Calcareous Ash in Europe - a reflection on technical and legal issues -

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Keywords: calcareous ash, production, standardization, waste, by-product, utilisation, cement, concrete, hydraulic road binders

1 Introduction

Calcareous ash is mostly produced by lignite combustion in dry-bottom boilers for heat and power generation. Lignite plays an important role in energy mix in the European countries, especially in central and Eastern Europe. About 490 million tonnes of lignite (including a small amount of sub-bituminous coal) were mined and used for power production in Europe in 2002 /1/. During combustion an estimated amount of 71 million tonnes of ashes is produced. Most of the ashes are used for the refilling and reclamation of depleted opencast lignite mines. Furthermore, the ashes are used as filler in asphalt, in underground mining, for surface recultivation, soil beneficiation, nutrition, cement production and as an addition to concrete.

The possibilities of utilization of coal combustion products (CCPs) depend on their chemical, mineralogical and physical properties. These properties are influenced by the source of coal, the type of coal feeding and the combustion process. A consistent product quality is most important for utilization of ashes in hydraulic binders, cement and concrete.

This paper deals with the production and utilisation of ashes from power stations fired with lignite, existing fields of application, the requirements for use in cement and concrete, the revision of standards as well as with update information about the revised Waste Directive and the REACH regulation.

2 ECOBA – MISSION AND WORK

ECOBA was founded in 1990 by European energy producers to ensure full beneficial and high grade utilisation of all CPPs. Therefore, ECOBA is active in the development of European standards and is represented on a number of CEN committees. The objectives of the Association are

a) to encourage the development of the technology for the use of all by-products from coal-fired power stations, both on the industrial and the environmental level, with regard to relevant industrial and environmental demands;

b) to promote the mutual interests of its members, internationally and particularly within the framework of the European organisations, which are of scientific, technical, ecological and legal nature;

c) to establish and/or develop necessary legal/regulatory measures for recognition, acceptance and promotion of the use of all by-products of coal-fired power stations as valuable recoverable resources;

d) to participate in international activities, including co-operation within the framework of the European organisations, and

e) to ensure the exchange of information and documentation among the various national and international bodies.

Today, the Association has 24 full members from 15 European countries, all generators of power, and is co-operating closely with comparable associations on other continents. The American Coal Ash Association (ACAA), the Canadian Industries Recycling Coal Ash (CIRCA), the Japan Coal Energy Center (JCOAL), the National Coal Ash Board of Israel (NCAB), the South African Coal Ash Association (SACAA) and the United Kingdom Quality Ash Association - UKQAA are affiliated members to ECOBA. In 2006, the co-operation with the Moscow Power Engineering Institut was established. In November 2008 URAL PROM MINERAL became member of ECOBA. Furthermore, ECOBA is a foundation member of the World-Wide CCP Council, a forum for the international exchange of information on CCPs via the Internet.

ECOBA members consider coal ashes and desulphurization products generated in coal-fired power plants to be valuable raw and construction materials which can be utilized in various environmentally compatible ways. It is the task of ECOBA to propagate this message especially amongst legislative and standardising institutions and to communicate the economic and ecological benefits of CCP utilisation. Therefore ECOBA has established working committees on communication and marketing of CCPs, on environmental issues and on standardization. ECOBA also represents the producers of CCPs on a number of CEN committees (Examples include Cement - CEN TC 51, Concrete - CEN TC 104, Road Materials – CEN TC 227 and Gypsum and Gypsum based Products – CEN TC 241). Specific working groups were installed for “Calcareous Fly Ash” and for REACH.

3 Production of CCPs in Europe

Since in 2004 the European Union (EU) grew up to 25 member states and again in 2007 to 27 Member States the total production of CCPs in the EU is estimated to be about 100 million tonnes (EU 27). ECOBA members provide data on production and utilisation of CCPs on a yearly basis. The data on production and utilisation of CCPs in Europe are published every year. Unfortunately, the figures of all of the 12 new EU Member States are by now not available to ECOBA, so more detailed information on the production in EU 27 cannot be provided for the time being. Therefore, the statistics presented in this report cover the situation in EU 15 member states.

The ECOBA statistics on production and utilisation of CCPs /2/ reflect the typical combustion products produced during the combustion of hard coal and lignite in coal-fired power stations. The CCPs are fly ash, bottom ash, boiler slag and fluidized bed combustion (FBC) ashes as well as the products from dry or wet flue gas desulphurisation, especially spray dry absorption (SDA) product and flue gas desulphurisation (FGD) gypsum.

Figure 1 shows the development of CCP production in EU 15 members states from 1993 to 2006. The total amount decreased from 57 million tonnes in 1993 to 55 million tonnes in 1999 and rose again to 64 million tonnes in 2005 due to higher production of electricity and heat by coal combustion. In 2006, the amount of CCPs produced in European (EU 15) power plants totalled 61 million tonnes, about 3 million tonnes less in the EU 15 member states compared to 2005. This reduction was caused by smaller production by coal combustion in some countries due to higher production by hydro power or the installation of de-NOx and de-SOx measures. In 2006, all combustion residues amount up to 80 % and the FGD residues up to 19 % by mass.

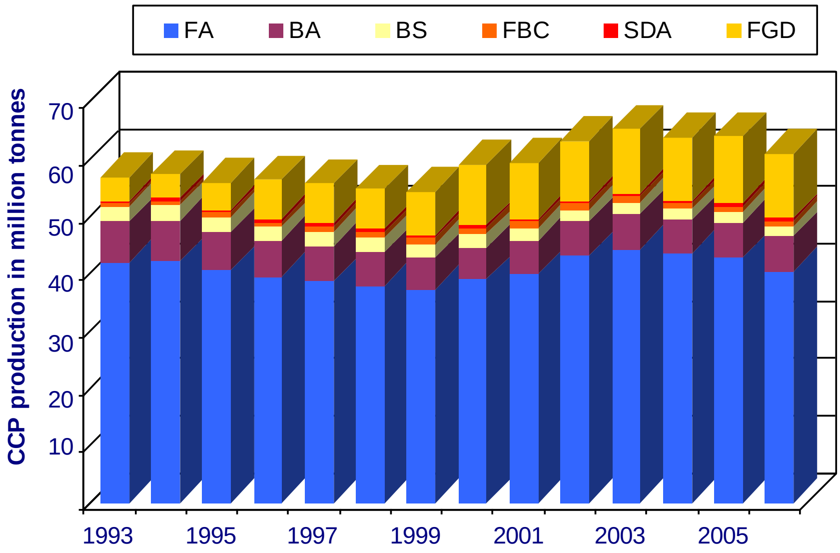

Figure 1: Development of the CCP production in Europe (EU 15) from 1993 to 2006

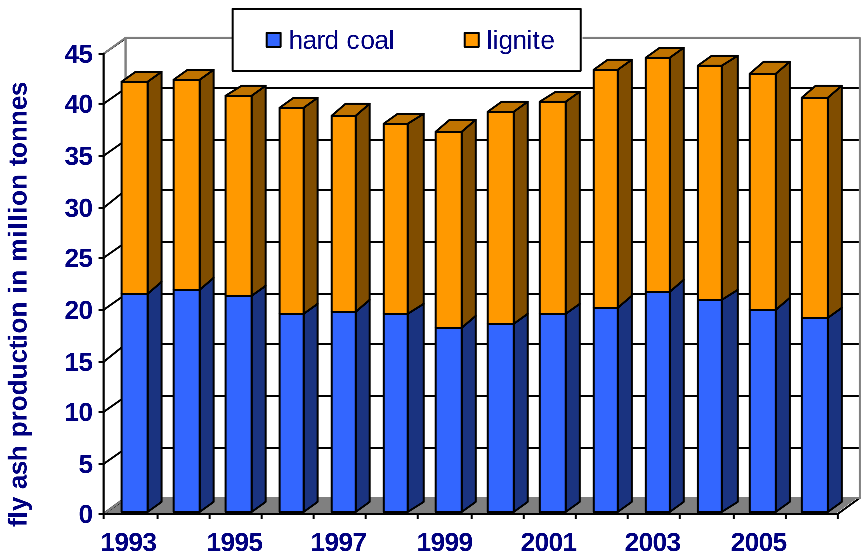

Figure 2: Development of the production of fly ash from hard coal and lignite in EU 15 from 1993 to 2006

The development of the production of fly ash form hard coal and lignite combustion in dry-bottom boilers is shown in figure 2. Although in 2006 a smaller production of mostly hard coal fly ash for the EU 15 members states is observed it has to be noted that this figure do not reflect the situation in the single EU member states. In some countries the production was at same level or even higher than the year before.

Lignite plays an important role in energy mix in the European countries, especially in central and Eastern Europe. About 490 million tonnes of lignite (including a small amount of sub-bituminous coal) were mined and used for power production in Europe in 2002 (see figure 1) /1/. During combustion an estimated amount of 71 million tonnes of ashes were produced.

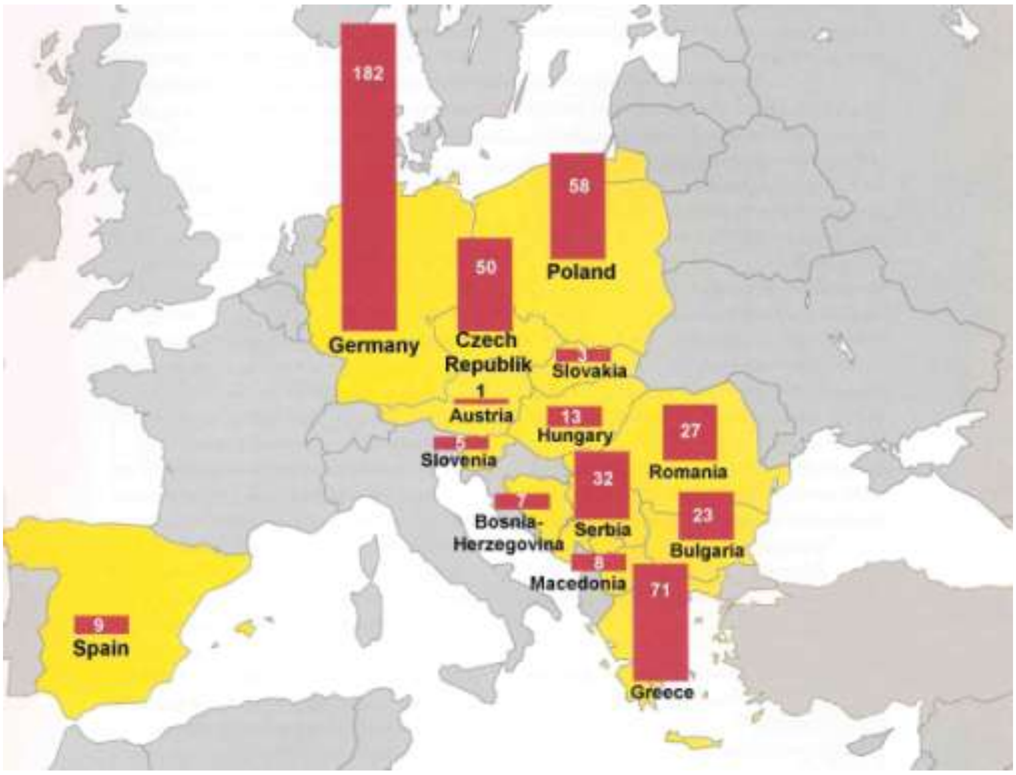

Figure 3: Mining of lignite in Europe (Source EURACOAL /1/)

4 CCPs from lignite in Europe

4.1 Production process

Fly ash and bottom ash and in addition, mineral products from desulphurization of the flue gases are obtained from the combustion process of lignite in power plants (see figure 4). All of these minerals can be utilized and are therefore called combustion products (CCPs). In most of the lignite power plants pulverized fuel is used. Lignite is ground to fine dust in coal mills and is pneumatically fed to dust burners. In the furnace of the power plant the pulverised lignite is combusted. The heat produced heats the water in the water-steam-circuit, the developing steam powers the turbine. A minor part of the mineral matter from the lignite falls down to the bottom of the furnace where it is removed as bottom ash in a water bath.

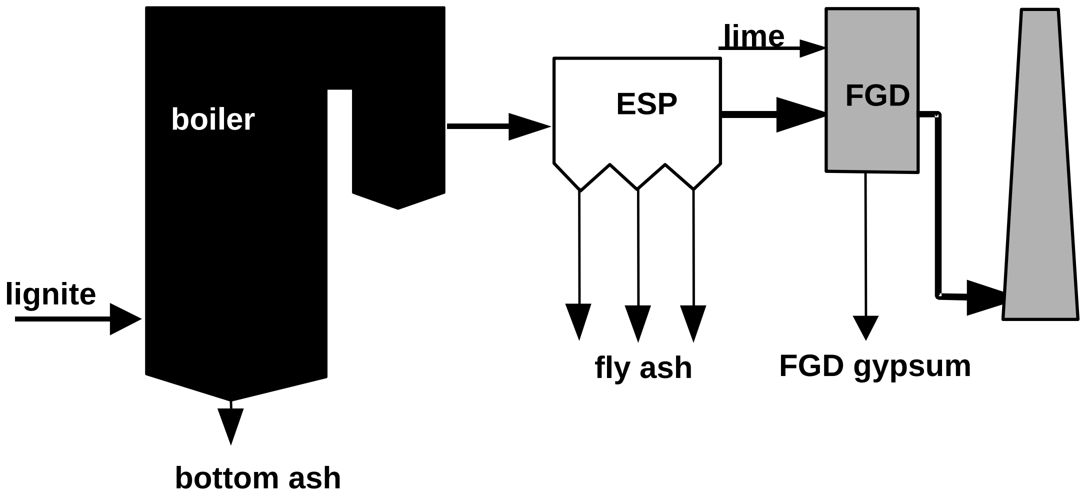

Figure 4: Combustion process and CCPs in a lignite fired power plant

The major part of the ash of approximately 80 % of the mineral matter is carried along with the flue gases to the electrostatic precipitator. The fine grained fly ash is separated from the flue gas, e.g. in a three stages precipitator at a ratio of 80 : 15 : 5 % by mass. Usually the fractions are extracted together. The ratio of bottom ash to fly ash volumes produced in lignite power plants is roughly 1 to 4.

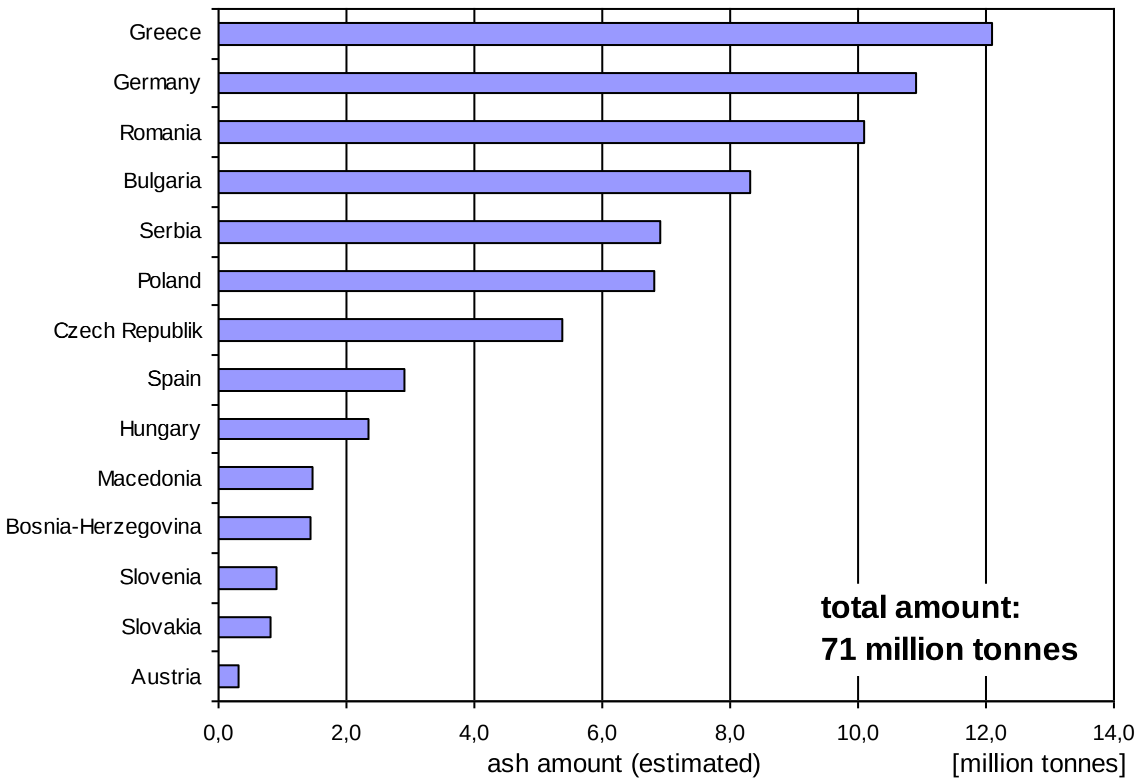

Figure 5: Estimated amount of ash obtained from combustion of lignite in European countries (calculation based on data published by EURACOAL /1/)

In most of the European countries, after dust separation in the electrostatic precipitator (ESP) the flue gas is desulphurized in the flue gas desulphurization (FGD) installation, where FGD gypsum or other minerals are produced. The clean gas, free from dust and sulphur is carried off via the chimney or the cooling tower.

Based on data on lignite production and ash content published by EURACOAL /1/ the amount of ash from lignite produced in Europe was estimated. If a range was given by EUREACOAL for the ash content, the mean value for the ash content was chosen for the calculation of the respective ash amount. Based on this calculation an estimated amount of 71 million tonnes of ashes were produced in Europe (see figure 5).

4.2 Properties of fly ash from lignite in Europe

The conditions in pulverised fuel-fired power plants for the power generation from lignite result in two different types of ashes, which differ in their particle size distribution and fineness as well as in their chemical composition. One of these two types is the coarser bottom ash, which is discharged via a water bath at the bottom of the furnace whereas the other one is the fly ash discharged with the flue gases and separated in the ESP. It might be reasonable to use both ashes together for certain purposes but the separated use of fly ash is advantageous for more demanding applications, where the chemical reactivity of the ashes is used because the reactivity increases with the fineness. The chemical and mineralogical composition of the ashes is determined by the chemical composition of the lignite and the mineral phases resulting from the temperature in the firing. Mineralogically, lignite fly ash consists of about 30 to 70 % of amorphous (glassy) components. The remains are crystalline (mainly quartz). Amorphous SiO_2, Al_2O_3 and Fe_2O_3 are able to react chemically with the reactive lime in the ash at room temperature if water is added. Thus, they develop calcium silicate hydrates and calcium aluminate hydrates like cement, whose structure leads to hardening and strength of the mixture. Therefore, calcareous lignite fly ashes usually have pozzolanic hydraulic properties. However, these properties can only be used technically if the material is sufficiently consistent.

Special attention has to be dedicated to the content of free lime and sulphate. In contact with water they react and produce voluminous reaction products. Depending on the content of the reactive components long-term reactions can occur, which destroy already existing hardened structures. Moreover, the leaching of sulphates can influence the environment in certain applications.

The chemical and mineralogical composition as well as the fineness is decisive for the reactivity of lignite ash. To use these properties, a certain consistency in the grain size distribution and in the chemical composition of the fly ash is required. The economic advantage of lignite fly ash compared to other mineral binders is that lignite fly ash as a fine reactive mineral does not need to be ground.

In table 1 the ranges of chemical composition of fly ashes from Germany, Greece, Poland and Spain are given. The ranges in single parameters are influenced by the composition of the lignite, with or without co-combustion, the kind of coal feeding to the burner and the burning technique. Updated figures will be given in a report of the ECOBA Working Group Calcareous Ash (under preparation).

The biggest ranges are observed for SiO_2 in ashes from Germany and Poland. These are caused by sand layers in lignite seams. The fluctuations of the other parameters are mainly a result of the differences in SiO_2 content.

Parameter	**Germany** /3/	**Greece** /4, 5/	**Poland** /6/	**Spain** /7/[1)]
	[% by mass]			
SiO_2	20 – 80	21 – 35	20 – 88	49.8 / 53.3
Al_2O_3	1 – 19	10 – 14	0.6 – 9	17.3 / 18.2
Fe_2O_3	1 – 22	4.5 – 6.5	1.5 – 7	8.7 / 7.9
CaO	2 – 52	30 – 45	3 – 49	24.9 / 20.8
CaO_{free}	0.1 – 25	≈ 10		11.4 / 8.6
MgO	0.5 – 11	1.5 – 3	0.5 – 7	1.9 / 1.7
K_2O	0. – 2	0.4 – 0.9		0.3 / 0.3
Na_2O	0.01 – 2	0.5 – 1		1.7 / 1.6
SO_3	1 – 15	4 – 8	0.4 – 12.5	4.3 / 4.7
TiO_2	0,1 – 1			
LOI	Max 5	3 – 7	1.6 – 2.2	2.3 / 1.8

1) two samples, only

Table 1: Ranges in chemical composition of lignite fly ash in selected European countries and Thailand

Investigations in Germany /8/ showed that the composition of fly ashes from the three main mining areas (Rhenish, Central German and Lusatian area) show characteristic differences. Whereas fly ash of the Rhenish and the Central German area contain high amounts of lime and sulphur those from Lusatian area show comparatively lower amounts.

The ranges in composition of lignite fly ashes from German power plants in different mining areas are given in table 2. This is due to the size of the mining area, the coal quality in the different parts of the mine as well as to the mining technology in respect to production of coal mixes from different seems. It has also to be considered that the ranges of fly ash from single power stations are even smaller.

	Mining area		
Parameter	Rhenish area	Central German area	Lusatian area
	[% by mass		
SiO_2	20 – 80	18 – 36	32 – 68
Al_2O_3	1 – 15	7 – 19	5 – 14
Fe_2O_3	1,5 – 20	1 – 6	6 – 22
CaO	2 – 45	30 – 52	8 – 23
CaO_{free}	2 – 25	9 – 25	0,1 – 4
MgO	0,5 – 11	2 – 6	2 – 8
K_2O	0,1 – 1,5	0,1 – 0,5	0,5 - 2
Na_2O	0,1 – 2	0,01 – 0,2	0,01 - 0,2
SO_3	1,5 – 15	7 – 15	1 – 6
TiO_2	0,1 – 1	0,5 – 1,3	0,2 – 1
Cl	< 0,2	< 0,1	< 0,02
C	< 2	< 1	< 2
LOI	max 5	max 5	max 5

Table 2: Ranges in chemical composition of lignite fly ash from German power plants in different mining areas /7/

5 Utilisation of CCPs

The CCPs from hard coal combustion are mainly utilised in the building material industry, in civil engineering, in road construction, for construction work in underground coal mining, the CCPs from lignite combustion mainly for recultivation and restoration purposes in open cast mines. In 2006, about 56% of the total CCPs are used in the construction industry, in civil engineering and as construction materials in underground mining and about 37% for restoration of open cast mines, quarries and pits. About 2 % were temporarily stockpiled for future utilisation and 4.8 % were disposed off (figure 6) /2/.

Compared to former years the figures for temporary stockpile and disposal changed due to a change in legal interpretation in the member states.

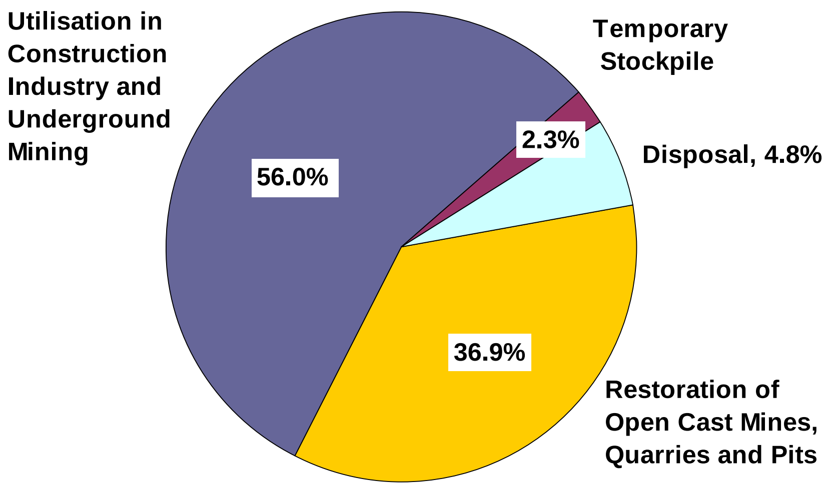

Figure 6: Utilisation and disposal of CCPs in Europe (EU 15) in 2006

The rates of utilisation, temporary stockpile and disposal for the single CCPs are given in figure 7.

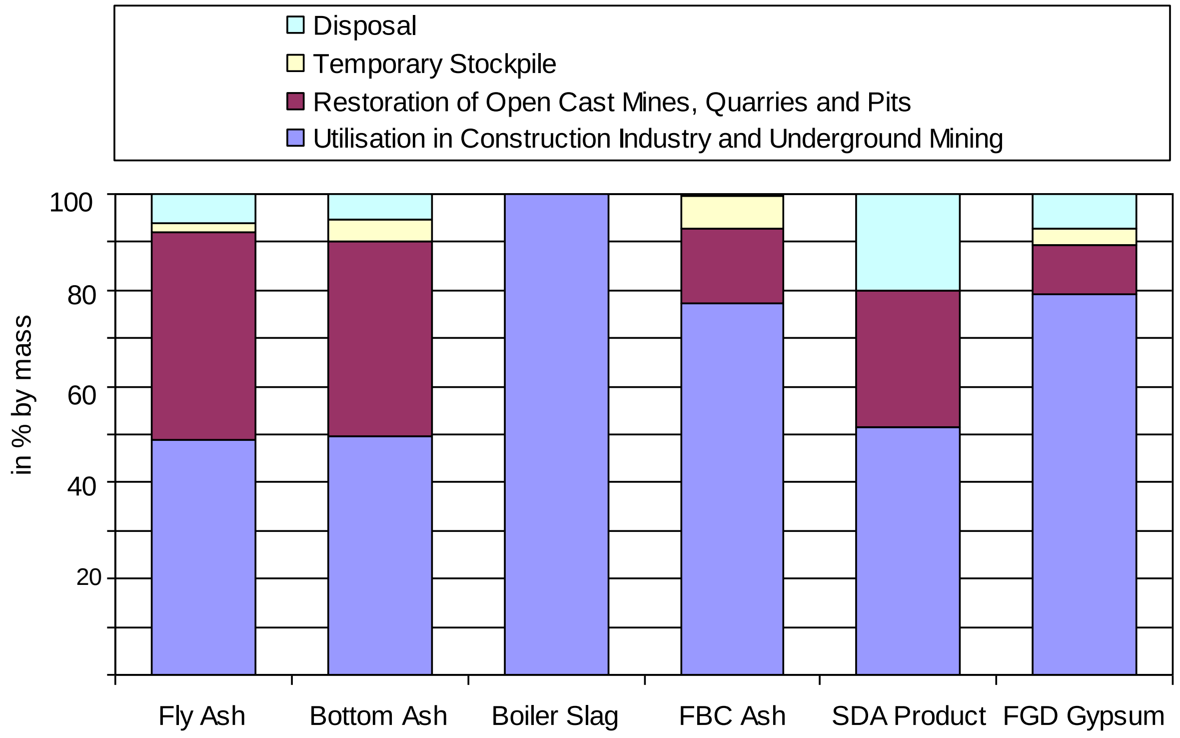

Figure 7: Utilisation, temporary stockpile and disposal of CCPs in Europe (EU 15) in 2006

5.1 Utilisation of fly ash

Fly ash obtained by electrostatic or mechanical precipitation of dust like particles from the flue gas represents the greatest proportion of the total CCP production. Depending on type of coal and type of boiler siliceous, silico-calcareous or calcareous fly ashes with pozzolanic and/or latent hydraulic properties are produced throughout Europe. The utilisation of fly ash across European countries is different and is mainly based on national experience and tradition.

In 2006, about 21 million tonnes of fly ash were utilised in the construction industry and for production purposes in underground mining (EU 15). Most of the fly ash produced in 2006 was used as concrete addition, in road construction and as raw material for cement clinker production. Fly ash was also utilised in blended cements, in concrete blocks and for infill (that means filling of voids, mine shafts and subsurface mine workings) (see figure A1 in the Annex).

5.2 Utilisation of bottom ash

Bottom ash is a granular material removed from the bottom of dry bottom furnaces operated at furnace temperatures of 1000 to 1200°C. Bottom ash is much coarser than fly ash. About 3.1 million tonnes of bottom ash were used in the construction industry. Out of this 41 % was used as fine aggregate in concrete blocks and in concrete and 46 % in road construction (see figure A2 in the Annex).

5.3 Utilisation of boiler slag

Boiler slag is a vitreous grained material derived from coal combustion in wet bottom boilers operated at temperatures of about 1600°C. Due to the high furnace temperature the coal ash is molten, it flows down to the bottom of the furnace and is removed from a water bath below the furnace bottom. Boiler slag is a glassy material. About 35 % of the boiler slag produced was used in road construction in drainage layers. Another 50 % was used as blasting grit and for grouting and about 12 was used as aggregate in concrete (see figure A3 in the Annex).

5.4 Utilisation of FBC ash

Fluidized Bed Combustion (FBC) Ash is produced in fluidized bed combustion boilers. The technique combines coal combustion and flue gas desulphurization in the boiler at temperatures of 800 to 900°C. As the combustion process is designed to handle different types of fuel also different kinds of sludges are often co-combusted (sewage sludge, paper sludge, …). FBC ash is rich in lime and sulphur. In 2006, about 0.4 million tonnes were mainly used for infilling of underground mines, for the construction of pavement base courses in road construction and for grouting (see figure A4 in the Annex). It has to be noted that this amount is small compared to the amount produced at least in Poland.

5.5 Spray Dry Absorption (SDA) Product

SDA product is a fine grained material resulting from spray dry or semi dry flue gas desulphurization with lime as a sorbent. In 2006, about 0.3 million tonnes of the total

SDA product was utilised in the construction industry and in underground mining (63 %), for plant nutrition (8 %) and as a sorbent in wet FGD (29 %) (see figure A5 in the Annex).

5.6 FGD Gypsum

FGD gypsum is produced in the wet flue gas desulphurisation process in coal-fired power plants. The desulphurisation of the flue gas in the power plant and a refining process in the FGD plant including an oxidation process are followed by gypsum separation, washing and dewatering. Based on its constant quality FGD gypsum is accepted in the gypsum and cement industry as a direct replacement of natural gypsum.

FGD gypsum is used as a raw material for a number of gypsum products by the gypsum industry because of its purity and homogeneity compared to natural gypsum. About 62 % was used for the production of plaster boards. Other applications include the production of gypsum blocks, projection plasters and self levelling floor screeds (31 %). In the cement industry FGD gypsum is used as set retarder (7 %) (see figure A6 in the Annex).

6 Requirements for use of fly ash in cement and concrete

For the use in or as construction materials the requirements in European standards, which have to be considered for the placing on the market of coal ash, as well as national standards, for the application in the countries, have to be considered. The standards for aggregates, for cement and concrete consist of technical requirements and define the measures for the internal production control as well as a third party control.

6.1 Cement clinker raw material

There are no standards or regulations for the use of coal ash as a raw material for cement clinker production. Nevertheless, the raw material situation of a cement plant, i.e. the composition of the limestone and marl resources and the plant technology cause specific requirements on fly ash quality. Furthermore, fly ash need to be licensed as a raw material component for the cement plant.

6.2 Constituent in blended cement

The requirements for siliceous and calcareous fly ash for the use as a constituent of blended cements are given by the definition of these ash types in EN 197-1 (see table 3) /8/. Beside requirements for the basic cement composition in view to reactivity limit values are defined for specific parameters (loss on ignition, sulphur, chlorine) to avoid unsoundness of or damaging reactions in concrete constructions. In 2007, the standard was revised regarding the definition of fly ash and the classes for loss on ignition by linking to the EN 450.

Parameter	siliceous fly ash	calcareous fly ash	
	V	W 1	W 2
Loss on ignition[1)]	0 up to 5 % by mass 2 up to 7 % by mass 4 up to 9 % by mass		
Reactive calcium oxide[2)]	≤ 10 % by mass	10 – 15 % by mass	≥ 15 % by mass
Free calcium oxide	≤ 1 % by mass [3)]		
Reactive silicon dioxide[4)]	≥ 25 % by mass		-
Compressive strength at 28d[5)]	-	-	≥ 10 N/mm²
Expansion[6)]	-	-	≤ 10 mm

1) LOI of up to 7 or 9 % by mass is allowed provided requirements at the place of use regarding durability are met
2) $CaO_{reactiv}$ = total CaO reduced by fraction calculated as $CaCO_3$ and $CaSO_4$
3) CaO_{free}-= amount up to 2,5 % by mass accepted when soundness is given (see 5))
4) $SiO_{2reactiv}$ = fraction of SiO_2 which is soluble after treatment with HCl and boiling KOH-solution
5) mortars with ground fly ash as binder, amount < 40µm between 10 and 30 % by mass
6) mixture of 30 % by mass ground fly ash, 70 % by mass cement

Table 3: Requirements on siliceous and calcareous fly ash according to EN 197-1 /8/

The use of fly ash with a LOI of up to 7.0 % by mass or up to 9.0 % by mass is permitted provided that particular requirements for durability, especially frost resistance, and for compatibility with admixtures are met according to the appropriate standards and/or regulations for concrete and mortar in the place of use.

6.3 Concrete addition

The standard EN 450 “Fly ash for concrete” was first published in 1994 /9/ and the revised standards EN 450-1 “Fly ash for concrete – Part 1: Definition, specifications and conformity criteria” and EN 450-2 “Fly ash for concrete – Part 2: Conformity evaluation” entered force on January 1, 2007 /10, 11/. EN 450-1 deals with definitions, specifications and conformity criteria for siliceous fly ash, which is produced by burning of pulverized coal, with or without co-combustion materials, and collected in a dry state, or which is processed by e.g. classification, selection, sieving, drying, blending, grinding or carbon reduction or by a combination of these processes. This is because in some countries fly ash has been processed according to national regulations for years or, in some cases, decades.

At present, the standards are under revision. All parameters are subject to critical review. Proposed changes will be documented in a respective background report.

Lignite (calcareous) fly ashes with a content of reactive calcium oxide > 10 % by mass may not be used as concrete addition according to EN 450-1. The first national standard for lignite fly ash for use in concrete was published in Greek FEK /12/ in

2007. National certificates for calcareous fly ash as an addition to concrete were granted in Poland and Germany.

6.4 Road construction

For the use of coal ashes in road construction bound and unbound applications have to be considered. Unbound applications cover the use e.g. in base layers as filling material, in dam construction or soil beneficiation. Bound applications cover the use in hydraulic road binders and in concrete for road construction. For these applications European, national and/or country specific regulations of road construction authorities have to be fulfilled.

Furthermore, the European standards for soil beneficiation with fly ash (EN 14227-13), fly ash bound mixtures (EN 14227 – 3) and for fly ash for hydraulically bound mixtures (prEN14227 – 4) have to be considered. The two last European standards refer to siliceous or calcareous fly ash which is produced from the combustion of pulverized coal or lignite in power plants. In contrary to the requirements in EN 197 the reactivity criteria have to be declared.

For the use in hydraulic road binders the requirements of the European standard prEN 13282 /13/ have to be considered. The revision of that standard resulted in the preparation of three parts. Part 1 is dealing with rapid hardening hydraulic road binders /14/. These are cement based binders which follow the requirements as already known from prEN13282. Part 2 /15/ is dealing with normal hardening hydraulic road binders. These binders have lower cements contents, the compressive strength have to be tested after 56 days (part 1 at 28 days). A slaking procedure was implemented to guarantee that also lime rich mixtures can be evaluated in the laboratory. Part 3 of the standard deal with the conformity evaluation.

Calcareous fly ash meeting the requirements of EN 197 as well as FBC ash meeting specific requirements regarding the chemical composition can be used as main constituents for the production of these binders.

It has to be noted that these European standards, by now, are not harmonized. They can be used in addition to or instead of national regulations.

6.5 Aggregates

On June 1, 2004 new harmonized European Standards for for aggregates for concrete (EN 12620) and for lightweight aggregates for concrete, mortar and grout (EN 13055-1) were introduced. These standards contain requirements regarding the characteristics of aggregates and the conformity criteria.

The standards have a common structure in view to the definition of categories, as in European countries different climate cause different requirements. National authorities have to introduce the relevant categories in their country by e.g. national application documents.

7 Present legal and standard issues

The impact of environmental regulations on management and utilisation of CCPs is investigated by the ECOBA Environmental Issues Committee. Some issues delt with over the last years were the “Thematic Strategy on Prevention and Recycling of Waste”, the “Amendment of the Waste Framework Directive”, the “Commission Guidelines on By-Products”, “Environmental regulations for the application of CCPs in concrete for road construction, in contact with soil/ground and in contact with drinking water”, REACH - “Registration, Evaluation and Authorisation of Chemicals”, the “Assessment of Release of Dangerous Substances (CEN TC 351) and the “Harmonised Standards Code” (HSC) of the World Customs Organisation (WCO). In close so-operation with EURELECTRIC the committee prepared comments and status reports within the ongoing revision of the Waste Directive.

7.1 Revision of the Waste Directive

According to the European Waste Framework Directive from 1991 waste is defined as follows:

> *“Waste shall mean any substance or object in the categories set out in Annex I, which the holder discards or intends or is required to discard”.*

The categories in Annex I as mentioned above include: *“Q 8 residues of industrial processes (e.g. slags, still bottoms, etc.)”* and *“Q 9 residues from pollution abatement processes (e.g. scrubber sludges, bag house dusts, spent filters etc.)”*.

Due to this Directive, CCPs have legally to be considered as waste. Within the revision of the Waste Directive the discussion on the legal definition of by-products and end of waste criteria was started at the European institutions. Whereas the Commission preferred not to include a definition in the Directive and to give some guidance to the industry by guidelines, Parliament and Council were in favour of a definition for by-products, based on the jurisprudence of the European Court of Justice, in the Directive. After long discussion between the Commission on one hand and Council and Parliament on the other hand the definition of “by-product” and of “end-of-waste” was agreed in the Waste Directive /16/. The most recent definition of “by-product” and “end-of-waste” is given in annex 1. The Waste Directive has to be introduced in the member states by December 12, 2010.

In article 6 of the Directive “end-of-waste” is defined by certain criteria to be defined by the Commission. The criteria shall *include limit values for pollutants where necessary and shall take into account any possible adverse environmental effects of the substance or object*.

The Commission ordered the Institute for Prospective Technological Studies (IPTS) and DG Joint Research Centre (JRC) to develop a general methodology for determining end-of-waste criteria. The methodology was evaluated for aggregates, compost and metal scraps. For these materials pilot studies were prepared and discussed at stakeholder workshops. The methodology is assessment based as it has to consider the wide range of waste materials. For aggregates the criteria will be based on leaching limit values. The final report is available on the IPTS website.

It has to be mentioned that in many European countries or even regions some CCPs have already been accepted as by-products by the authorities. Furthermore, it has to be noted that CCPs which are not subject to waste legislation are then subject to the REACH regulation.

7.2 REACH Regulation

On 1st June 2007, the REACH-Regulation (Registration, Evaluation, Authorisation and Restriction of Chemicals) entered into force /17/. REACH requires that chemical substances on their own, in preparations and those which are intentionally released from articles have to be registered to the European Chemicals Agency (ECHA).

The overriding goal of the regulation is to improve the protection of human health and the environment from the risks of chemicals while enhancing the competitiveness of the EU chemicals industry. By this, all chemicals manufactured in or imported into the EU have to be registered at the European Chemicals Agency (ECHA). The registration requires information on the properties and the potential risks of the substances.

REACH is not specifically made for CCPs. But as CCPs are mainly utilised in the building material industry, in civil engineering and in road construction they are placed on the market and for many applications they are subject to REACH.

Each producer or importer of coal combustion products (CCPs) placed on the market as construction materials has to pre-register and to register its substances. The pre-registration requires information on the substance identity, the tonnages and the name and address of the producer. The registration requires i.a. comprehensive information about toxicology and ecotoxicology of the substances.

In Europe, non registered substances can not be placed on the market after 1st June 2008 any more! For CCPs, since they are already registered in the European Inventory of the Existing Commercial Chemical Substances (EINECS) the deadline for registration is extended to 30 November 2010. This is only true if the producer pre-register in the period of 1st June to 30 November 2008!

At present, the European producers of CCPs are forming consortia for the registration of the different CCPs. A major problem is the identification of the huge number of producers regarding the produced CCP as well as the definition of the substance specification.

7.3 Environmental compatibility of the use of CCPs

There are many environmental benefits connected with the use of CCPs as saving of natural resources, saving of energy, saving of emissions of pollutants to the air, saving of CO_2 emissions and saving of disposal space. Nevertheless, the environmental impact of the use of CCPs has to be considered in any application. Fly ash and bottom ash as any natural minerals contain a certain amount of trace element compounds. The concentrations of some of the trace elements may be higher in fly ash than in natural minerals or products used for a certain application. In order to avoid any negative impact on the environment or on human health, regulations have been developed for the different uses of industrial by-products at a national level in the European Member States.

In November 2005, CEN established a new Technical Committee (CEN/TC 351) for "Construction products: Assessment of release of dangerous substances". The TC shall develop horizontal standardised assessment methods for harmonised approaches relating to the release (and/or the content when this is the only practicable or legally required solution) of regulated dangerous substances under the Construction Products Directive (CPD) taking into account the intended conditions of the use of the product. It addresses emission to indoor air, and release to soil, surface water and ground water. With the assessment methods information may be given for the CE marking of construction products on the release of dangerous substances in the use phase.

8 Summary

The total production of coal combustion products (CCPs) in EU 27 is estimated to amount to about 100 million tonnes. A major part of is produced in lignite fired power stations. The CCPs include combustion residues such as boiler slag, bottom ash and fly ash from different types of boilers as well as desulphurisation products like spray dry absorption product and FGD gypsum.

CCPs from hard coal combustion are mainly utilised in the building materials industry, in civil engineering, in road construction, for construction work in underground coal mining. The CCPs from lignite combustion are mainly used for recultivation and restoration purposes in open cast mining. Depending on their chemical, mineralogical and physical properties, they are also used as filler in asphalt, in underground mining, for surface recultivation, soil beneficiation, cement production and as addition to concrete. CCPs are used as a replacement of natural resources. Their utilisation helps to save natural resources and to reduce the energy demand and greenhouse gas emissions to the atmosphere caused by mining and generation of products which are replaced by CCPs.

The use of CCPs has developed by the years and is mostly based on requirements of standards or other specifications which are subject to regular revision by CEN or national authorities. At present, the European standards EN 450-1 and EN 450-2 are under revision. Within the ongoing revision of the standards all parameters are subject to critical review. Proposed changes will be documented in a respective background report. Furthermore, the European standard for hydraulic road binders with basic definition also for FBC ash as a main constituent, will be published in an updated version with three parts.

The utilisation is becoming more and more restricted by environmental regulations. A European Technical Committee is working on horizontal standardised assessment methods for the release of dangerous substances from construction materials. In addition, the legal definition of CCPs as waste causes hurdles, which are unnecessarily impeding the utilisation markets, which have been developed in the last decades. The revised Waste Directive contains a definition of “by-products” and “end-of-waste” and have to be introduced by December 12, 2010.

Materials not being waste are subject to REACH and have to be registered before being placed on the market. For CCPs, a special regulation is used since they are already registered in the European Inventory of the Existing Commercial Chemical Substances (EINECS). By this, the deadline for registration is extended to 30 November 2010. This is only true if the producer have pre-registered in the period of 1st June to 30 November 2008! Not pre-registered producers must register directly.

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/17/ Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC Official Journal of the European Union, ISSN 1725-2555 L 396, Volume 49, 30 December 2006

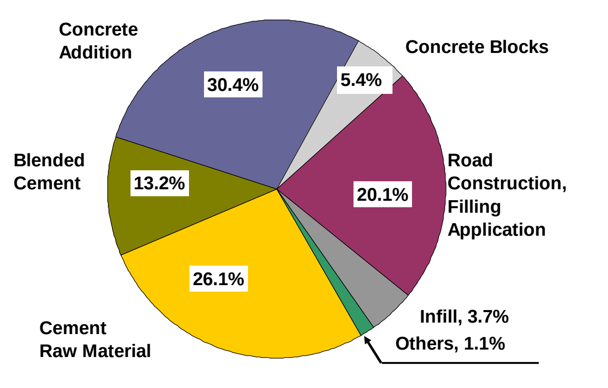

Figure A1:
Utilisation of Fly Ash in the Construction Industry and Underground Mining in Europe (EU 15) in 2006.
Total utilisation 20.1 million tonnes.

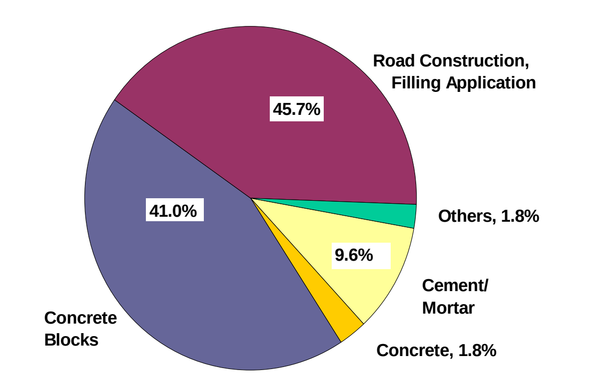

Figure A2:
Utilisation of Bottom Ash in the Construction Industry and Underground Mining in Europe (EU 15) in 2006.
Total utilisation 3.1 million tonnes.

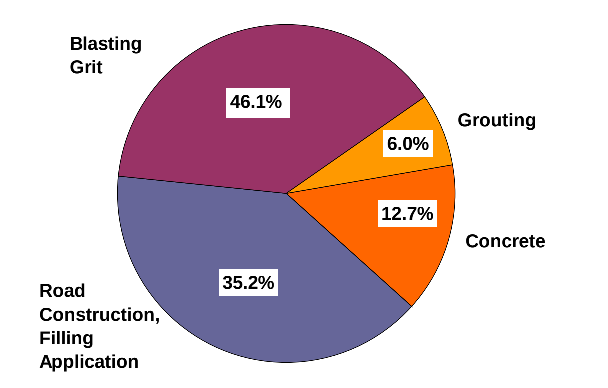

Figure A3:
Utilisation of Boiler Slag in the Construction Industry and as Blasting Grid in Europe (EU 15) in 2006.
Total utilisation 1.8 million tonnes.

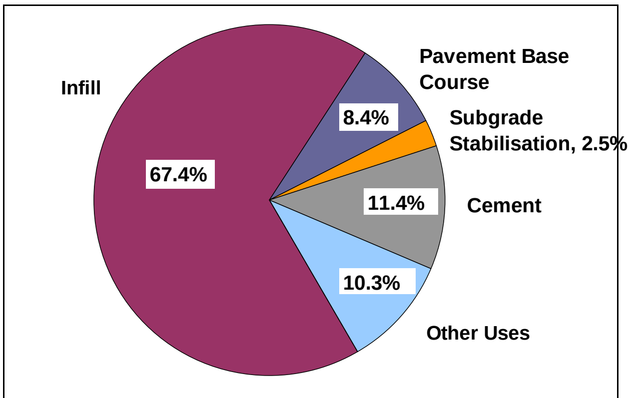

Figure A4:
Utilisation of FBC Ash in the Construction Industry and Underground Mining in Europe (EU 15) in 2006.
Total utilisation 0.4 million tonnes.

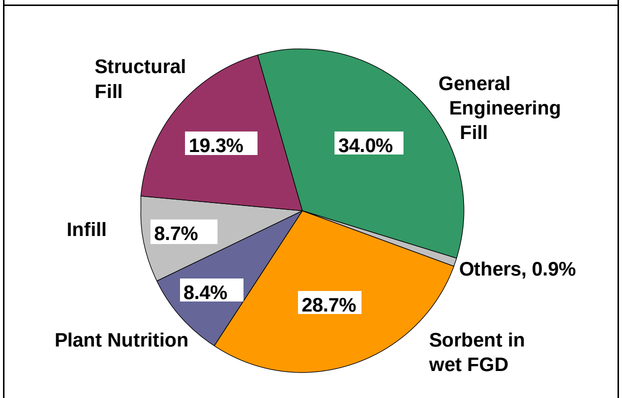

Figure A5:
Utilisation of SDA- Product in the Construction Industry and Underground Mining in Europe (EU 15) in 2006.
Total utilisation 0.3 million tonnes.

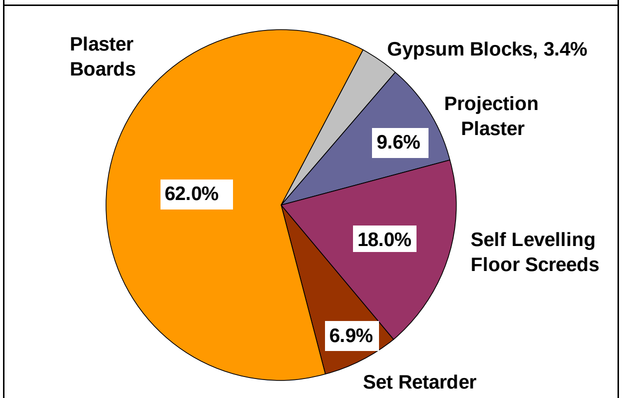

Figure A6:
Utilisation of FGD gypsum in the Construction Industry in Europe (EU 15) in 2006.
Total utilisation 9.0 million tonnes.

Annex II

The revised Waste Directive[1] contains a proposal for a definition of by-products in article 5 as well as for end of waste status in article 6.

Article 5
By-products

1. *A substance or object, resulting from a production process, the primary aim of which is not the production of that item, may be regarded as not being waste referred to in point (1) of Article 3 but as being a by-product only if the following conditions are met:*

   (a) further use of the substance or object is certain;

   (b) the substance or object can be used directly without any further processing other than normal industrial practice;

   (c) the substance or object is produced as an integral part of a production process; and

   (d) further use is lawful, i.e. the substance or object fulfils all relevant product, environmental and health protection requirements for the specific use and will not lead to overall adverse environmental or human health impacts.

2. *On the basis of the conditions laid down in paragraph 1, measures may be adopted to determine the criteria to be met for specific substances or objects to be regarded as a by-product and not as waste referred to in point (1) of Article 3. These measures, designed to amend non-essential elements of this Directive by supplementing it, shall be adopted in accordance with the regulatory procedure with scrutiny referred to in Article 39(2).*

Article 6
End-of-waste status

1. *Certain specified waste shall cease to be waste within the meaning of point (1) of Article 3 when it has undergone a recovery*, *including recycling*, *operation and complies with specific criteria to be developed in accordance with the following conditions:*

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1 Waste Directive (2008/98/EC) of the European Parliament and the Council of 19 November 2008 on waste and repealing certain Directives, Official Journal of the European Union (L312/3), 22.11.2008

(a) the substance or object is commonly used for specific purposes;

(b) a market or demand exists for such a substance or object;

(c) the substance or object fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products; and

(d) the use of the substance or object will not lead to overall adverse environmental or human health impacts.

The criteria shall include limit values for pollutants where necessary and shall take into account any possible adverse environmental effects of the substance or object.

2. The measures relating to the adoption of such criteria and specifying the waste, designed to amend non-essential elements of this Directive, by supplementing it, shall be adopted in accordance with the regulatory procedure with scrutiny referred to in Article 39(2). End-of-waste specific criteria should be considered, among others, at least for aggregates, paper, glass, metal, tyres and textiles.

3. Waste which ceases to be waste in accordance with paragraphs 1 and 2, shall also cease to be waste for the purpose of the recovery and recycling targets set out in Directives 94/62/EC, 2000/53/EC, 2002/96/EC and 2006/66/EC and other relevant Community legislation when the recycling or recovery requirements of that legislation are met.

4. Where criteria have not been set at Community level under the procedure set out in paragraphs 1 and 2, Member States may decide case by case whether certain waste has ceased to be waste taking into account the applicable case law. They shall notify the Commission of such decisions in accordance with Directive 98/34/EC of the European Parliament and of the Council of 22 June 1998 laying down a procedure for the provision of information in the field of technical standards and regulations and of rules on Information Society services[i] where so required by that Directive.

[i] OJ L 204, 21.7.1998, p. 37.