
Cemsuisse, Switzerland
Holcim, Switzerland

Cement Associations
VOZ, Vereinigung der Osterreichischen Zementindustrie, Austria
CEMBUREAU, The European Cement Association, Belgium
Febelcem, Fédération de l'Industrie Cimentière Belge, Belgium
Czech Cement Association, Czech Republic
KNC, Kunda Nordic Cement Corporation, Estonia
SFIC, Syndicat Français de l'Industrie Cimentiere, France
VDZ, Verein Deutscher Zementwerke, Cement trade association, Germany
BDZ, Bundesverband der Deutschen Zementindustrie e.V., Association of the German Cement Industry, Germany
Hellenic Cement Industry Association, Greece
VNC ,Vereniging Nederlandse Cementindustrie, Holland
Magyar Cementipari Szovetseg, Hungary
AITEC, Associazione Italiana Tecnico Economica del Cemento, Italy
Ciments Luxembourgeois S.A., Luxembourg
PCLA, Stowarzyszenie Producent¢w Cementu i Wapna, Poland
ATIC, Associacao Tecnica da Industria de Cimento, Portugal
OFICEMEN, Agrupacion de Fabricates de Cemento de Espana, Spain

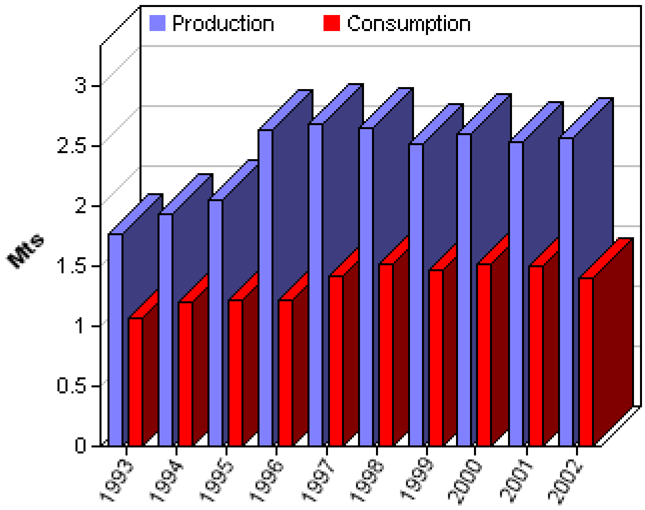
North America
Allentown Cement Co.
Ash Grove Cement
California Air Resources Board California CA Integrated Waste Management Board/Waste Tire Branch
California Portland Cement Co.
Canadian Portland Cement Association
Capitol Aggregates
The Cement Kiln Recycling Coalition (CKRC)
Essroc, Italcementi Group
Georgia Dept of Natural Resources
Holnam Corporate HQ
Idaho Dept of Health & Welfare
Iowa D.N.R.
Kansas Bureau of Waste Management, Kansas Dept Health and Environment
Lafarge Canada Inc.
Maine Dept of Environment Protection
Michigan Dept of Environment Quality
Missouri Dept of Natural Resources
National Cement Co. of Alabama Inc.
North Texas Cement
Oregon Dept of Environment Quality
Portland Cement Association
St Lawrence Cement
Signal Mountain Cement Co.
Texas Lehigh Cement
TXI Riverside Cement (also see opposition group information)
Utah Dept of Environment Quality

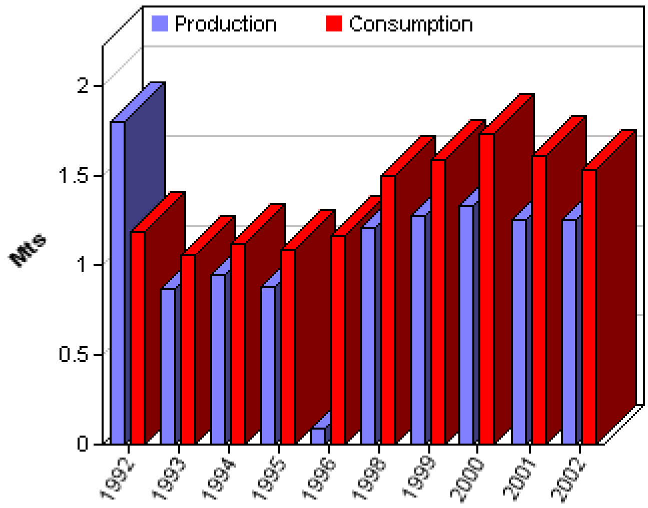
Appendix C Production and consumption of cement

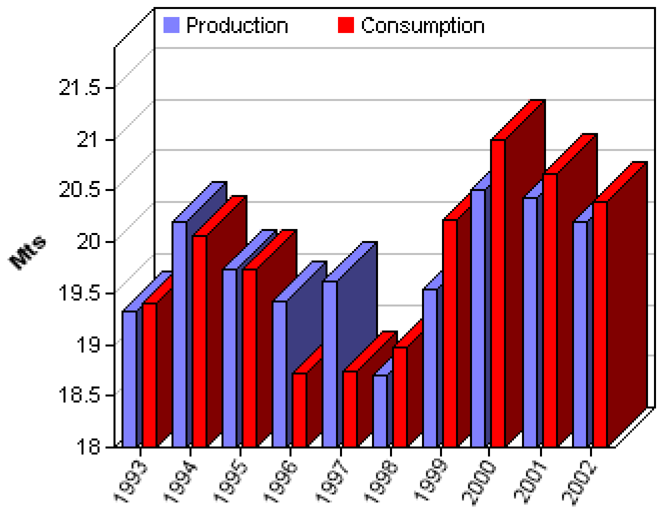
Table C.1 presents the production and consumption trends by country for Europe and the USA. The information is correct up to 2002 and is sourced from the Global Cement Report[1].
Table C.1. Production and consumption trends by country for Europe and the USA.

Country	*National production and consumption of cement (Note – range on the axes vary by country)*	*Summary*
Austria		Having felt the brunt of a slow construction sector over the past few years, the Austrian cement industry has followed a rather static path. Domestic producers are currently awaiting an upswing in activity, which should see levels rise within the next 2 years. In summary: • 12 plants, 6.2 Mt/a total capacity • Construction activity remains slow • Domestic market remains fragmented • Lafarge market leader • HeidelbergCement could become a consolidator • Cement prices return to even footing
Belgium		The Belgian construction industry is expected to pick up shortly, having contracted over the past 2 years. Cement consumption and production have, in turn, witnessed a decline, but forecasts for 2003-2004 offer encouragement. Belgium remains one of the leading countries in terms of usage of alternative fuels. In summary: • Seven plants, 8.1 Mt/a total capacity • Pick-up in construction anticipated for 2003-2004 • Range of alternative fuels accepted • High acceptance of metallurgical cement

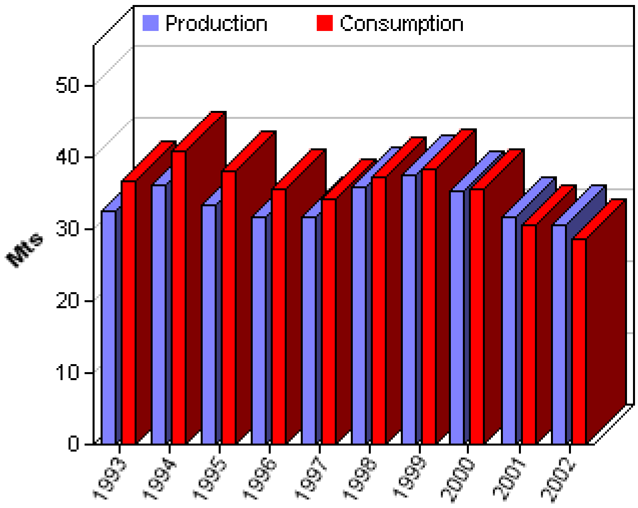
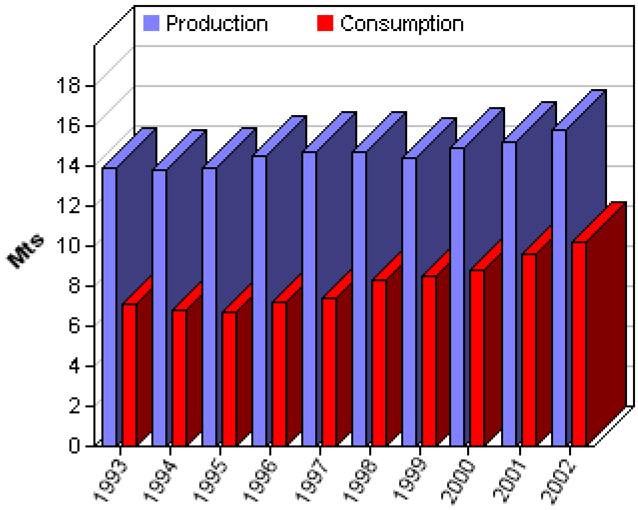
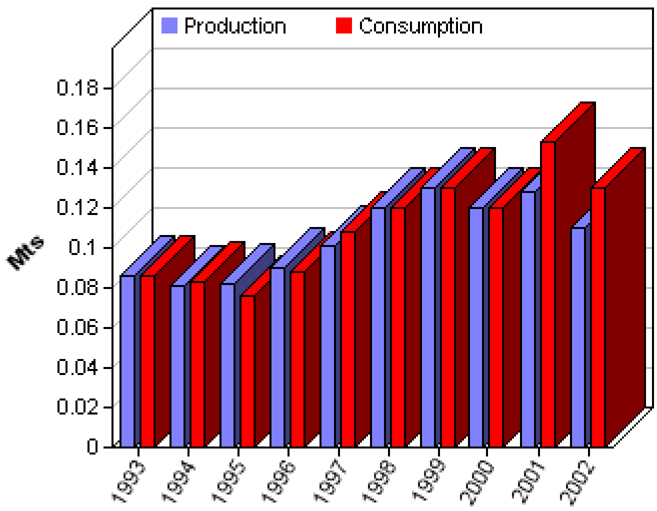
[1] Cemnet (2005) Information published online – The Global Cement Report. Available online at: http://www.cemnet.com/externalSites/globalDBFrame.asp. Accessed March 2005.

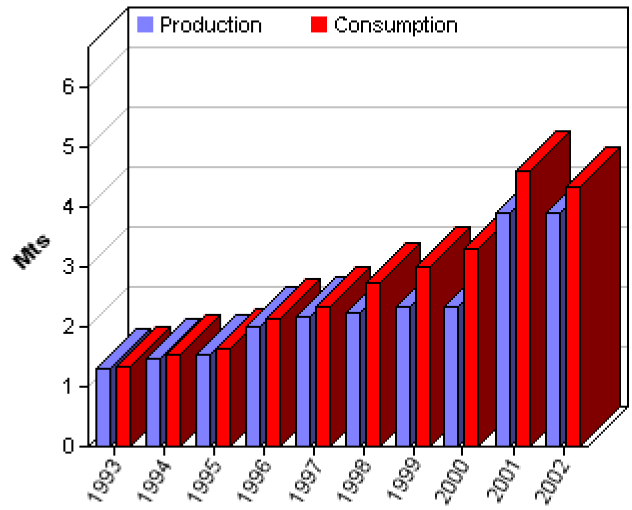
<table>
<tr><th>Country</th><th>National production and consumption of cement (Note – range on the axes vary by country)</th><th>Summary</th></tr>
<tr><td>Denmark</td><td>
</td><td>Denmark is a leading producer and exporter of white cement. Its domestic sales of grey cement are somewhat less as the country has a low per capita consumption following the completion of many infrastructure projects. Its sole cement plant runs at close to full capacity, and any excess not being consumed for domestic use is put towards satisfying a strong export market. For now, the focus rests on promoting the use of alternative fuels to reduce costs and converting some grey capacity into white. In summary,

one plant, 2.7 Mt/a total capacity, of which 2.15 Mt is grey cement and 0.65 Mt white
Leading producer and exporter of white cement
Weaker but relatively stable domestic market for grey cement
Coastal shipping is important to distribution
</td></tr>
<tr><td>Finland</td><td>
</td><td>Finnish cement demand peaked in 2000 at 1.7 Mt. Most of this requirement is met by the domestic cement producer Finnsementi, although some cement is imported from nearby countries, such as Russia and Lithuania. Increased civil engineering activity is expected to force national consumption up again in 2003, followed by the impulse of other construction sectors the year after. As a result, domestic sales should come close to their 2000 peak again. In summary

Three plants, 1.45 Mt/a total capacity
A sound cement market in a strong economy
One single cement producer
High utilisation of clinker capacity
</td></tr>
<tr><td>France</td><td>
</td><td>In 2001, the French cement industry recorded the highest level of cement consumption for more than a decade. In a country where four international groups control the production base, growth remains strong, although such positive figures are unlikely to be repeated in the near-term, while the construction industry experiences a slowdown. In summary:

33 plants, 26.7 Mt/a total capacity
Reasonably encouraging price scenario
Market consolidation with four international groups controlling manufacturing facilities
Third party imports remain relatively modest
</td></tr>
</table>

Country	*National production and consumption of cement (Note – range on the axes vary by country)*	*Summary*
Germany		As the German economy has continued to show slower expansion rates and the construction industry has shown no signs of recovery, cement demand has been falling unhampered since 1999, with the eastern provinces particularly affected. Combined with a price war, started earlier this year, German cement producers brace themselves for a difficult 2003. Expectations are that this climate will speed up plant closures as the industry suffers from excess capacity, a trend already started by companies such as HeidelbergCement, which is closing its Kiefersfelden works at the end of this 2003. In Summary: • 62 plants, 52 Mt/a total capacity • Severe price competition as cosy arrangements are banned • Some excess capacity likely to be eliminated • No substantial recovery in demand envisaged • Market fragmented with many family-owned companies remaining
Greece		Greece is currently enjoying a construction boom, thanks to the 2004 Olympic Games. It also boasts the fourth highest per capita consumption in Europe. Following the Games, demand is likely to decrease but, nevertheless, domestic consumption should remain firm. In Summary: • Eight plants, 16.3 Mt/a total capacity • Higher per capita consumption • Major cement exporter • Extensive use of maritime transport, both for domestic and export markets
Iceland		For Iceland, the cement growth years appear over for the near future, at least as the housing boom comes to an end. In step, production and imports are expected to fall off. Outlook: • Housebuilding activity is expected to continue to decline from 2003 and the impetus to growth in demand is likely to come from the industrial sector, where plans exist for the construction of a power station and an aluminium smelter. • With an import businesses now firmly established and the price level reduced there must be a question over domestic clinker, though not cement, production over time, particularly if the country's industrial base is expanded in industries that can take more advantage of the country's natural resources.

<table>
<tr><td>Country</td><td>National production and consumption of cement (Note – range on the axes vary by country)</td><td>Summary</td></tr>
<tr><td>Ireland</td><td>


</td><td>After a good start to the millennium, Irish cement consumption is falling on the back of a slowing construction industry. While the building market is expected to contract further during 2003-2004, activity in the sector should, however, remain healthy. This should enable local cement producers to benefit from a market that has one of the highest per capita cement demand levels in Europe and give them additional scope for improving their capacity utilisation rates. In summary:

- Six plants, 4.75 Mt/a total capacity
- High per capita consumption rate
- After prolonged boom, construction activity is cooling off
- Increased domestic production capacity
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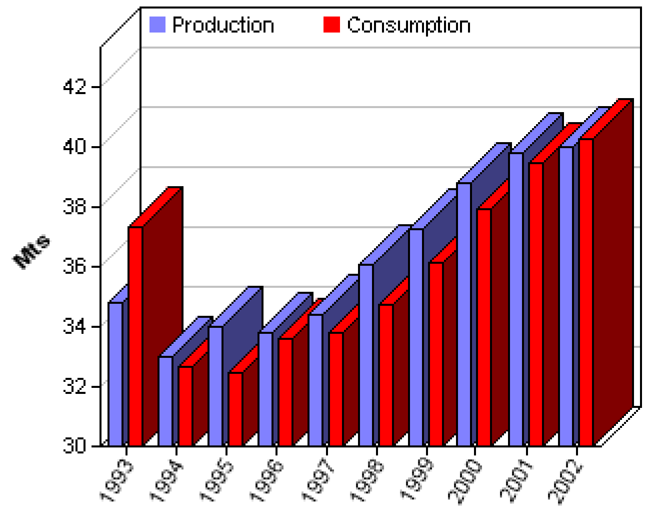
<tr><td>Italy</td><td>


</td><td>Italian cement producers have enjoyed a growing market in recent years, although expansion has been decelerating slightly. For the future, civil engineering projects are expected to supply most of the growth in cement consumption in the near future, while in the medium term the Italian government's plans for infrastructural spending should provide an additional increase in demand after 2004. As demand rises, imports are also forecast to increase, putting additional pressures on domestic price levels. The scope for exporting cement and clinker is not expected to alter in the near future, with levels stable. In summary

- 80 plants, 55 Mt/a total capacity
- Medium-term outlook boosted by infrastructure plans
- Positive development in volumes and prices
- Further scope for industry consolidation
- Export levels stable, but imports set to increase significantly
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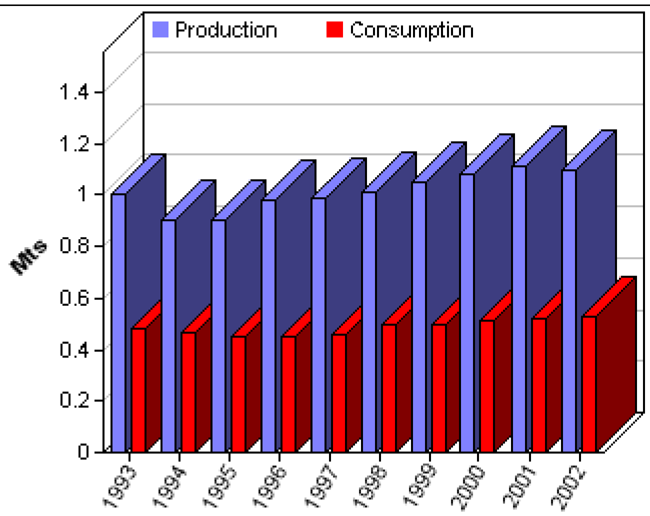
<tr><td>Luxembourg</td><td>


</td><td>With the highest cement consumption rates in Europe, there is little room for growth in Luxembourg. However, it is expected to remain a stable market with solid exports. Outlook:

- The government's long-term development plan, which relates both to infrastructure and to social housing, ensures a stable background but, given the already high level of cement consumption, offers little scope for any material increase in domestic demand for cement.
- Exports of cement and clinker to Germany are unlikely to recover before 2004.
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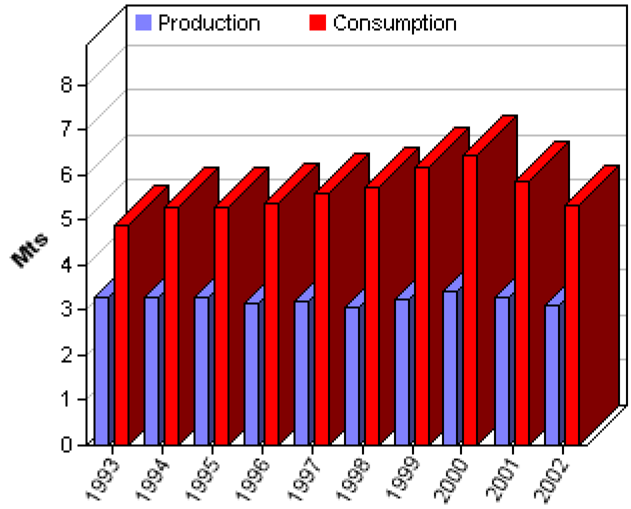
<tr><th>Country</th><th>National production and consumption of cement (Note – range on the axes vary by country)</th><th>Summary</th></tr>
<tr><td>Netherlands</td><td>
</td><td>The Dutch cement consumption is highly dependent on activity in the housebuilding market, which has seen a significant decline in recent years. As a result, cement demand in the kingdom has fallen since 2001. However, forecasts indicate that the level of decline will be bottoming out in 2003 and modest improvements are expected for the year after, boosted also by higher civil engineering activity, which is to remain high in the coming years. In summary:

Three plants, 3.8 Mt/a total capacity
Good underlying demand from civil engineering
Shortage of raw materials makes Dutch cement market dependent on imports
Exports are essentially re-exports
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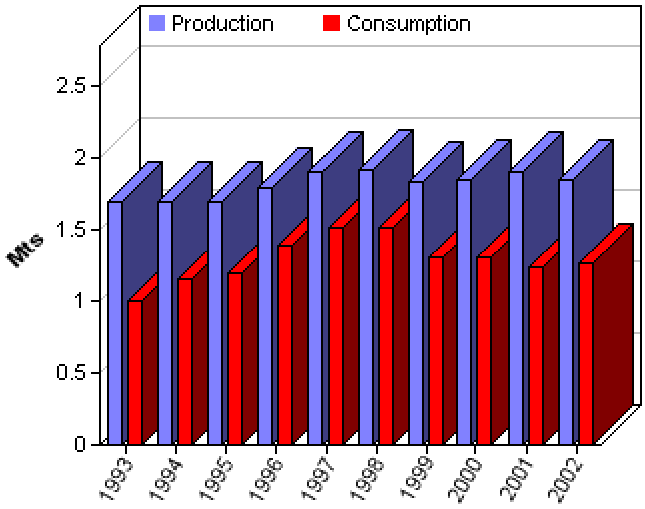
<tr><td>Norway</td><td>
</td><td>2002 has been kinder to Norway's sole cement producer, with national consumption growth rates swinging back into positive figures as housebuilding and civil engineering activity increased, particularly in the first half of 2002. However, in the short-term, civil engineering gains are expected to be unable to off-set declines in the commercial and industrial building markets, pushing Norwegian cement demand down once again. Combined with a forecast rise in import levels, competition in the Norwegian market is set to increase. In summary:

Two plants, 1.9 Mt/a total capacity
A coastal market, mainly supplied by water
Over 40% of production is exported
Decline in consumption anticipated
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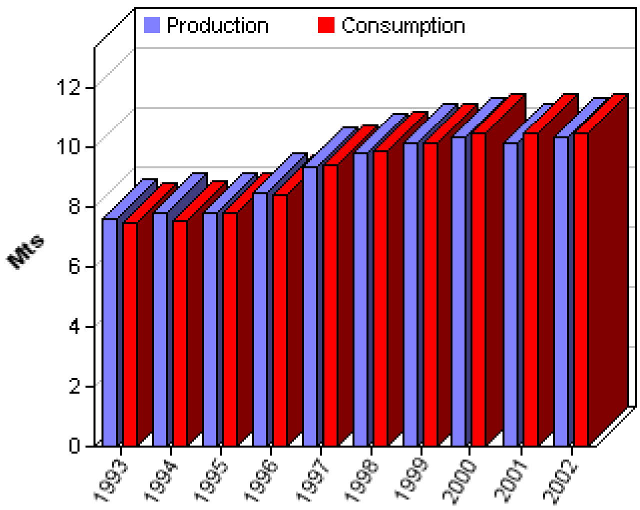
<tr><td>Portugal</td><td>
</td><td>Despite the domestic construction sector reporting slower results, Portugal's per capita cement consumption remains at very high levels with no signs to suggest that this cannot be maintained. The country's two cement producers have been busy, with market leader Cimpor increasing capacity through the extension of its Souselas works, but also losing some market share. Semapa, however, has been engaged in trying to increase its international presence. In summary:

Six grey cement plants, 10.4 Mt/a total capacity
Very high per capita consumption rate
Construction rate of increase slows
Only two cement producers
Limited imports supported by contractors
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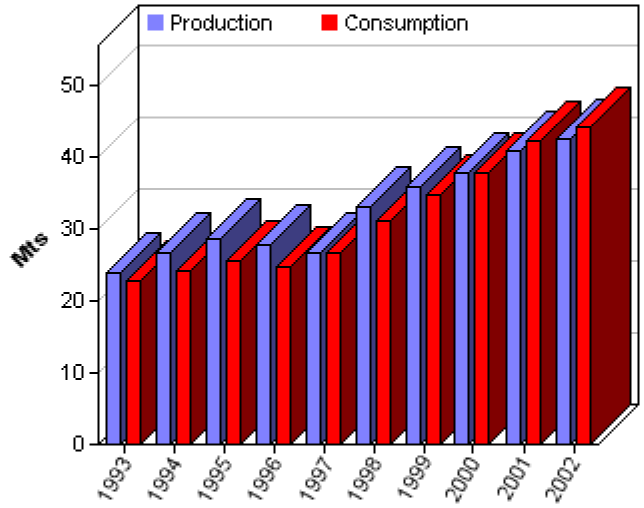
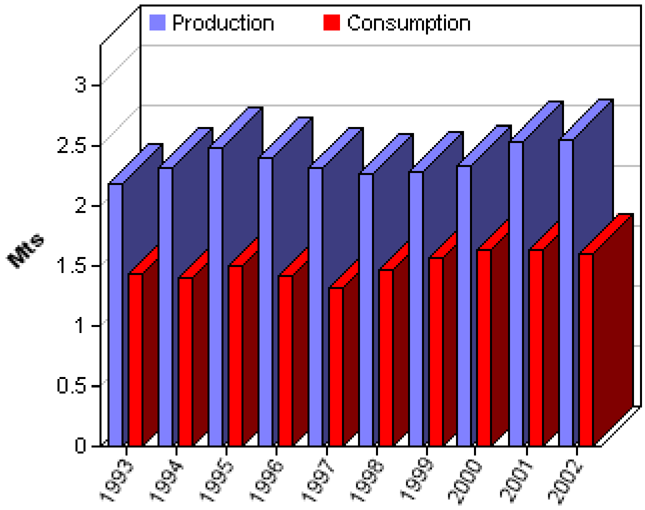
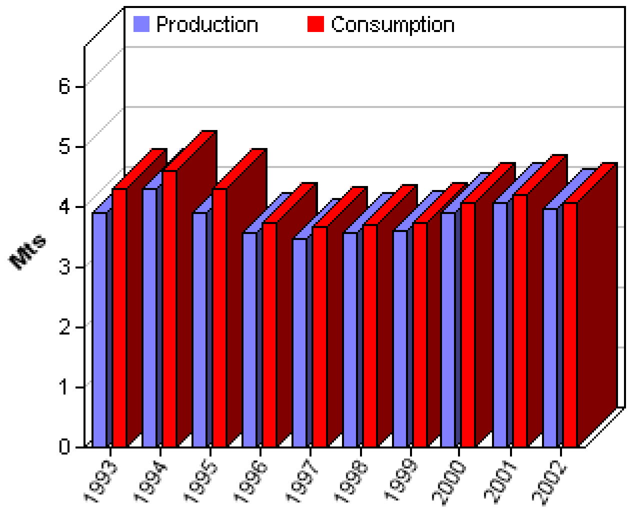
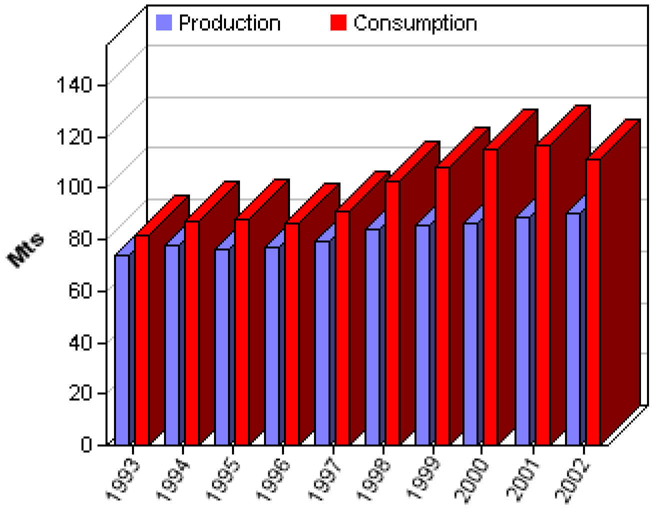
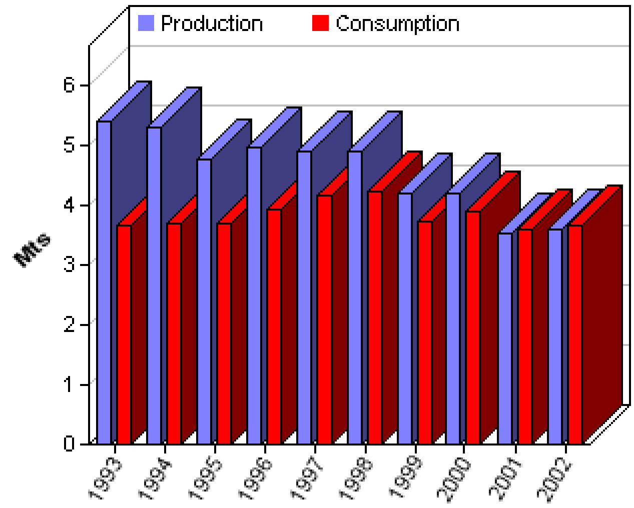
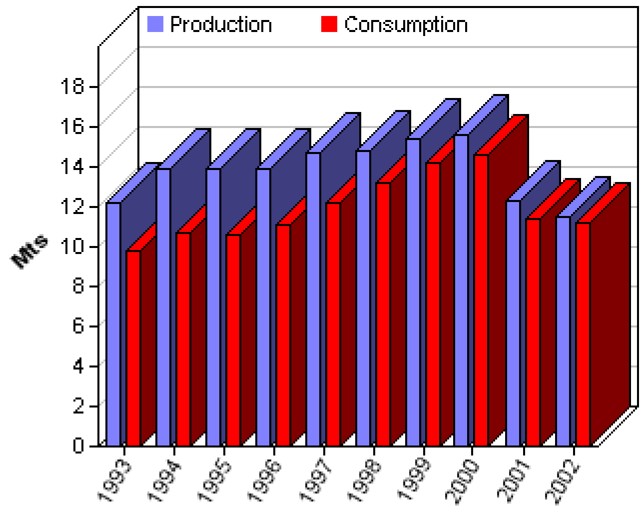
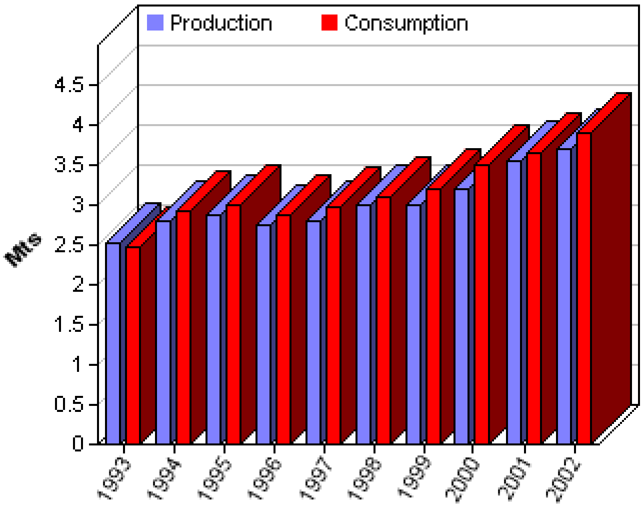
Country	*National production and consumption of cement (Note – range on the axes vary by country)*	*Summary*
Spain	 	Despite the decelerating growth of Spain's construction markets, there is still good business to be found in the local cement markets. Cement consumption continues to rise, albeit at a slower rate. As domestic consumption moved up, the country turned from exporter to importer as foreign cement producers seized the opportunity to sell their product to an expanding market, which found it increasingly hard to source all its requirements from cement factories within its national borders. In summary: • 39 plants, 43 Mt/a total capacity • A buoyant but decelerating construction market • Spain has turned from cement exporter to cement importer to meet national requirements • Some scope for further consolidation within the cement industry
Sweden	 	Swedish cement demand has fluctuated significantly over the past few years, however, per capita consumption remains low in this part of northern Europe. Positive forecasts for the next couple of years are unlikely to influence this much, with the figure remaining under 200 kg per capita. In summary: • Low per capita consumption rate • High export ratio, helped by major coastal plan • Shipping provides cheap transport into the main markets
Switzerland	 	With infrastructural spending providing a sound basis for cement demand, the projected decline in consumption for 2003 should be modest while medium-term forecast put cement demand at around 4 Mt/a. Most of this market requirement will be delivered by Swiss cement producers. In summary: • Nine plants, 5 Mt/a total capacity • Holcim dominates market • Railway spending underpins cement demand • International cement trade is very modest

Country	*National production and consumption of cement (Note – range on the axes vary by country)*	*Summary*
USA		American cement consumption decreased 3% in 2002 after climbing every year for a decade, from 1992 to 2001. Taking into consideration all the fears and economic uncertainties, that clouded the outlook for the USA in 2002, this is still an excellent performance. In summary: • 36 companies, 114 plants, 106 Mt/a total capacity, 197 kilns • Consumption holds strong despite slower economy • Huge increase in imports, which should decline in the near-term • Production fell well below domestic demand
Czech Republic		The severe flooding that hit key areas, such as Prague, is expected to shift work from new construction away to renovation, for the near future at least. Producers are expected to concentrate on these domestic markets in the short term as the scope for exports narrows. In summary: • Eight plants 6.8 Mt/a total capacity • International groups control cement industry • Recent flooding may delay new construction projects
Poland		Polish cement consumption has taken a sharp drop as investment in the construction industry slows. In the near-term, this decline in building activity is expected to continue, albeit at a reduced rate. However, by 2004 civil engineering should grow into double figures, providing the cement industry the required scope for improvement. In summary • 20 plants, 21.5 Mt/a total capacity • Much improved pricing scenario • A major economy with good prospects for construction activity • Exports continue to decrease mainly because of the east German cement decline

Country	*National production and consumption of cement (Note – range on the axes vary by country)*	*Summary*
Hungary		With construction markets booming again, cement consumption is forecast to accelerate its growth to over 10% in 2003. For the country's two cement producers this translates favourably, as imports are expected to remain relatively low and plants to run at near full capacity. In summary: • Four plants, 4.3 Mt/a total capacity • Positive construction outlook • Improving capacity utilisation • Industry effectively in the hands of two companies