

Coal Ash Utilisation over the world and in Europe

Hans-Joachim Feuerborn



European
Coal Combustion
Products Association



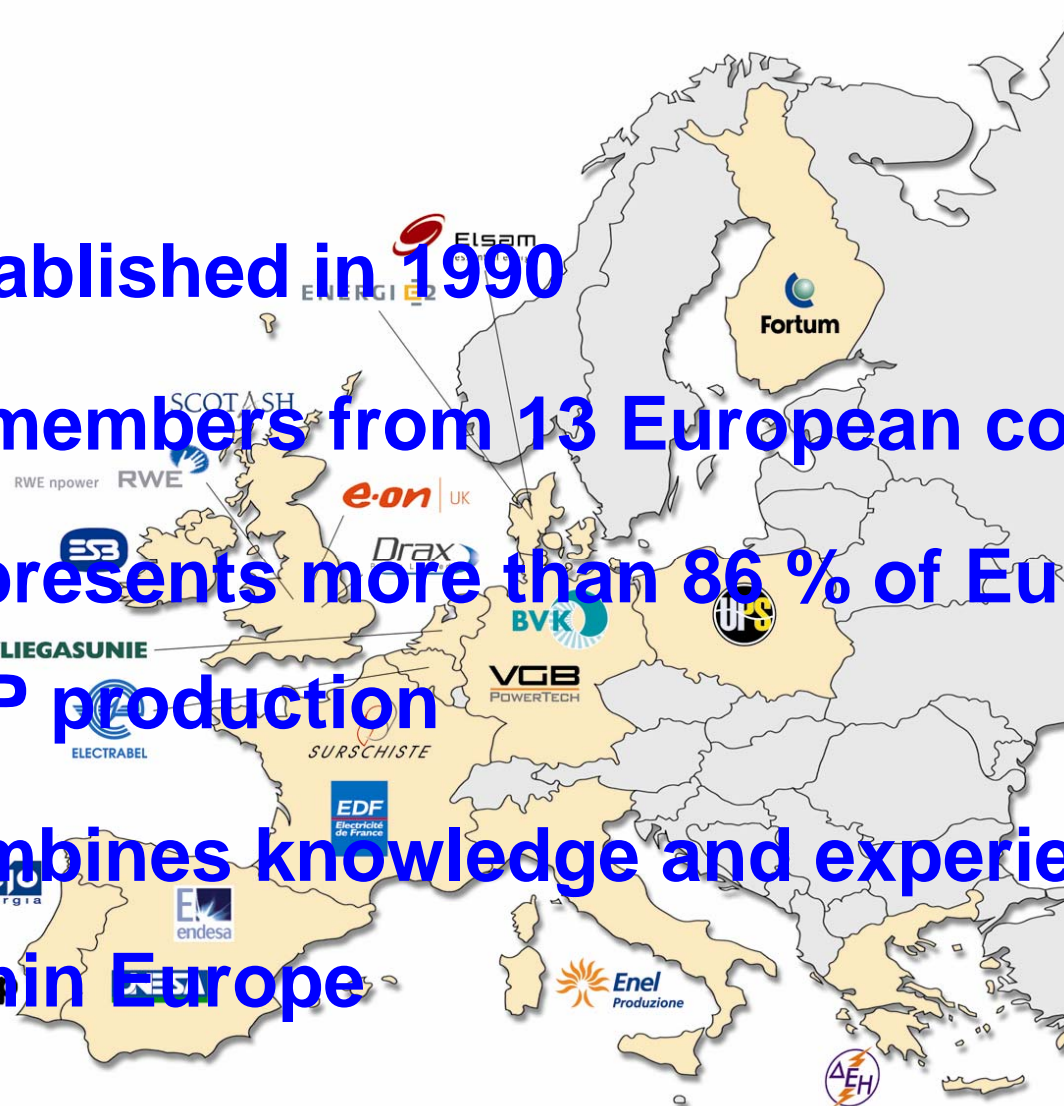
ECOBA Mission

**ECOBA - European Coal Combustion Products Association
represents
Power Plant Operators producing CCPs
and
CCP marketing companies in Europe**

ECOBA's mission is

- **to encourage the development of the use of CCPs**
- **to promote the mutual interests of their members within the framework of the European Organisations**
- **to develop the legal/regulatory measures for the recognition, acceptance and promotion of CCPs in Europe**

- ◆ Established in 1990
- ◆ 21 members from 13 European countries
- ◆ Represents more than 86 % of European CCP production
- ◆ Combines knowledge and experience within Europe



- ◆ American Coal Ash Association (ACAA)
- ◆ Canadian Industries Recycling Coal Ash (CIRCA)
- ◆ Japan Coal Energy Center (JCOAL)
- ◆ National Coal Ash Board of Israel (NCAB)
- ◆ United Kingdom Quality Ash Association

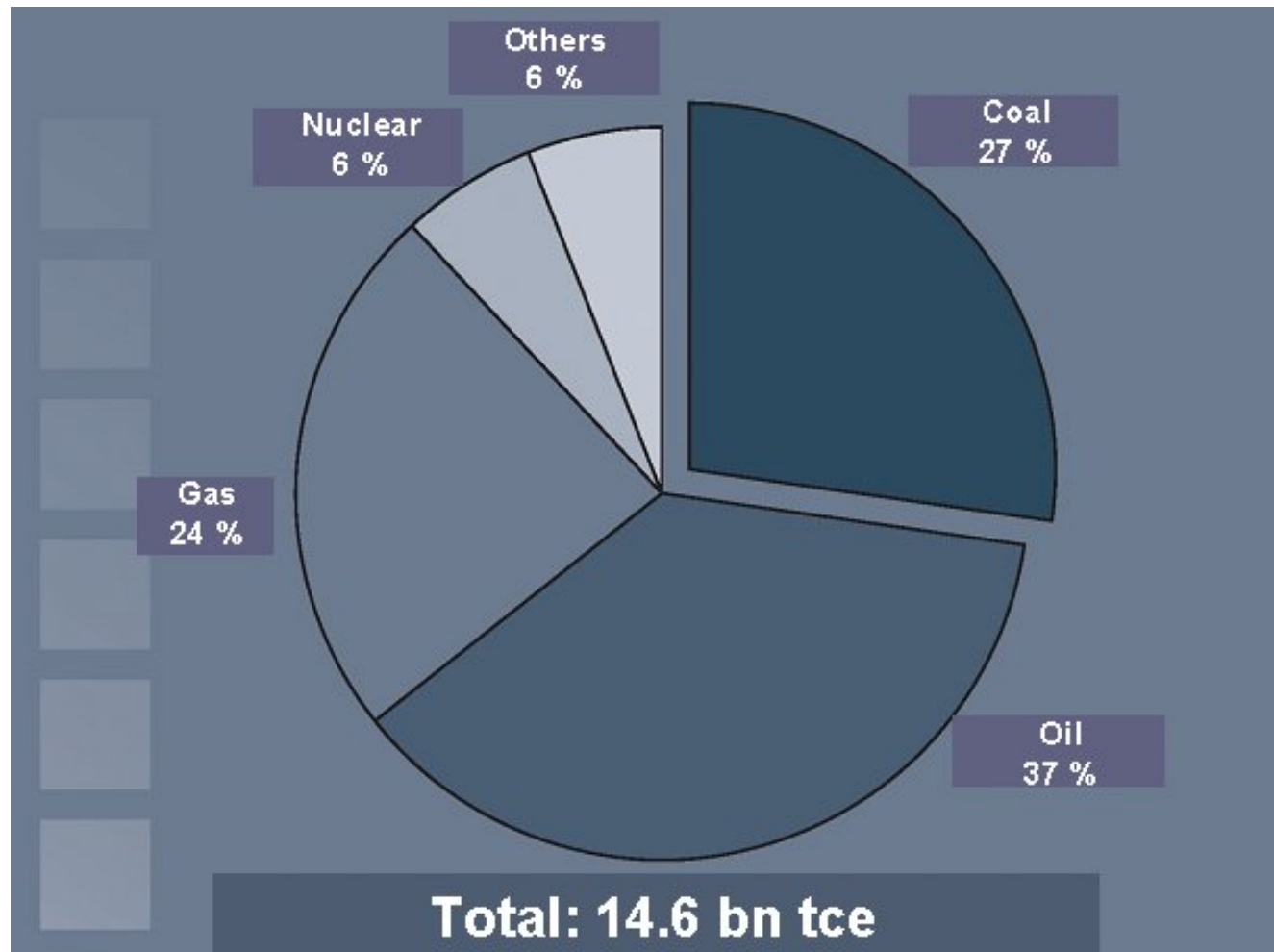


Content

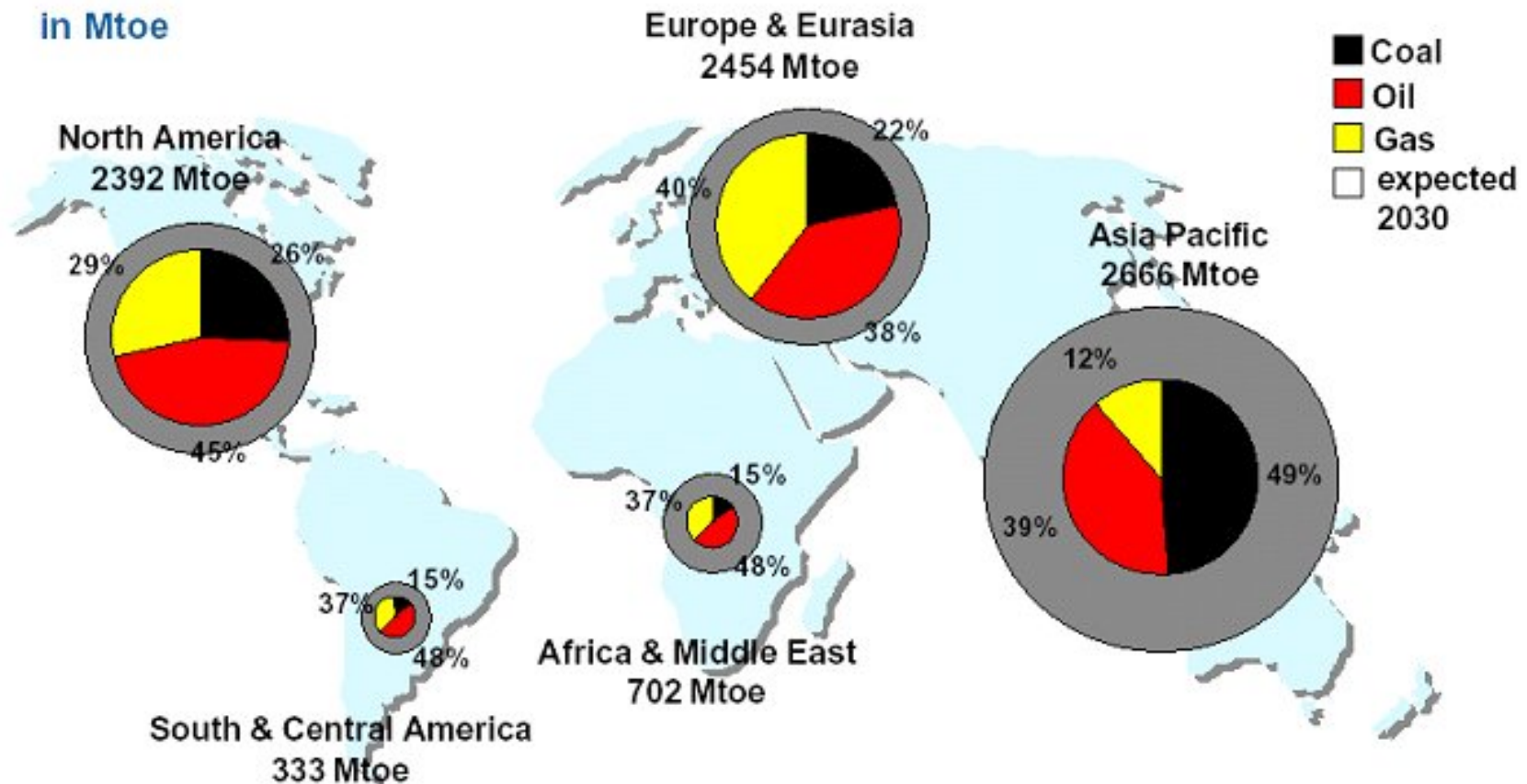
- 1. Introduction – role of coal in energy mix**
- 2. Production and utilisation of CCPs**
 - over the world**
 - in Europe**
- 3. Selected examples of CCP utilisation**
- 4. Environmental benefits of CCP utilisation**
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Introduction – role of coal in energy mix

World – Energy consumption 2004



Introduction – role of coal in energy mix

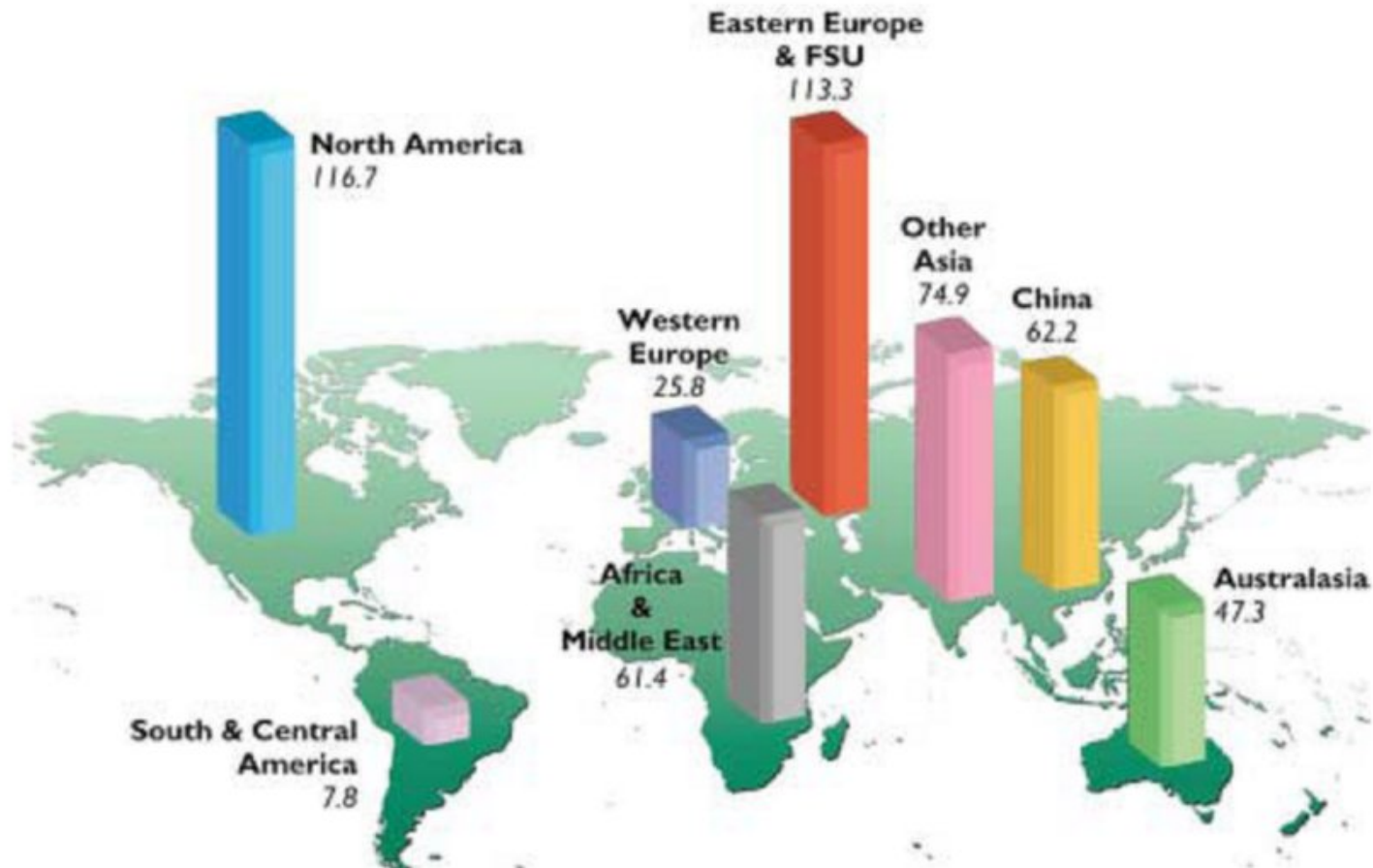


Source: BP – 2004, EU Commission

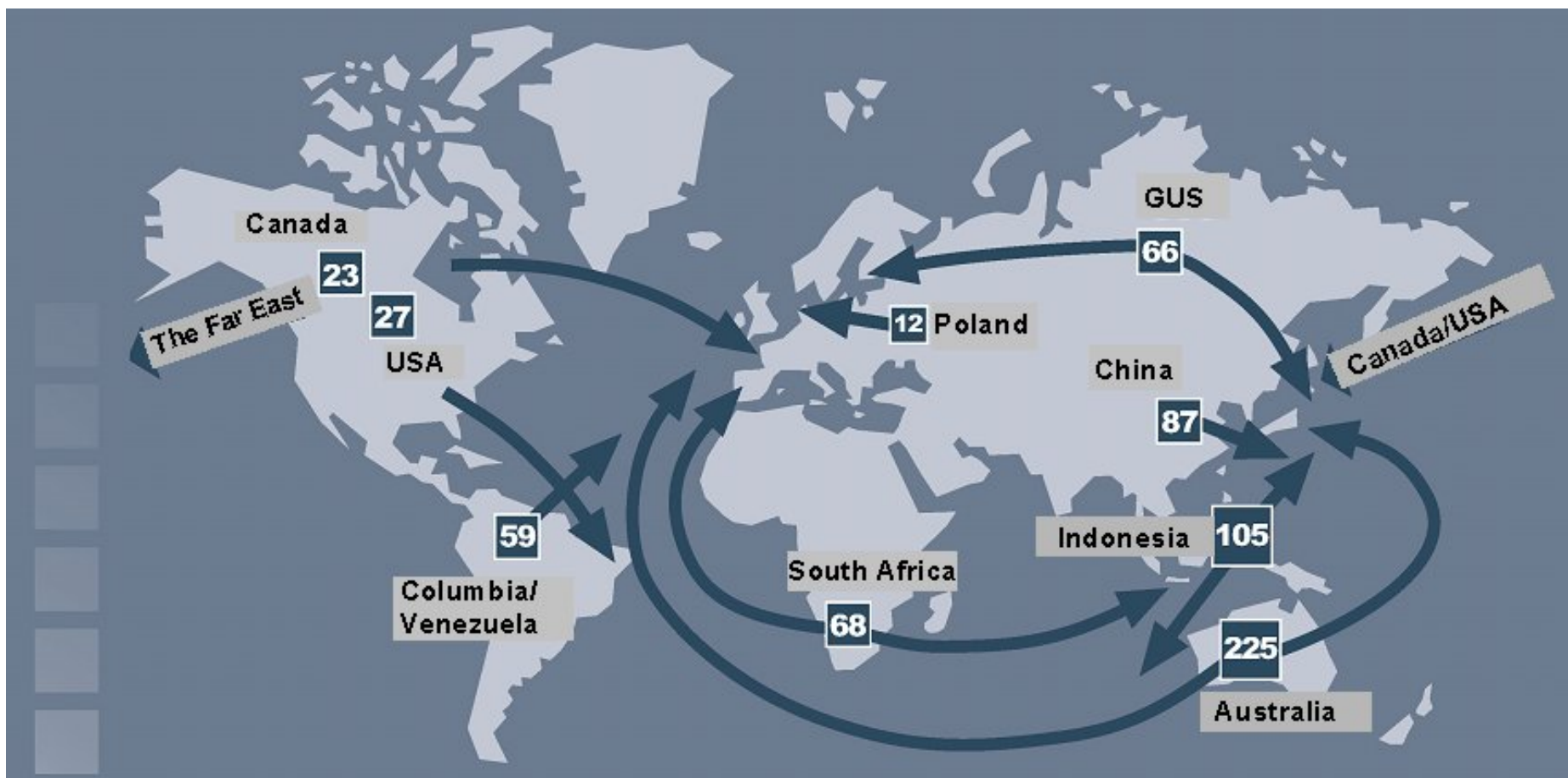
Primary energy consumption of fossil fuels - 2003

Introduction – role of coal in energy mix

Coal reserves of the world

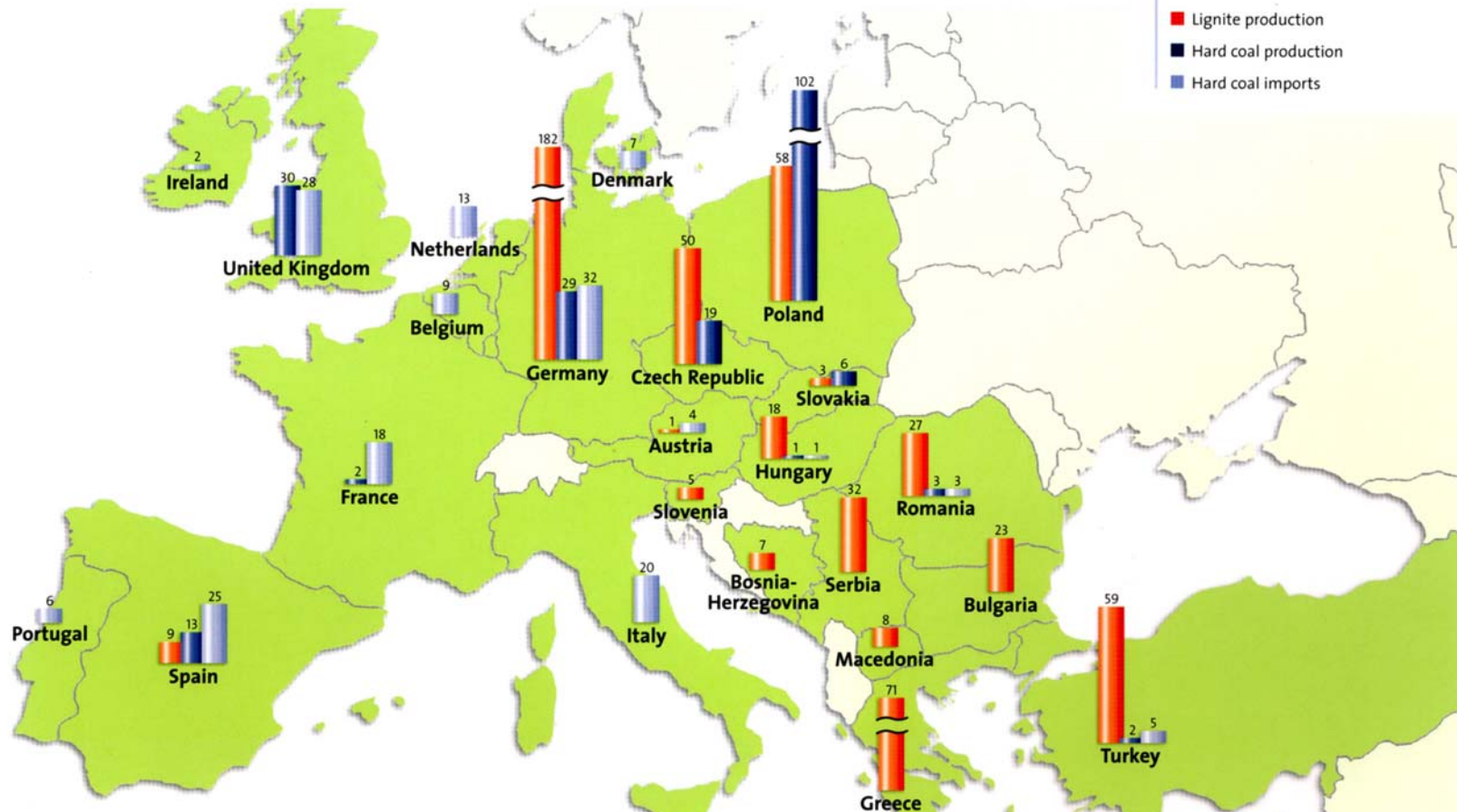


Hard coal maritime traffic 2004: 685 million tonnes



Introduction – role of coal in energy mix

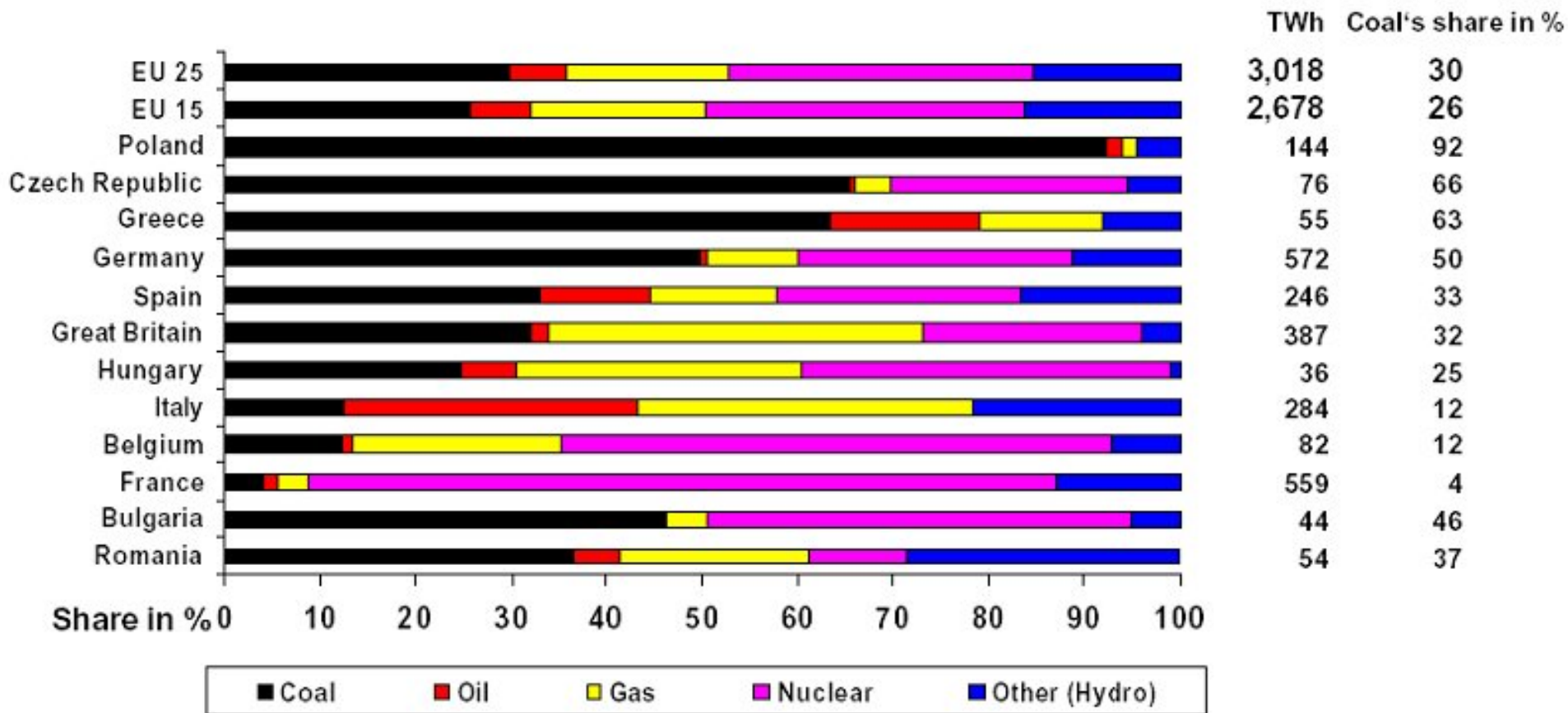
Coal in Europe



About 490 mill. t/a and 550 mill t/a lignite in Europe

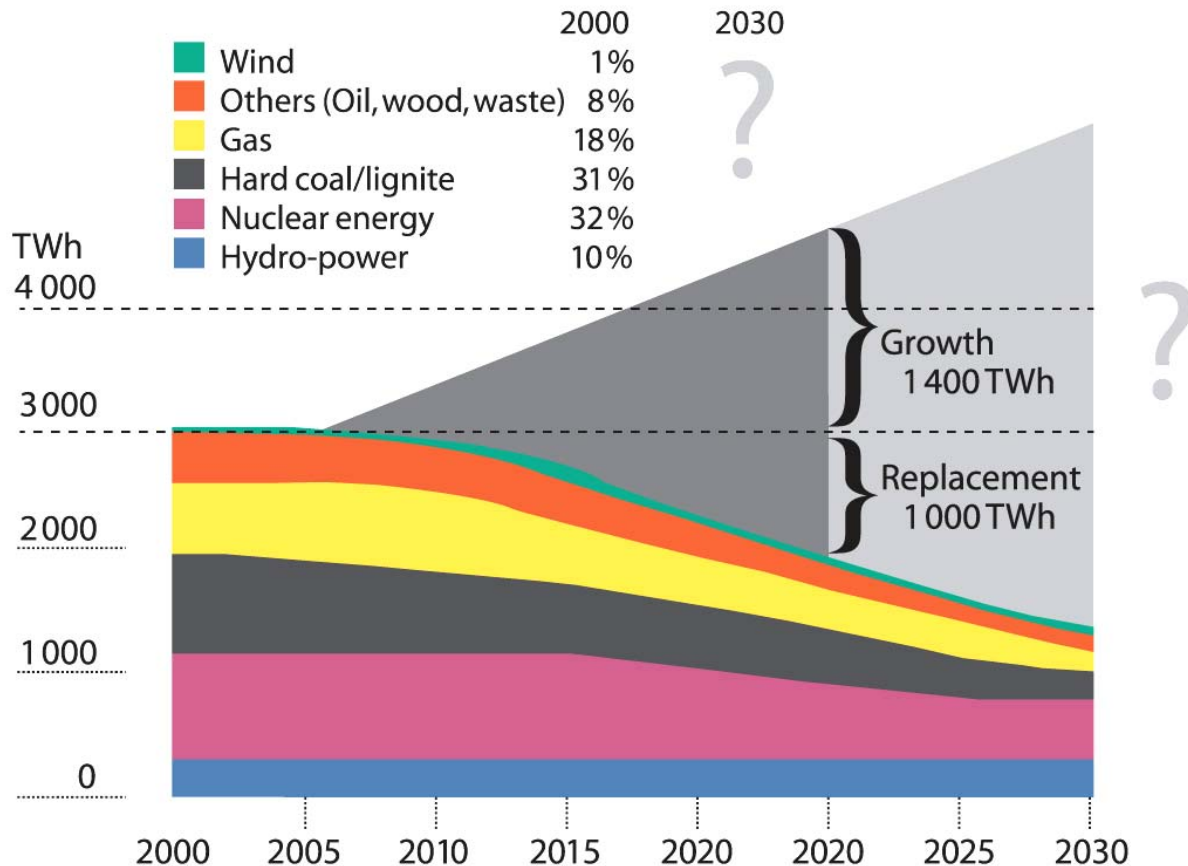
Introduction – role of coal in energy mix

Cross power generation - 2002



Introduction – role of coal in energy mix

Development of electricity generation in the EU 25 between 2000 and 2030



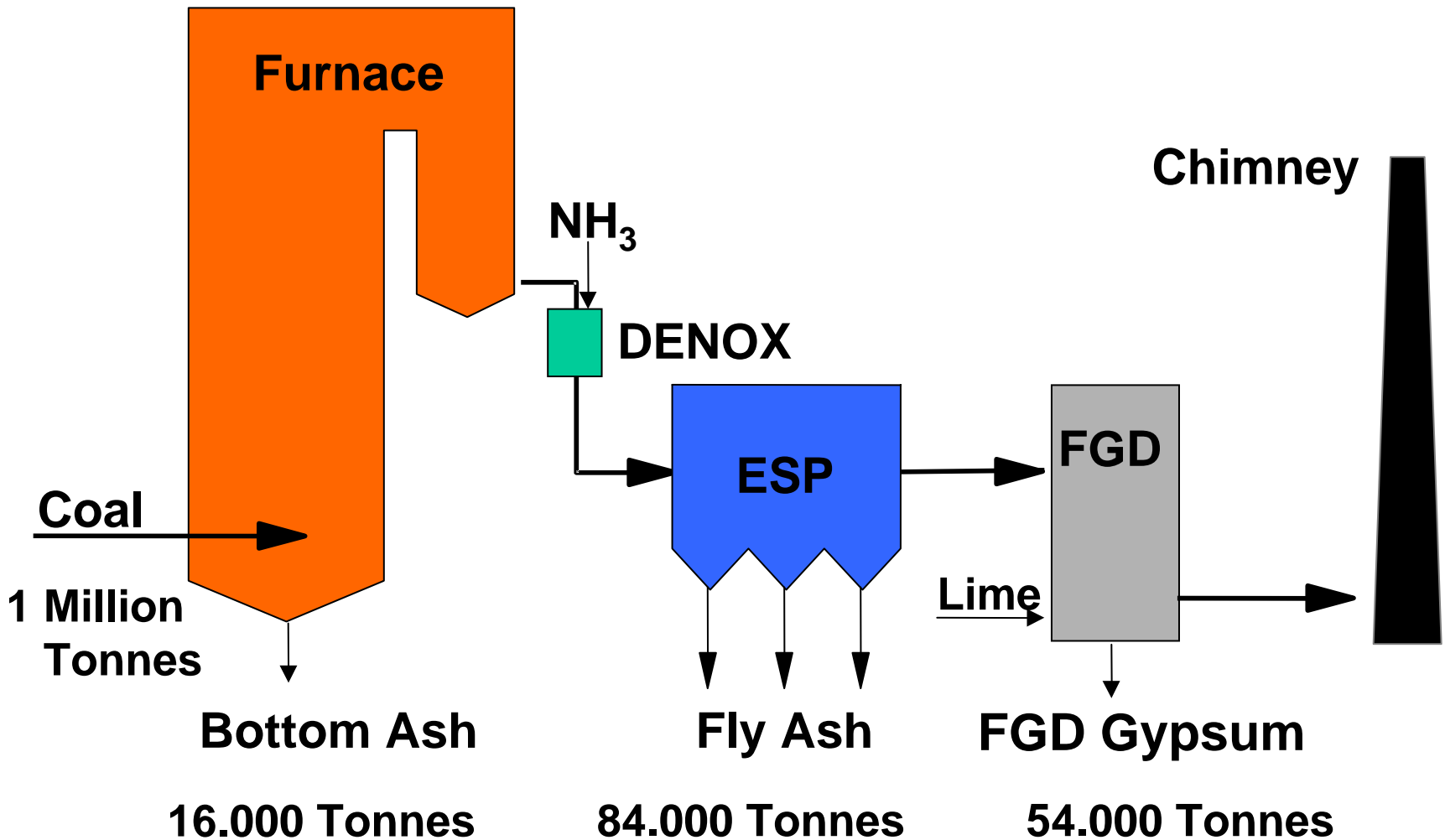
Source: EU – Energy and Transport Outlook

Clean Coal Technology

- Improvement of efficiency of power generation
- Reduction of CO₂ emissions
- Abatement of emissions of pollutants to air and water
- Production (and utilisation) of minerals (CCPs)

Introduction – role of coal in energy mix

750 MW_e Coal-Fired Power Plant 6000 Hours Full Load



2. Production and utilisation of CCPs



Fly Ash




Boiler Slag



Bottom Ash

2. Production and utilisation of CCPs

American Coal Ash Association 16200 E. Grand Ave., Ste. 300 Aurora, CO 80014-3100		Phone: 720-870-7697 Fax: 720-870-7699 Internet: www.ACAA-USA.org Email: info@acaa-usa.org				2004 Coal Combustion Product (CCP) Production and Use Survey		
CCP Categories (Short Tons)	Fly Ash	Bottom Ash	FGD Gypsum	FGD Material Wet Scrubbers	Boiler Slag*	FGD Material Dry Scrubbers*	FGD Other*	FBC Ash*
CCP Production Category Totals**	70,800,000	17,200,000	11,950,000	17,500,000	2,202,296	1,829,830	115,596	867,397
CCP Production Total								122,465,119
CCP Used Category Totals***	28,068,970	8,152,469	9,044,955	1,195,877	1,973,385	177,480	3,291	473,391
All CCP Used Total								49,089,818
CCP Use By Application****	Fly Ash	Bottom Ash	FGD Gypsum	FGD Material Wet Scrubbers	Boiler Slag	FGD Material Dry Scrubbers	FGD Other	FBC Ash
1. Concrete/Concrete Products /Grout	14,121,868	789,071	291,439	0	0	37,343	0	0
2. Cement/ Raw Feed for Clinker	2,345,754	615,192	449,063	39,378	33,505	0	0	0
3. Flowable Fill	179,735	0	0	0	0	11,274	0	0
4. Structural Fills/Embankments	4,685,091	3,064,773	0	266,651	7,268	0	0	61,985
5. Road Base/Sub-base/Pavement	488,214	1,092,006	0	0	7,070	0	0	0
6. Soil Modification/Stabilization	500,630	21,117	0	0	0	0	0	190,426
7. Mineral Filler in Asphalt	90,033	0	0	0	39,942	0	0	0
8. Snow and Ice Control	5,563	830,329	0	0	87,711	0	0	0
9. Blasting Grit/Roofing Granules	0	70,312	0	0	1,747,238	0	0	0
10. Mining Applications	1,113,361	39,682	0	282,033	0	122,589	0	134,648
11. Wallboard	0	0	8,148,078	0	0	0	0	0
12. Waste Stabilization/Solidification	2,441,513	257,375	0	338	4,615	0	0	70,722
13. Agriculture	52,314	19,272	131,058	10,593	0	2,775	0	0
14. Aggregate	7,995	409,362	0	0	38,000	3,499	0	0
15. Miscellaneous/Other	2,036,899	943,978	25,317	596,884	8,036	0	3,291	15,610
CCP Category Use Totals	28,068,970	8,152,469	9,044,955	1,195,877	1,973,385	177,480	3,291	473,391
Application Use To Production Rate	39.65%	47.40%	75.69%	6.83%	89.61%	9.70%	2.85%	54.58%
Overall CCP Utilization Rate								40.08%
Cenospheres Sold (Pounds): 11,391,150								

* As submitted based on 60 percent coal burn.

** CCP Production totals for Fly Ash, Bottom Ash, FGD Gypsum, and Wet FGD are extrapolated estimates rounded off to nearest 50,000 tons.


*** CCP Used totals for Fly Ash, Bottom Ash, FGD Gypsum, and Wet FGD are per extrapolation calculations (not rounded off).

**** CCP Uses by application for Fly Ash, Bottom Ash, FGD Gypsum, and Wet FGD are calculated per proportioning the CCP Used Category Totals by the same percentage as each of the individual application types' raw data contributions to the as-submitted raw data submittal total (not rounded off).

2. Production and utilisation of CCPs

Production and Utilisation of CCPs in 2003 in Europe (EU 15) [kilo tonnes (metric)]

		Fly Ash	Bottom Ash	Boiler Slag	FBC-Ash	Other	SDA-Product	FGD-Gypsum		
		1	2	3	4	5	6	7		
CCP Production		44.217	6.045	2.110	1.089	76	490	11.276		
Subtotal 1 - 5		68.637								
Subtotal 6 - 7								11.788		
Total 1 - 7		86.909								
CCP Utilisation									Total	%
Cement raw material	1	5.460	151					Cement raw material	5.611	8,4
Blended cement	2	2.377	125					Blended cement	2.502	3,8
Concrete addition	3	5.872	98	161				Concrete addition	6.131	9,2
Aerated concrete blocks	4	845	16					Aerated concrete blocks	861	1,3
Non-aerated concrete blocks	5	380	1.264			5		Non-aerated concrete blocks	1.649	2,5
Lightweight aggregate	6	93	0					Lightweight aggregate	93	0,1
Bricks + ceramics	7	133	23			16		Bricks + ceramics	172	0,3
Grouting	8	481		126	84			Grouting	691	1,0
Asphalt filler	9	158						Asphalt filler	158	0,2
Subgrade stabilisation	10	184	98		1			Subgrade stabilisation	283	0,4
Pavement base course	11	387	258	998	72			Pavement base course	1.715	2,6
General engineering fill	12	1.777	377		0	35	17	General engineering fill	2.206	3,3
Structural fill	13	1.911	145		63			Structural fill	2.119	3,2
Soil amendment	14	37	1		22			Soil amendment	60	0,1
Infill	15	689	94		288		15	Infill	1.086	1,6
Blasting grit	16	0		660				Blasting grit	660	1,0
Plant nutrition	17	3					22	Plant nutrition	25	0,0
Set retarder for cement	18							642 Set retarder for cement	642	1,0
Projection plaster	19						760	Projection plaster	760	1,1
Plaster boards	20						4.897	Plaster boards	4.897	7,4
Gypsum blocks	21						261	Gypsum blocks	261	0,4
Self levelling floor screeds	22						1.401	Self levelling floor screeds	1.401	2,1
Other uses	23	329	6	165	27	9	41	5 Other uses	582	0,9
Reclamation, Restoration	24	18.964	2.686	0	178		180	1.645 Reclamation, Restoration	23.653	35,6
Temporary stockpile	25	3.507	128	0	40			1.581 Temporary stockpile	5.256	7,9
Disposal	26	1.207	613	0	314	11	215	84 Disposal	2.444	3,7
Total utilisation 1 - 26	27	21.118	2.868	2.110	567	86	96	7.888 Total utilisation 1 - 26	34.565	52,4
Utilisation rate in %	28	47	44	100	51	88	19	71 Utilisation rate in %		
Average utilisation rate in %	29							62 Average utilisation rate in %		
Total utilisation 1 - 24	30	40.080	6.342	2.110	756	86	276	8.811 Total utilisation 1 - 24	58.218	88,3
Utilisation rate in %	31	89	88	100	87	88	58	86 Utilisation rate in %		
Average utilisation rate in %	32							88 Average utilisation rate in %		
Total production 1-28	34	44.784	6.083	2.110	1.088	78	490	11.278 Total production 1-28	65.918	100,0
Reuse of stockpiled CCPs	33	677	38	0	0	0	0	0 Reuse of stockpiled CCPs	615	0,9
Total production 1-28 incl. reuse	34	45.461	6.121	2.110	1.088	78	490	11.278 Total production 1-28 incl. reuse	66.533	100,0



2. Production and utilisation of CCPs

CANADA: TOTAL COAL COMBUSTION PRODUCTS (CCPs) - PRODUCTION AND USE - 2001 1/ 2/
(thousand tonnes)

	Fly Ash	Bottom Ash	FGD Gypsum	Other 3/	Total CCPs
Production:					
Produced	4815	1592	382	111	6900
Disposed/stored	3881	1535	0	111	5526
Removed from disposal	97	123	0	0	220
Use (domestic):					
Cement	420	202	0	0	622
Concrete/grout	408	0	0	0	408
Mining applications	145	0	0	0	145
Roadbase/subbase	8	46	0	0	54
Wallboard	0	0	530	0	530
Other 4/	71	12	0	0	84
Total use	1052	261	530	0	1843
Individual use percentage	22%	16%	139%	0%	n.a.
Cumulative use percentage	22%	20%	27%	27%	27%

1/ Reported production of coal combustion products (CCPs) may include both dry and ponded categories.

2/ Use (domestic), as reported, includes amounts imported (assumed to be HS codes 2621.00 relating to fly ash, and HS 2520.10 relating to gypsum).

3/ Cfb (circulating fluidized bed) fly ash and bottom ash.

4/ Includes waste stabilization and specialty uses such as mineral filler and flowable fill.

Note: Total reported cross-border trade in fly ash (exports plus imports) amounted to about 370 000 tonnes.
n.a., not applicable; FGD is synthetic gypsum derived from flue-gas desulphurization.

Sources:

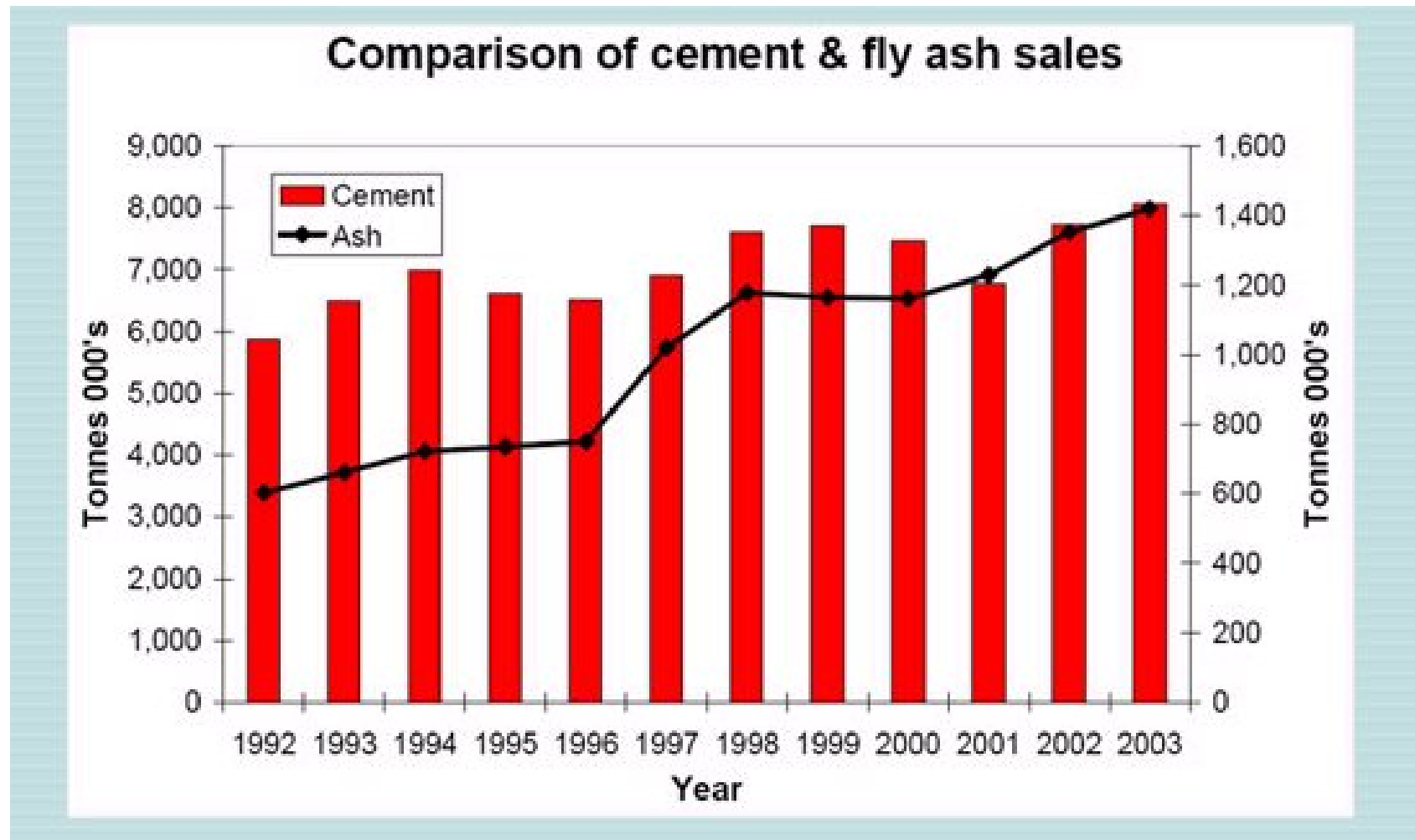
Compiled by Natural Resources Canada (Minerals and Metals Sector), in cooperation with Canadian Industries Recycling Coal Ash (CIRCA)

2. Production and utilisation of CCPs

Year	Ash Production $t \times 10^{-3}$	Beneficial Ash Usage $t \times 10^{-3}$	Total Ash Sales $t \times 10^{-3}$	Cementitious Ash Sales $t \times 10^{-3}$	% of Cement Sales
1975	nr	nr	303	257	5.1
1976	nr	nr	335	285	5.8
1977	nr	nr	357	303	6.1
1978	nr	nr	394	335	6.8
1979	nr	nr	452	384	7.7
1980	nr	nr	512	435	8.1
1981	nr	nr	559	475	8.3
1982	nr	nr	530	451	6.9
1983	nr	nr	497	422	8.6
1984	nr	nr	524	445	8.9
1985	nr	nr	563	479	8.5
1986	nr	nr	579	492	8.0
1987	nr	nr	618	525	9.0
1988	nr	nr	740	604	9.9
1989	nr	nr	770	655	9.6
1990	8,145	0	722	614	9.5
1991	8,340	0	696	592	9.5
1992	8,451	776	709	603	10.3
1993	8,510	850	780	661	10.2
1994	8,865	980	902	722	10.3
1995	9,290	1,910	1,275	735	11.1
1996	9,680	3,210	842	750	11.5
1997	9,980	4,545	1,140	1,020	14.8
1998	10,980	5,393	1,363	1,178	15.5
1999	11,416	3,809	1,323	1,165	15.1
2000	11,770	3,901	1,522	1,161	15.6
2001	12,182	2,158	1,618	1,229	18.1
2002	12,510	2,210	1,827	1,353	17.5
2003	13,010	2,450	1,925	1,420	17.6

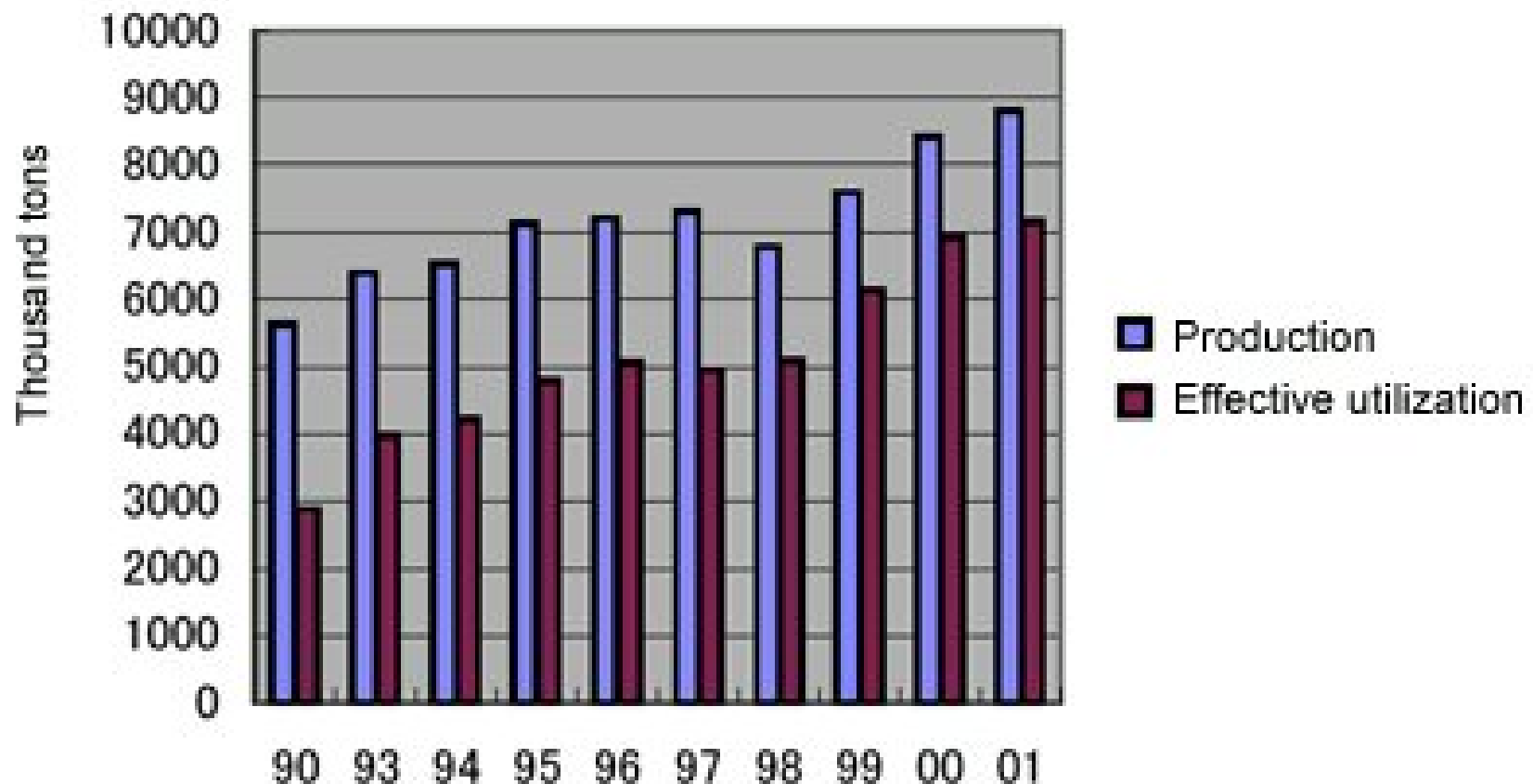
Ash production and sales in Australia

2. Production and utilisation of CCPs



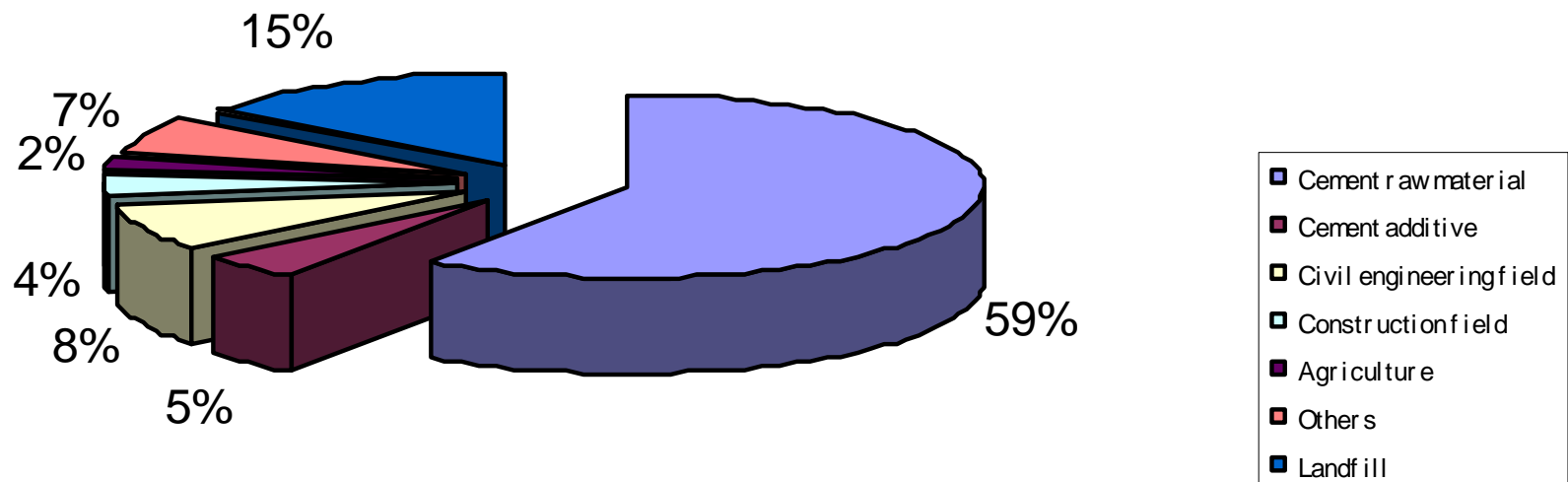
Ash production and sales in Australia

2. Production and utilisation of CCPs



Ash production and utilisation in Japan

2. Production and utilisation of CCPs



Utilization fields in 2003

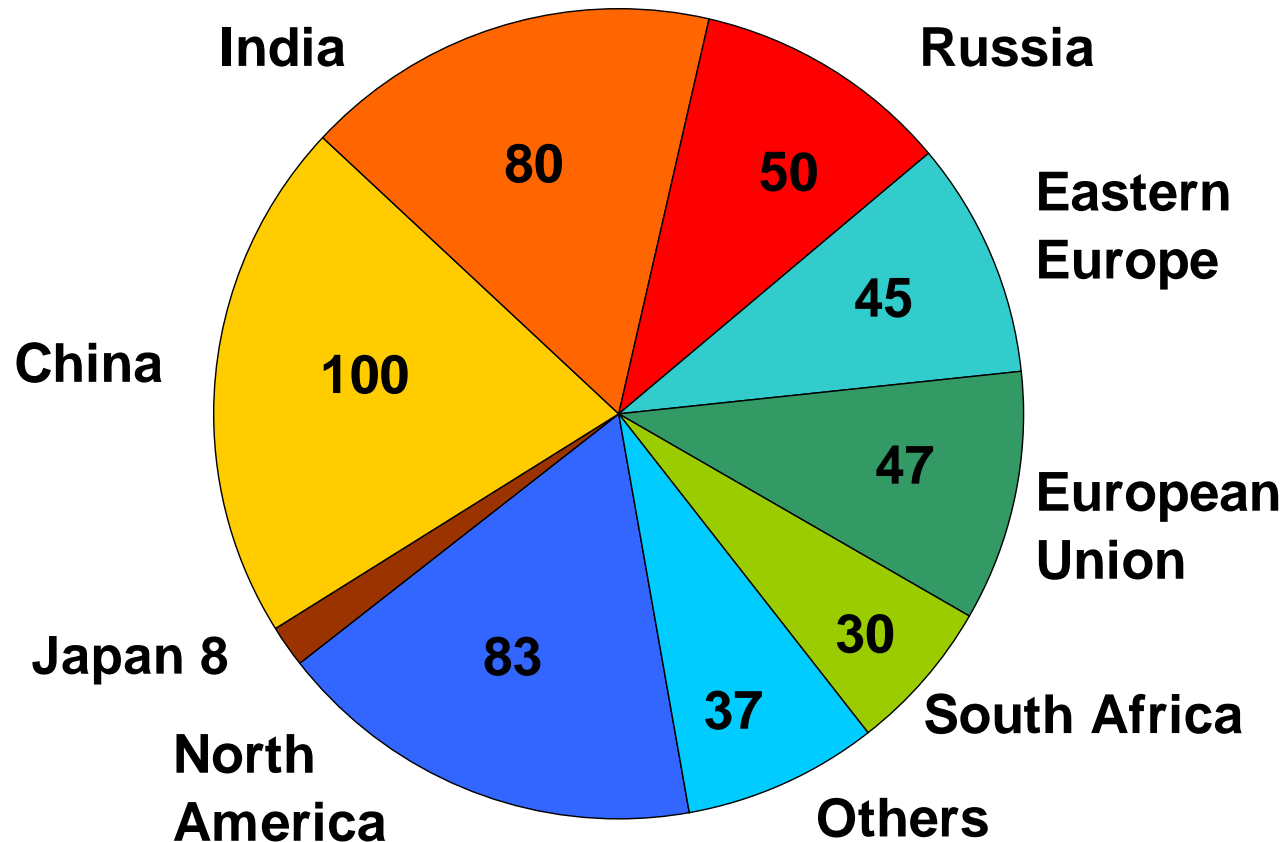
Ash utilisation in Japan

2. Production and utilisation of CCPs

World-wide Annual Production of Ashes

Estimation 3/2002, Based on Figures Published by O. Manz)

Total 480 million tonnes



2. Production and utilisation of CCPs



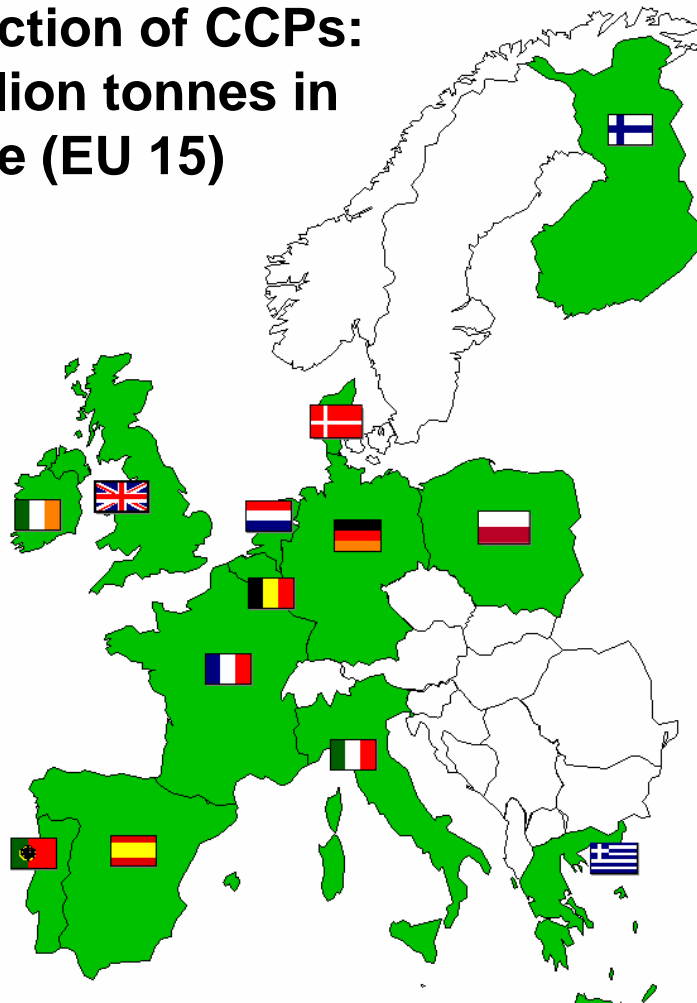
Worldwide Coal Combustion Product Network

.....,The name, Worldwide Coal Combustion Ash Network, embodies the essential elements of the expected results – opportunities for organizations throughout the world to increase the exchange of information about coal ash, or CCPs.

The role of the Worldwide Coal Combustion Product Network will be to create opportunities for international stakeholders to exchange information with peers not only through face-to-face meetings, but, and perhaps primarily, through electronic networking.

2. Production and utilisation of CCPs

**Production of CCPs:
63 million tonnes in
Europe (EU 15)**

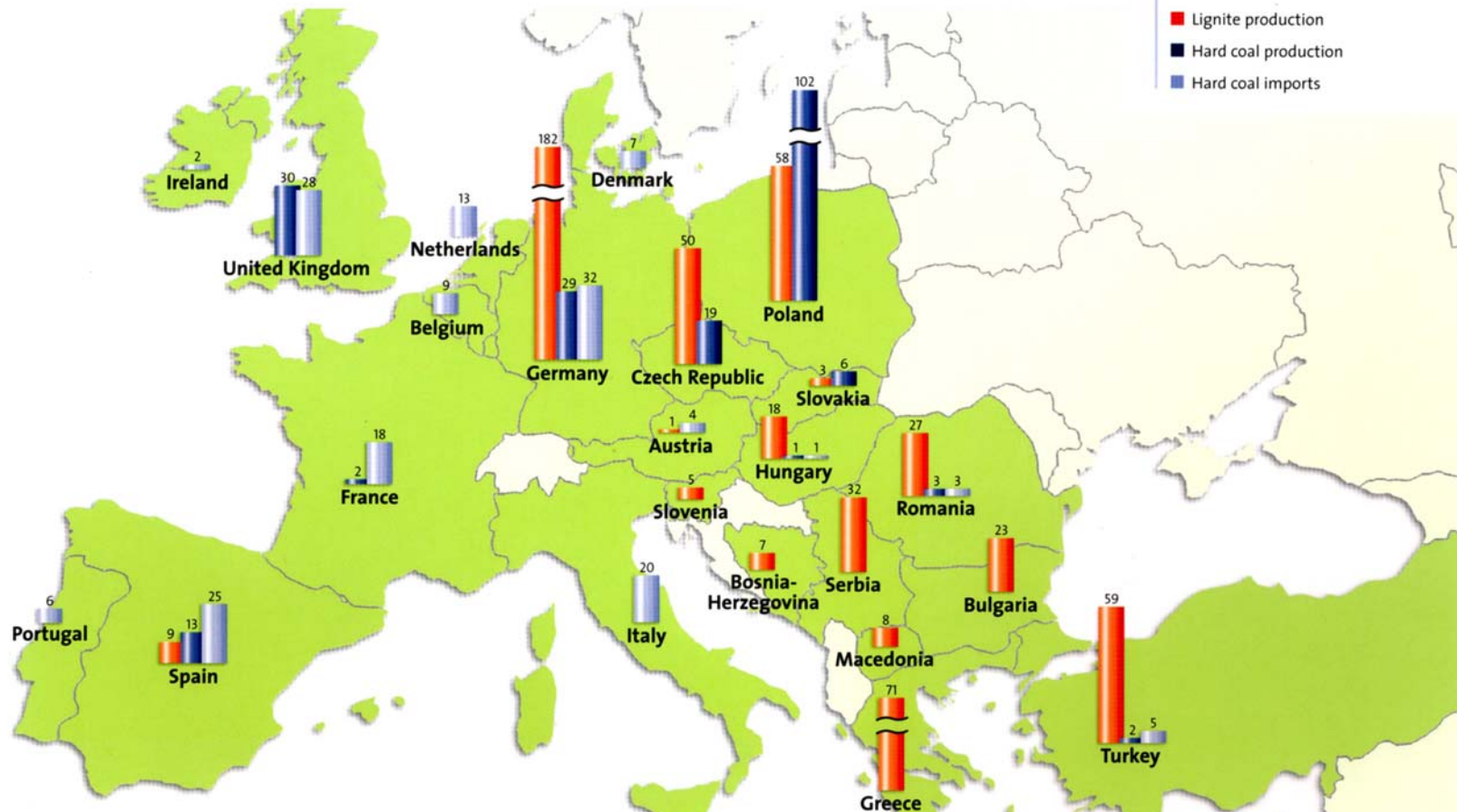


**Production of CCPs:
about 30 million tonnes in
new EU member states**

**Estonia
Latvia
Lithuania
Poland
Czech Republik
Slovakia
Hungary
Slovenia
Malta
Cyprus**

2. Production and utilisation of CCPs

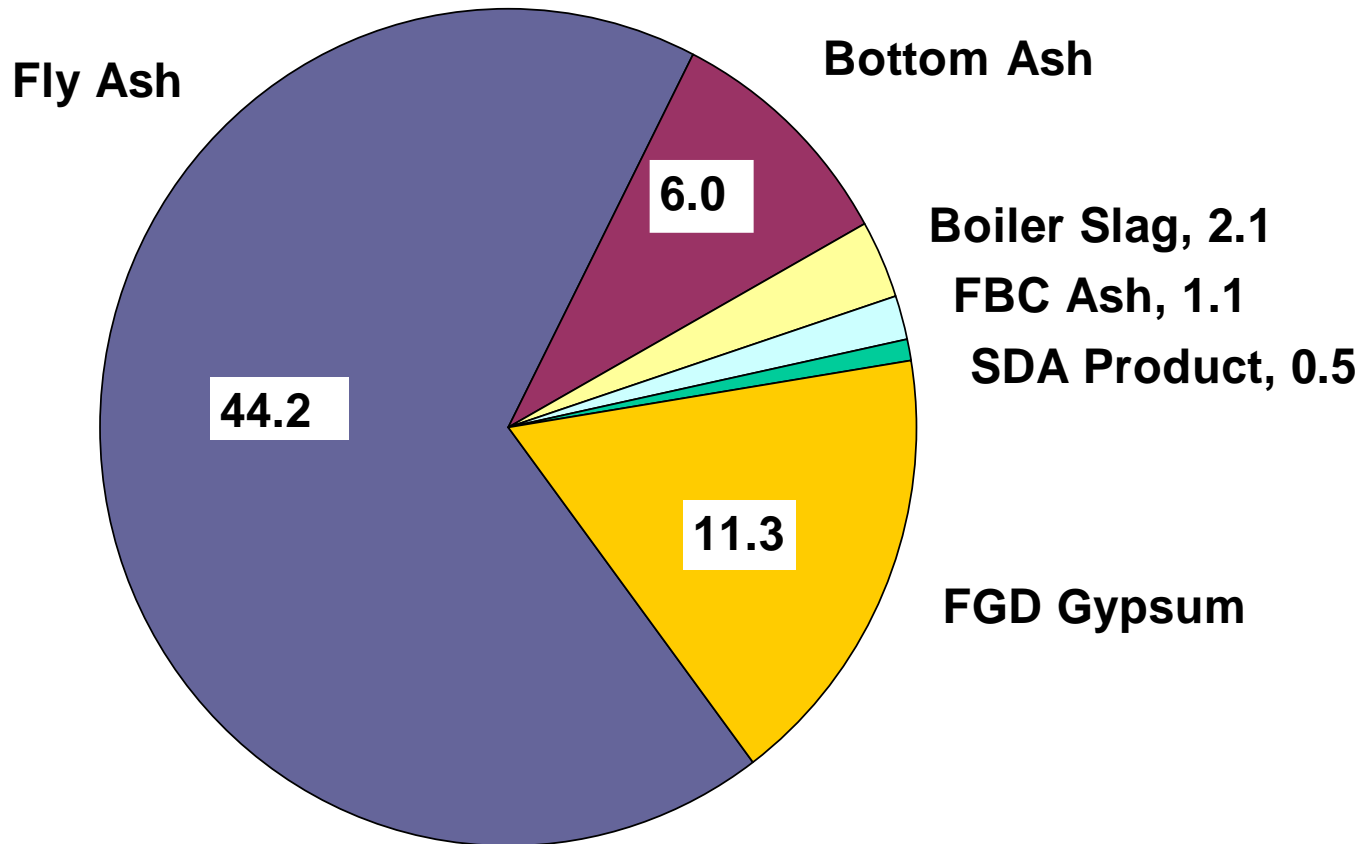
Coal in Europe



About 490 mill. t/a and 550 mill t/a lignite in Europe

2. Production and utilisation of CCPs

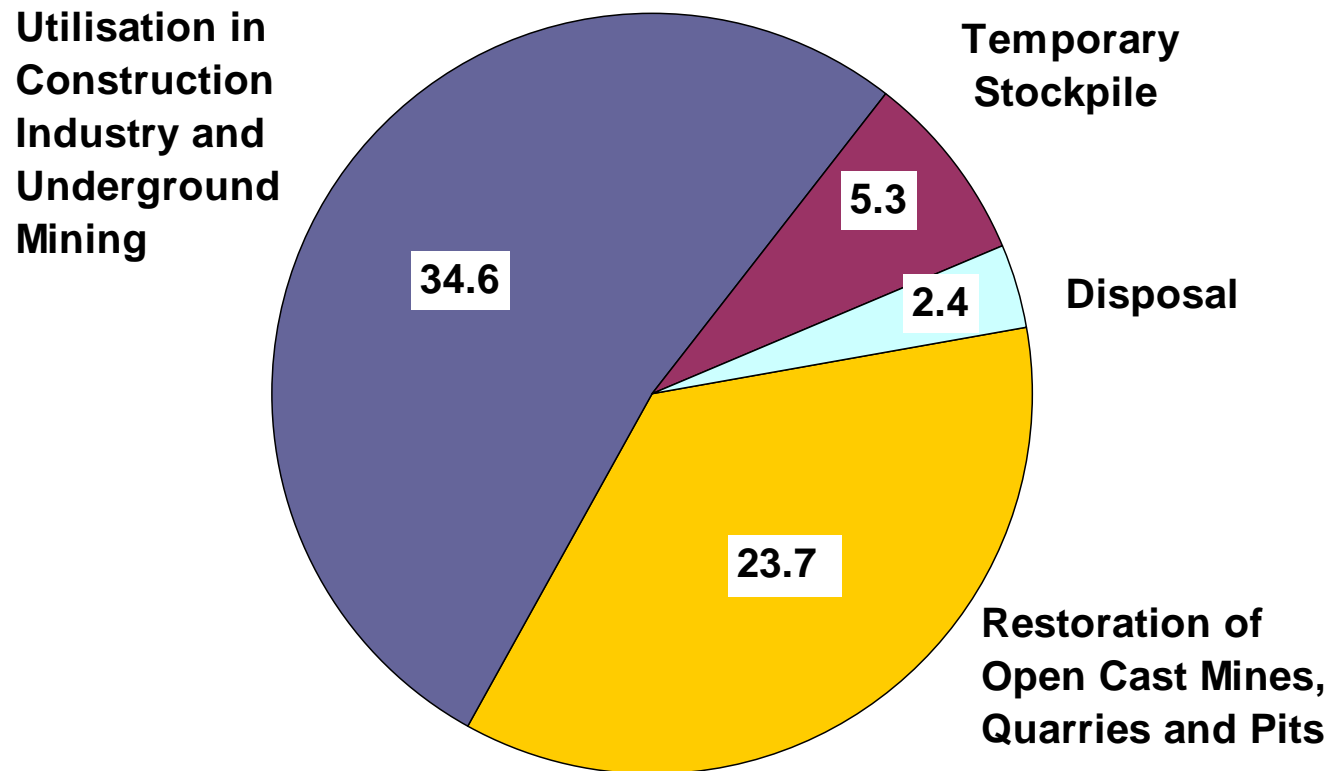
Production of CCPs in Europe (EU 15) in 2003 [million tonnes]



(total production: 65 million tonnes)

2. Production and utilisation of CCPs

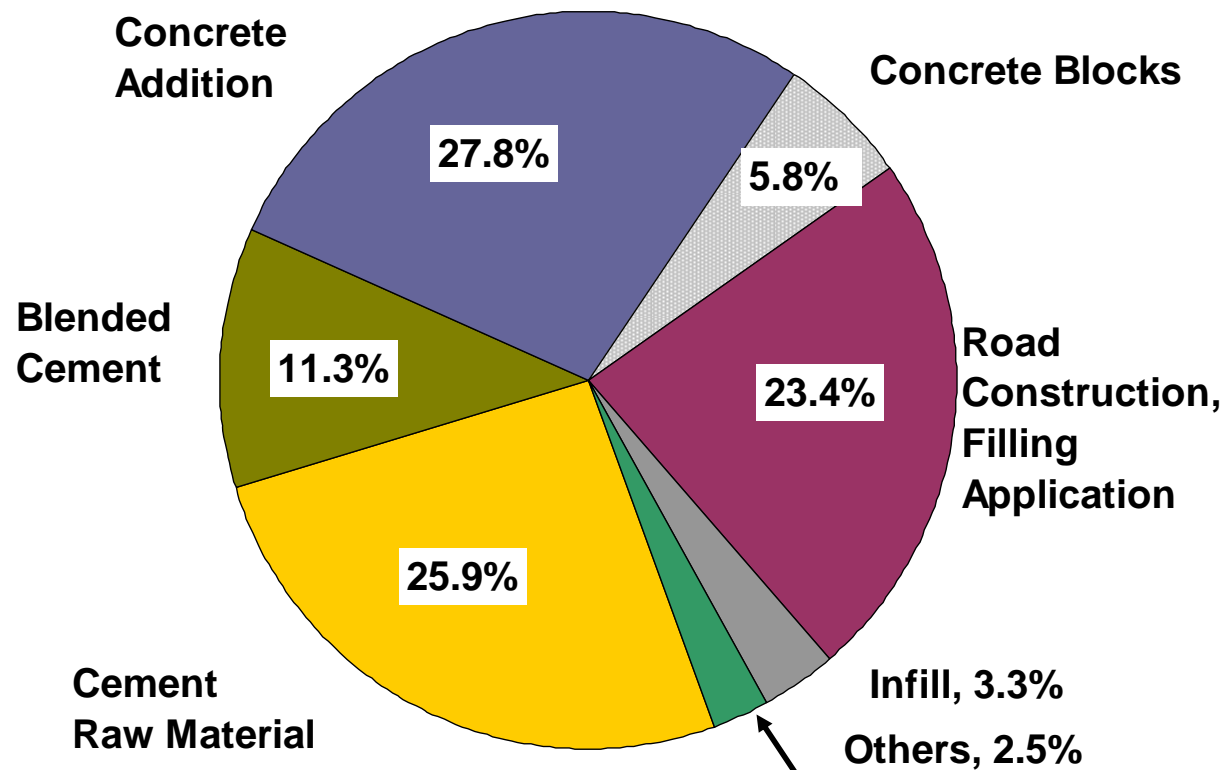
Utilisation and disposal of CCPs in Europe (EU 15) in 2003 [million tonnes]



(total production: 65 million tonnes)

2. Production and utilisation of CCPs

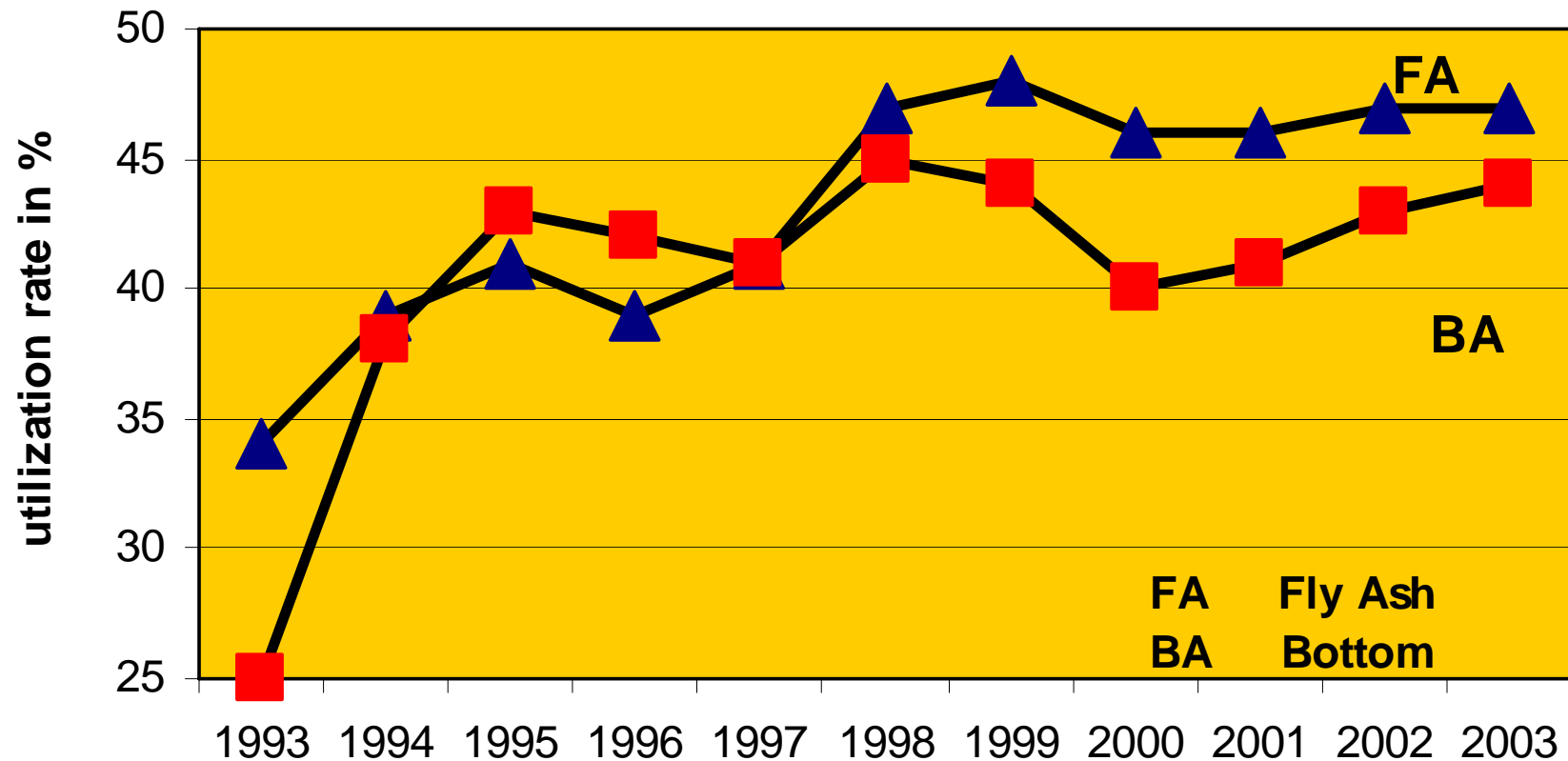
Utilisation of **fly ash** in the construction industry and in underground mining in Europe (EU 15) in 2003



(total utilisation 21.1 million tonnes)

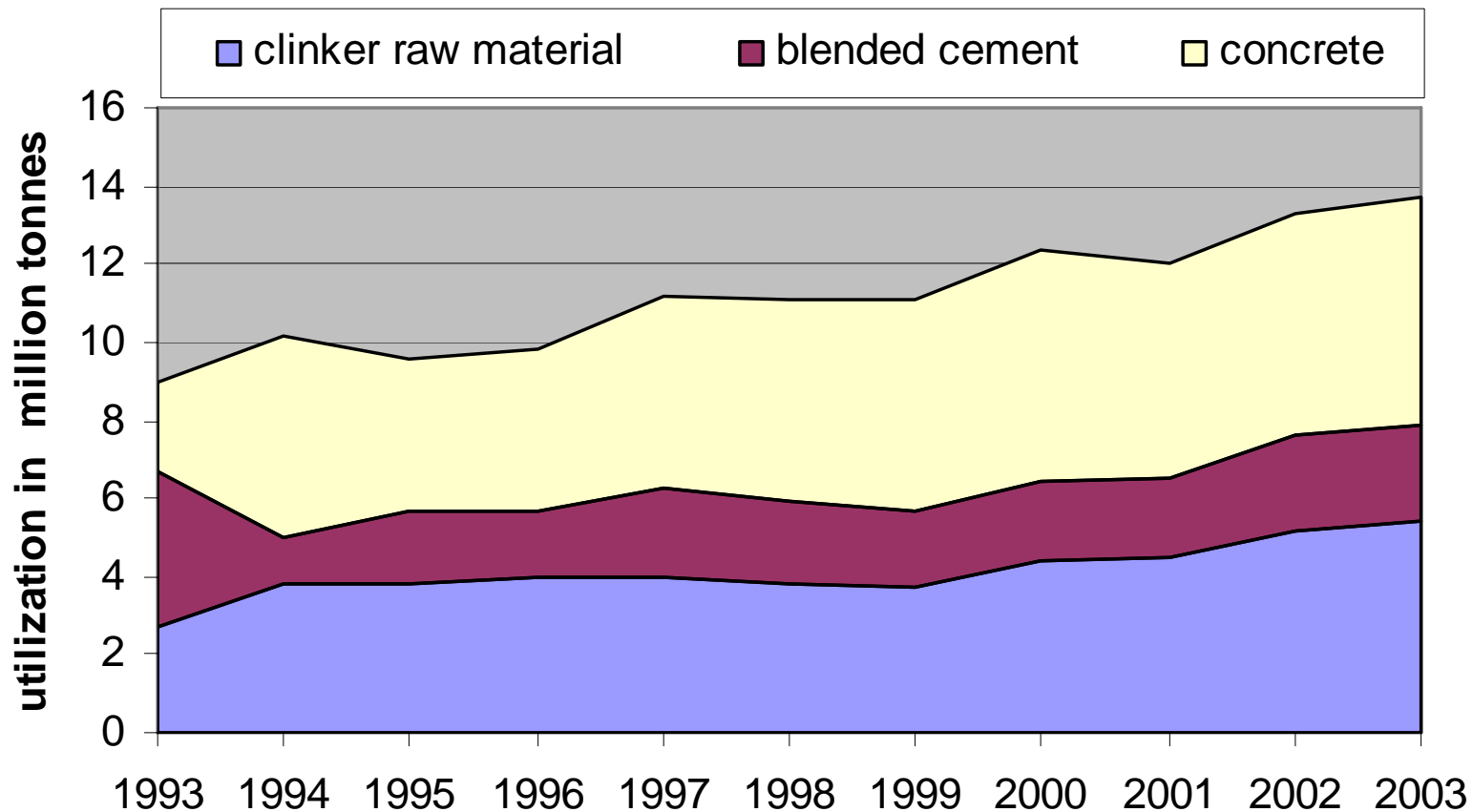
3. Development of CCP utilisation in Europe

Development of the utilisation rate of fly ash and bottom ash in the construction industry in Europe (EU 15) from 1993 to 2003



3. Development of CCP utilisation in Europe

Utilisation of Fly Ash in the cement and concrete industry in Europe (EU 15) from 1993 to 2003



2. Production and utilisation of CCPs

Demands of the construction market

- ▶ availability of huge amounts of material
 - ▶ constant quality (continuous process)
 - ▶ sufficient product properties (grain size distribution, surface,
 - ▶ long term availability
 - ▶ meeting of technical requirements
 - ▶ environmental compatibility
- ▶ research work and pilot projects
 - ▶ teaching of CCP properties, education
 - ▶ installation of silo capacity
 - ▶ beneficiation of fly ash to increase availability in summer time (re-drying facilities)

2. Production and utilisation of CCPs

Technical regulations

- ▶ **beneficial utilization of CCPs over decades led to**
 - **acceptance as construction materials by industries and authorities**
 - **standards and specifications for CCPs as construction materials**
- ▶ **specific requirements for CCPs as cement raw materials**
- ▶ **EN 197-1 for fly ash as constituent in blended cement**
- ▶ **EN 450 for fly ash for use as concrete addition**
- ▶ **Quality criterias for FGD gypsum, published by (EUROGYPSUM)**

2. Production and utilisation of CCPs

EN 450-1

„Fly ash for concrete“


**Part 1: Definitions,
specifications and
conformity criteria**

EN 450-2

„Fly ash for concrete“

Part 2:

Conformity evaluation


AnyCo Ltd, PO Box 21, B-1050 05 01234-CPD-00234
<p style="text-align: center;">EN 450-1</p> <p>Fly ash for concrete</p> <p>Fineness Category: N Declared value of fineness in case of category N: 25 % Loss on ignition Category : A Particle density: 2300 kg/m³ Dangerous Substance: NL, F</p>

3. Selected examples of CCP utilisation



The Puylaurent dam in France.

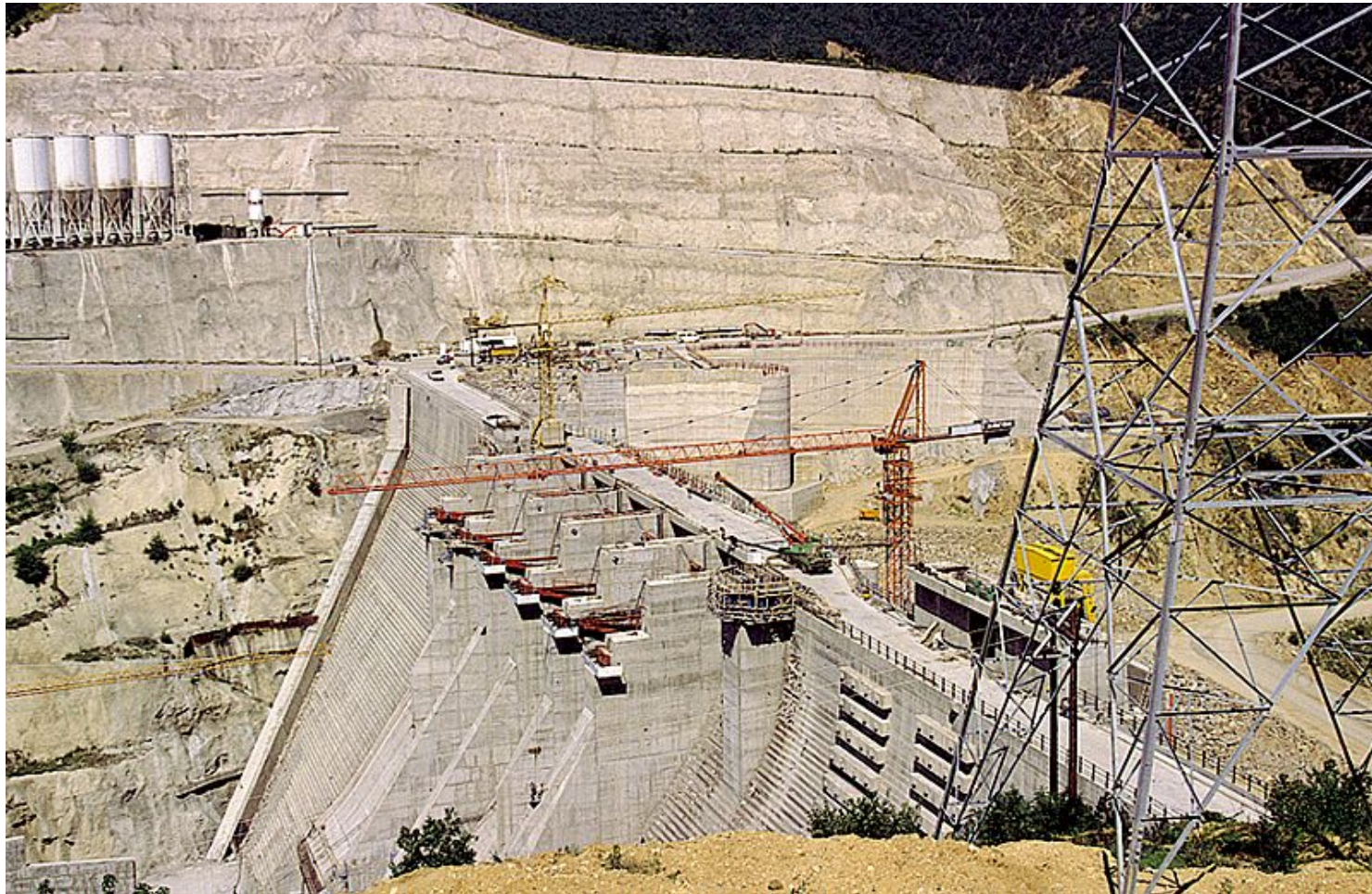
It was completed at the end of 1995.

Its maximum height is 73 meters over the foundation,

with a crest length of 220 meters

3. Selected examples of CCP utilisation

Platanovryssi dam in Greece



3. Selected examples of CCP utilisation

Great Belt Bridge, Denmark

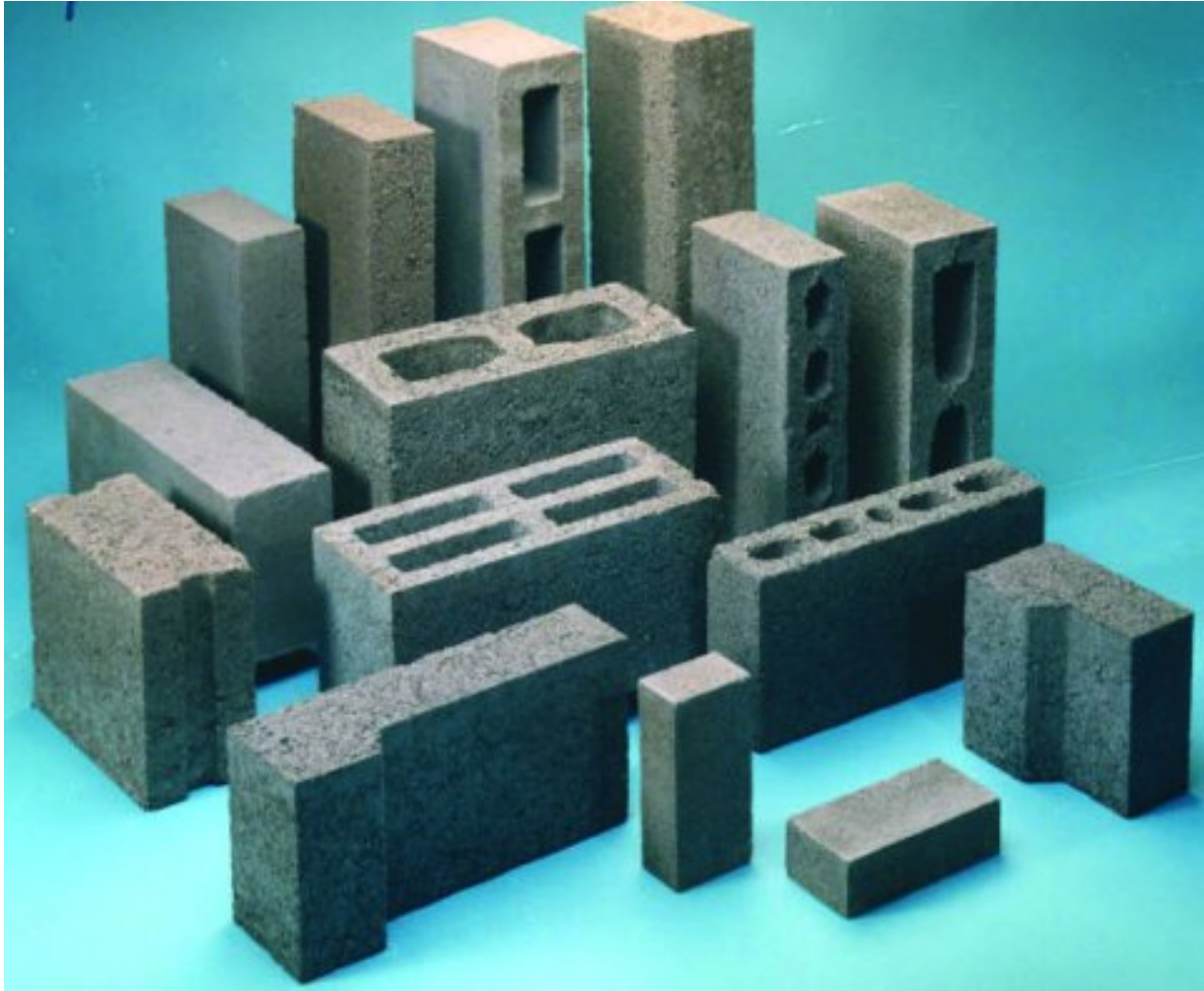


3. Selected examples of CCP utilisation

Construction of a bridge over Main-Donau canal / Germany



3. Selected examples of CCP utilisation



**Use of fly ash
and bottom ash
in
concrete blocks**

3. Selected examples of CCP utilisation

Use of fly ash in road construction

- **Soil stabilisation**
- **Landscaping**
- **Dams and embankments**
- **Hydraulically bound bearing layers**
- **Asphalt filler**
- **Additions to concrete**

3. Selected examples of CCP utilisation

Soil amendment with calcereous fly ash



3. Selected examples of CCP utilisation

CCPs in road construction – Sochaczew Bypass road / Poland



3. Selected examples of CCP utilisation

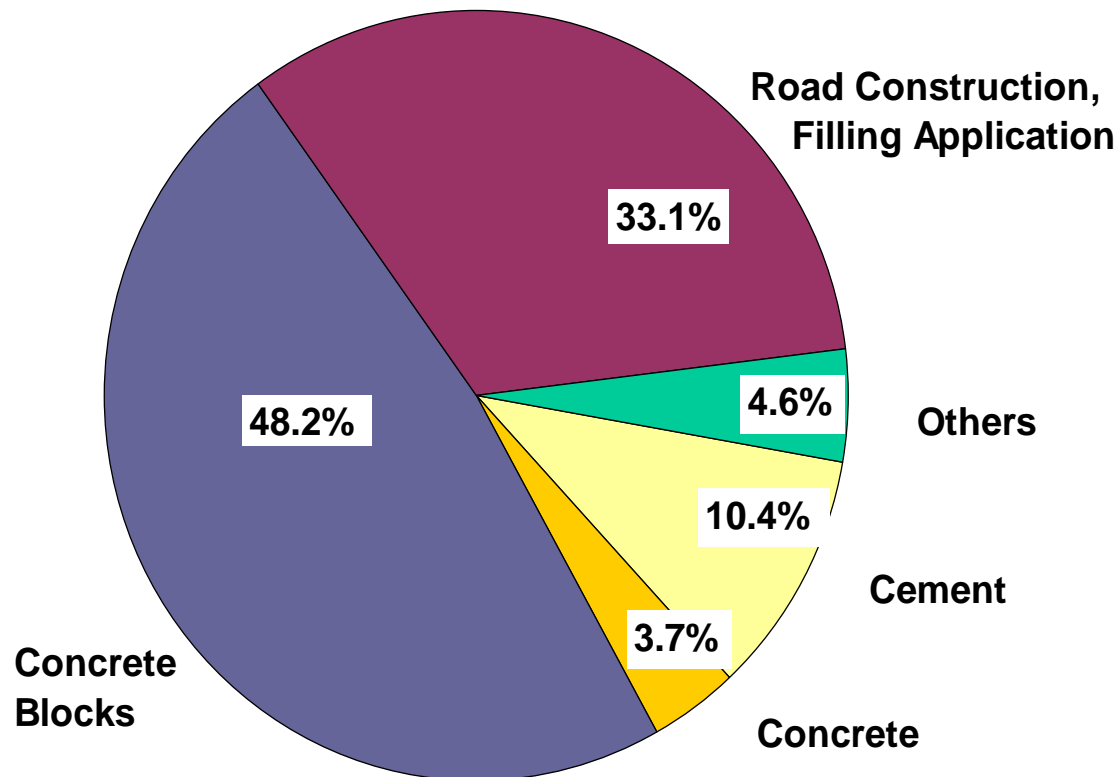


Filler in Asphalt

- stabilises the mixture
- increases the viscosity of the bituminous binder
- reduces sensitivity of the mixture to temperature
- improves adhesion of bitumen to the aggregates

3. Utilisation of CCPs

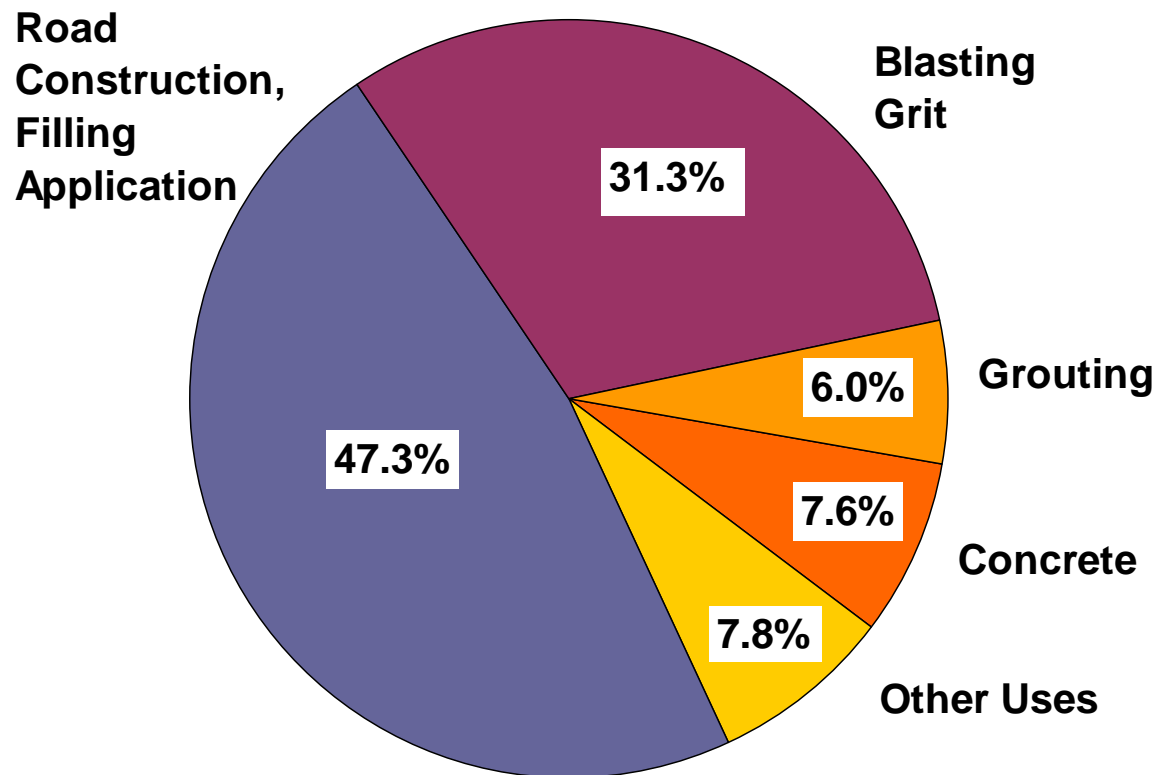
Utilisation of **bottom ash** in the construction industry and in underground mining in Europe (EU 15) in 2003



(total utilisation 2.7 million tonnes)

3. Selected examples of CCP utilisation

Utilisation of **Boiler Slag** in the construction industry and as blasting grit in Europe (EU 15) in 2003



(total utilisation 2.1 million tonnes)

3. Selected examples of CCP utilisation

Boiler Slag as a filling material for road construction



3. Selected examples of CCP utilisation



Use of processed
Boiler Slag
as blasting grit

4. Environmental benefits of CCP utilisation

Environmental considerations

- ▶ saving of natural resources
 - mining
 - processing
 - transport
 - ▶ reduction of energy demand
 - ▶ reduction of emissions (CO₂) needed for or result from manufacturing process of products which are replaced
- ▶ CCPs are fine grained raw materials
 - ▶ CO₂ reduction in
 - cement production (0.7 to 1.2 kg CO₂ per kg clinker, dep. on fuel)
 - concrete when fly ash is used as conc. add.
 - ▶ saving of drying energy when fly ash is used to dry wet raw materials

5. Conclusion (1)

- Coal will play an important role in future energy mix.
- About 480 million tonnes of Coal Combustion Products are produced in the world (estimate).
- In 2003, 65 million tonnes of CCPs were produced in Europe (EU 15).
- Including the 10 new EU member states the amount was increased to about 95 milion tonnes (EU-25) from 2004.

5. Conclusion (2)

- **CCPs are mainly utilized in building materials industry, in civil engineering, in road construction, for construction work in underground mining, for recultivation and restoration purposes.**
- **CCPs are produced to meet requirements for different fields of applications.**
- **Production and utilisation of CCPs is influenced by e.g. liberalization of electricity market, by European and national regulations and the construction market.**

5. Conclusion (3)

- **CCPs are used as a replacement for natural materials. Therefore, they contribute to sustainable development as they**
 - **avoid the need to quarry or mine natural resources,**
 - **help to reduce energy demand as well as emission to atmosphere during production**
 - **replace part of the cement in blended cement and concrete.**
- **CCPs will be available as valuable raw materials as coal will continue to play an important role as important source of primary energy.**

Thank you for your attention!

Hans-Joachim Feuerborn



European Coal Combustion Products Association



www.ecoba.org