Industry Reviews

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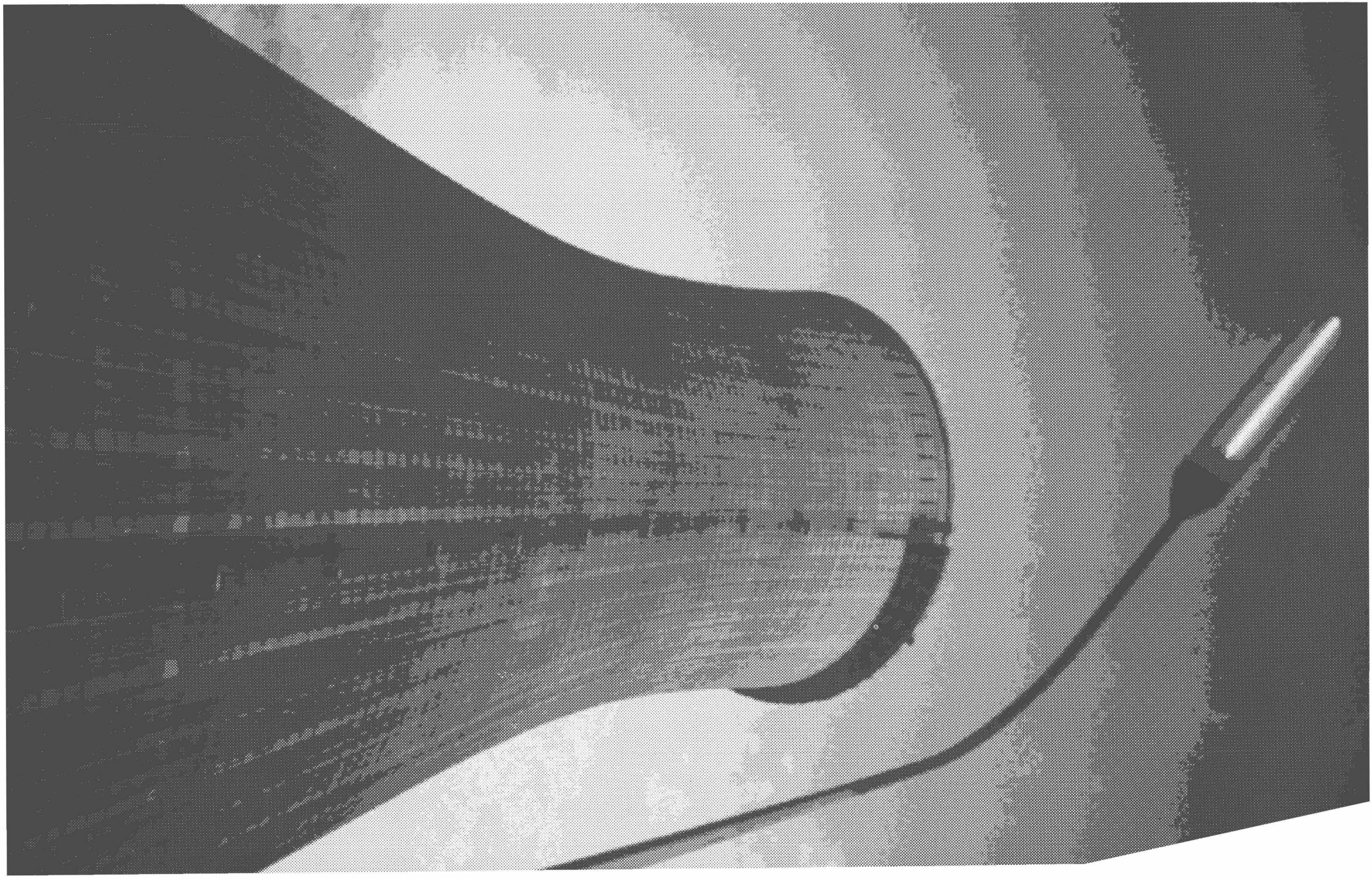
Energy



Energy

The energy policy laid down several years ago by the European Community is aimed at reducing its dependence on energy. The main objectives assigned to the energy sector for the 1985-1995 period were to: keep down the share of oil imports to one third of energy consumption, limit the demand for oil to 40% of total primary energy consumption, to improve energy efficiency by 20% and to increase the share of coal. This study assesses the validity of these objectives and the way in which they have been achieved or approached.

Also in 1990, the first measures relating to the establishment of an internal energy market were implemented, in response to a desire to increase competition between protagonists in the energy sector to the benefit of the consumer. The initial consequences were identified and the reactions of the protagonists outlined.

The production, conversion (oil refining, power stations) and utilisation of energy can be activities which cause pollution, more especially in the case of fossil fuel. It is therefore important that EC power supplies be implemented with minimum effect on the environment. This study reviews the R&D programmes and environmental protection policies adopted by the Community in order to achieve that aim.

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Table 1
Energy
Main indicators, 1980-90

(million toe)	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Final energy consumption	692.6	663.2	644.9	642.1	655.6	676.2	689.1	703.1	706.9	711.3	720
Gross inland consumption	1 036.7	1 002.5	980.0	965.1	990.9	1 029.4	1 043.8	1 062.6	1 061.8	1 098.4	1 100
Net exports	- 591.8	- 509.0	- 476.4	- 434.9	- 458.3	- 456.8	- 479.5	- 489.6	- 503.0	- 522.1	- 560
Primary production	479.0	503.6	513.6	537.5	533.7	589.0	600.5	600.8	589.0	575.5	580
Employment	2 016.9	2 055.0	2 025.9	2 014.9	1 967.1	1 914.9	1 870.4	1 796.9	1 755.5	1 725.4	N/A

(1) Excluding Portugal; employment figures are for energy and water.
Source: Eurostat (Sirene), GD XVII

Definition and structure of the energy industry

The energy industry covers the following sectors:

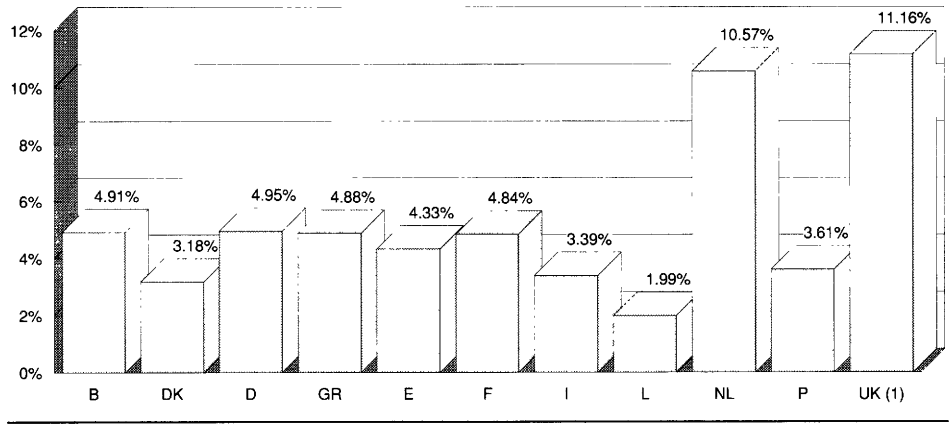
- extraction and briqueting of solid fuels (NACE 11);
- coke ovens (NACE 12);
- extraction of petroleum and natural gas (NACE 13);
- oil refining (NACE 14);
- the nuclear industry (NACE 15);
- production and distribution of gas, electricity, steam and hot water (NACE 16).

Although the forms of energy used are physically very different (automotive fuel, coal, electricity, etc.), they can be accounted for jointly. Their gross calorific value - the amount of heat that can be obtained from each form of energy - makes consolidation possible. All the energy forms are converted into a common unit. The tonne oil equivalent (TOE) is widely used, more especially for establishing Community energy balances.

Capability of substitution amongst forms of energy corresponds to this idea of energy compatibility: one and the same use, for example heat production in an industrial boiler, can be served by coal, oil products, natural gas or electricity. In such a case, one speaks of "competitive" use, as opposed to "specific uses".

Energy is produced (primary energy: coal, crude oil, natural gas,...), converted (refineries, power stations,....) and consumed. Differentiation is made between:

Figure 1
Energy
Share of the added value of the energy sector in the EC countries GNP, 1988



(1) 1987
Source: OSCE

Table 2
Energy
Main companies, situation 1989
(Turnover in million ECU)

Names	Activity	Country	Turnover	Employment
Royal Dutch Shell	oil	NL	78 300	135 000
British Petroleum	oil	UK	44 500	120 000
ENI	oil	I	24 900	83 000
Veba	oil	D	22 900	95 000
RWE	electricity	D	21 500	98 000
ELF Aquitaine	oil	F	21 500	72 000
Edf	electricity	F	21 100	121 800
The Electricity Council (1)	electricity	UK	18 800	130 000
Total CFP	oil	F	15 500	36 000
ENEL	electricity	I	15 100	113 000
INL	oil	E	14 000	151 400
British Gas	gas	UK	12 000	80 500
Rhurkohle	coal	D	11 400	124 800
Petrofina	oil	B	10 300	23 600
Repsol	oil	E	8 900	19 200

(1) company privatised in 1990
Source: Le Nouvel Economiste, Nov 1990

Table 3
Energy
Primary production by fuel type 1980-89

(1000 toe)	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Hard Coal	159 806	161 872	156 922	148 584	107 639	133 597	139 496	133 908	129 714	125 810
Lignite and peat	34 357	36 541	36 241	36 089	37 618	35 634	33 854	32 582	32 447	34 136
Crude oil	89 924	100 292	115 892	130 607	141 680	144 765	145 697	144 082	136 288	113 235
Primary petroleum products	2 392	2 486	3 755	4 737	5 546	5 860	6 239	5 725	4 591	4 214
Natural gas	129 265	125 236	115 984	119 940	119 952	127 117	124 565	129 101	120 177	125 268
Other fuels	1 660	1 397	1 593	1 833	1 562	1 664	1 660	2 169	2 160	2 684
Nuclear/geothermal heat	46 094	61 144	68 280	80 934	104 443	125 711	132 888	138 583	148 735	158 848
Electrical energy	15 388	14 642	14 905	14 772	15 042	14 581	14 246	15 189	16 520	11 287

Source: Eurostat (Sirene)

- final energy consumption, which merely consists of the energy used by end consumers;
- primary energy consumption, which takes into account losses along the whole of the energy chain (production, conversion, transport and distribution), as well as consumption by concerns within the energy sector.

Energy consumption in the EC countries is characterised by the presence of major companies, some of which with international standing (the big oil companies), whilst others are national or regional, often State-owned, or with large state holdings. Several are de jure or de facto monopolies, especially in the field of gas and electricity supply.

Level of attainment of 1985-1995 Community oil objectives

The first two objectives were:

- ❖ to keep the share of oil imports to one third of energy consumption;
- ❖ to limit the demand for oil to 40% of total primary consumption.

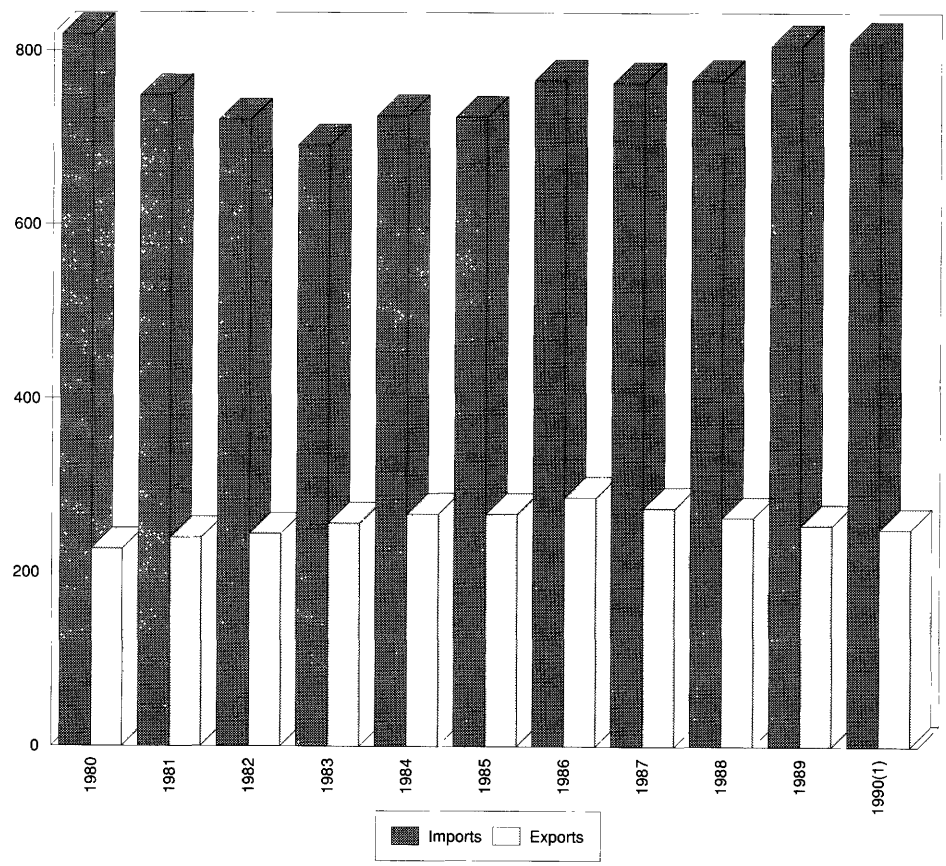
These objectives can be appraised simultaneously through production trends, external trade and energy consumption in respect of the Community.

Total production of energy within the EC has been on the decline since 1987. The main producer countries are the United Kingdom (oil, coal), the Netherlands (natural gas), the Federal Republic of Germany (coal and lignite), and Spain (coal and lignite).

The European Community shows a deficit balance. Net imports were 552 million TOE in 1989 i.e. 50% of gross internal consumption. Gross energy imports (from the Middle East for oil and principally the U.S.S.R. for gas) represented 7% of Community imports in 1989.

The fall in oil prices in 1986 brought about a substantial improvement in the EC trade balance of 61 billion ECU between 1982 and 1988, with a reduction in the deficit from 101 billion ECU in 1982 to 40 billion ECU in 1988. Other factors giving rise to this improvement are energy savings and low economic growth at the

Figure 2
Energy
EC external trade 1980-90



(1) Estimated
Source: Eurostat (Sirene), DG XVII

beginning of the 1980s.

In 1989 the increase - even though slight - of energy prices, combined with a renewed start-up of economic activity, led to a rapid increase in energy imports: the trade balance deficit shot up by 12 billion ECU, to 52 billion ECU (43 of which were for oil).

Some important changes have taken place in the trade structure of the EC during the past ten years. The share of Africa, Norway and the Soviet Union has increased significantly, whilst that of the Middle East dropped.

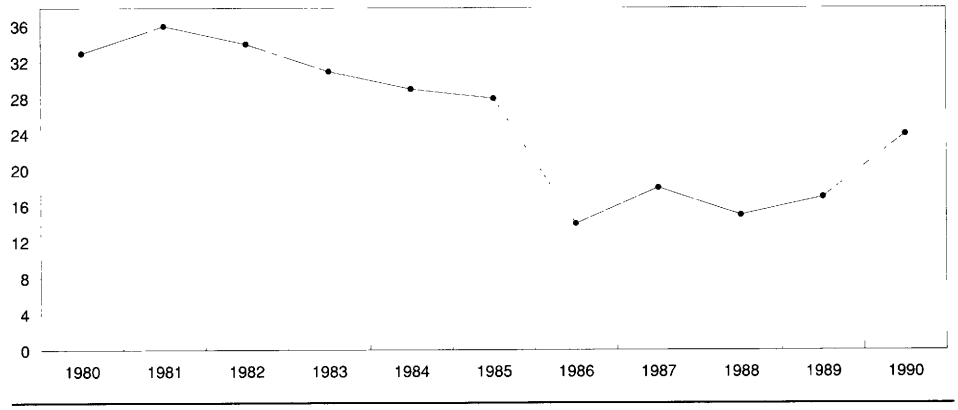
In 1989, the Middle East, with 195 million tonnes, still represented 42% of Community imports of crude oil, as against 29% for Africa and 20.6% for Eastern Europe. This share reached 46% in July 1990 before the outbreak of the Gulf crisis.

Gross energy imports represented 87 billion ECU (including 71 billion for oil) i.e. 7% of the total imports of the EC.

If we look at net crude oil imports alone (since the United Kingdom exports outside the EC), we see that the ratio of primary energy consumption in 1989 was 34%, in other words exactly coinciding with the target allocated to the sector. This indicator, however, has been on the decline since 1985, when oil represented less than 29% of total primary consumption. Furthermore, there are considerable disparities between the various countries.

The share of oil in primary energy consumption stabilised between 1985 and 1989, only decreasing from 44.9 to 44.8%, whereas the assigned target was 40%.

Figure 3
Energy
Oil price (US $ par baril)



Source: Sema Group Management Consultants

Table 4
Energy
Share of crude oil imports in total primary energy consumption

(%)	1980	1985	1987	1988	1989
Belgique/België	72.5	47.0	59.2	55.7	63.8
Danmark	31.6	21.6	16.4	17.8	17.7
BR Deutschland	38.8	24.3	23.9	26.5	25.0
Hellas	95.8	60.3	82.6	74.2	68.7
España	67.1	62.3	62.3	64.3	61.0
France	61.1	39.3	33.8	37.0	35.0
Ireland	25.2	14.3	15.8	14.6	16.9
Italia	69.1	55.3	55.5	54.4	54.0
Luxembourg	0.0	0.0	0.0	0.0	0.0
Nederland	77.1	63.3	72.3	78.3	76.6
Portugal	86.4	69.9	69.1	67.0	70.1
United Kingdom	3.5	-22.5	-19.1	-13.2	-0.5
Total EC	46.6	28.6	29.9	32.6	34.4

Source: Eurostat

Table 5
Energy
Share of crude oil in primary energy consumption

(%)	1980	1985	1987	1988	1989	1980-89
Belgique/België	49.7	40.1	41.7	41.7	40.1	-9.8
Danmark	66.3	57.1	52.7	53.4	52.9	-13.4
BR Deutschland	49.1	40.9	41.7	41.7	39.7	-9.4
Hellas	76.6	63.0	60.3	59.9	62.1	-14.5
España	70.6	54.2	54.5	55.3	52.5	-18.1
France	58.5	43.5	42.9	42.3	41.8	-16.7
Ireland	69.2	47.5	46.9	42.8	41.4	-27.8
Italia	69.1	60.7	61.2	61.0	60.9	-8.2
Luxembourg	30.3	33.9	42.9	42.4	43.3	+13.0
Nederland	44.7	34.0	36.0	37.4	36.7	-8.0
Portugal	86.7	81.7	75.4	73.6	78.8	-7.9
United Kingdom	39.7	38.0	35.9	37.7	36.9	-2.8
Total EC	54.0	44.9	44.8	45.3	44.8	-9.2

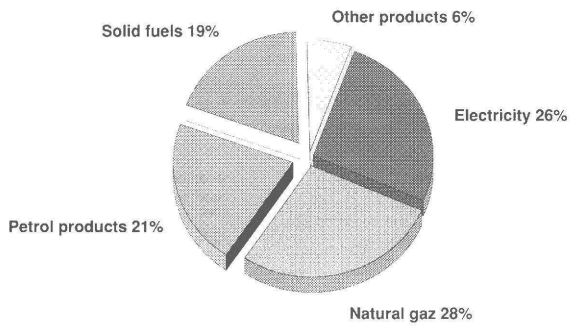
Source: Eurostat + ERA

Table 6
Evolution of the energy intensity in the EC by country (1)
(1985=100)

(%)	1980	1985	1986	1987	1988	1989	1989/85
Belgique/België	124	100	102	101	98	96	-4
Danmark	116	100	98	89	94	87	-13
BR Deutschland	111	100	97	93	87	83	-17
Hellas	92	100	98	103	106	111	11
España	108	100	98	95	100	100	0
France	103	100	97	93	87	83	-17
Irland	104	100	103	102	99	95	-5
Italia	110	100	99	101	89	100	0
Luxembourg	132	100	94	91	90	93	-7
Nederland	112	100	102	103	100	97	-3
Portugal	97	100	104	103	108	119	19
United Kingdom	108	100	99	95	91	90	-10
Total EC	105	100	99	97	84	93	-7

(1) Energy intensity equals to final energy consumption divided by GDP
Source: Eurostat

Figure 4
Energy
Share of the final energy consumption in the EC (by energy source), 1989



Source: Eurostat

Level of attainment of 1985-1995 Community objectives for energy efficiency

Energy intensity Energy intensity corresponds to how much energy is consumed (measured, for example, in tonne oil equivalents) corresponding to one unit of GDP (measured, for example, in million ECU).
It varies from country to country depending on the economic background, national resources used, policies pursued (energy prices and incentive measures) as well as the climate.

Between 1985 and 1989, GDP of the EC increased by 13%, gross energy consumption by 7%, and net consumption by 5%. Global energy intensity decreased by an average of 7% during that period, with the Federal Republic of Germany achieving the most significant result (-17%).
The reduction in energy intensity was therefore 50% of the target fixed for 1995 (20%).

Energy demand by sector Analysis of energy activity reveals three main user sectors:

- industry, corresponding to productive uses of energy;
- transport, consisting of transport of goods and people,
- the residential and service sector, within which the item "heating" plays an important part in temperate or cold countries.

Between 1973 and 1989, consumption in the EC industrial sector decreased by 10%. Today it represents 28% of final consumption. Consumption in the transport sector showed a notable increase (+72%) over the same period; it now represents 28% of total demand. Finally, the residential and service sector has remained stable (+1%) and represents 34% of consumption. The share of non-energy uses has also remained stable: 10% of final consumption.
These overall trends for each sector reflect certain far-reaching changes: the increase of useful energy supplied to the consumer is frequently offset by an improvement in energy efficiency thanks to the improved efficiency of user appliances.

Energy efficiency in industry Industrial consumption of energy fluctuated fairly perceptibly between 1980 and 1989. These shifts are largely explained by the evolution of the activity as a whole.
Energy-intensive industries such as iron and steel, chemicals, metallurgy and building materials, continue to dominate industrial energy consumption. However, energy consumption by the majority of these industries continued to fall during 1980-89, especially in respect of the iron and steel industry (-15%) and nonmetallic ores (-17%). The distribution of industrial energy consumption is uniform. In comparison with the situation in 1980, the sharp fall in oil products (-16%) has basically benefited natural gas (+7%) and electricity (+6%) respectively.

Energy efficiency within industry The improvement of energy efficiency within

Table 7
Energy
Final energy consumption by sector, 1973-89 (1)

(million toe)	1973	%	1980	%	1983	%	1986	%	1988	%	1989	%
Industry	247.9	35	227.0	32	186.4	29	189.4	27	197.5	28	221.1	28
Transport	128.2	18	153.6	22	155.6	24	172.5	25	187.9	26	220.8	28
Residential	264.9	37	265.8	38	252.6	38	275.4	39	263.0	37	268.4	34
Non-energy	70.3	10	60.0	8	57.4	9	63.5	9	67.4	9	75.1	10
Total	711.3	100	706.4	100	652.0	100	700.8	100	715.8	100	786.5	100

(1) EC10
Source: DG XVII, Eurostat (Sirene)

Table 8
Energy
Evolution of energy consumption by industrial sector 1980-89

(1000 toe)	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Iron and steel	61 281	58 399	52 138	49 000	52 928	54 890	49 799	48 973	50 543	51 196
Non-ferrous metals	9 726	9 102	10 431	8 778	10 520	11 107	10 774	9 559	9 679	9 721
Chemicals	41 234	40 089	38 054	39 074	38 221	36 644	37 976	43 332	42 911	42 759
Non-metallic minerals	36 346	31 702	32 661	29 406	29 574	28 236	28 729	29 036	29 898	30 141
Ore-extraction	2 818	2 485	2 462	2 551	2 512	2 378	2 380	2 246	2 203	2 141
Food, drink and tobacco	19 832	18 551	17 933	17 587	17 061	17 450	17 929	18 395	18 744	19 329
Textiles, leather	8 453	8 314	7 870	7 687	7 619	7 239	7 259	7 446	7 968	7 580
Paper, cardboard	11 696	10 890	10 780	10 532	10 793	10 149	10 748	11 193	11 627	12 180
Engineering	24 353	22 856	21 761	20 591	20 606	20 978	21 797	22 308	21 979	21 707
Other	19 067	15 127	13 342	16 158	14 394	14 448	17 859	20 378	20 422	20 421
Total (all sectors)	244 621	225 136	210 996	205 130	211 068	213 363	208 602	216 619	218 856	222 120

Source: DG XVII, Eurostat (Sirene)

Table 9
Energy
Evolution of the final energy consumption by fuel type 1980-89

(1000 toe)	1980	1983	1984	1985	1986	1987	1988	1989	%
Hard coal and patent fuel	10 889	13 961	14 852	18 727	16 668	17 411	18 333	18 507	6
Coke	28 494	24 238	26 443	27 125	24 166	21 559	22 788	22 733	10
Lignite, peat and derived products	1 695	2 028	2 156	2 236	1 903	1 798	1 833	2 139	1
Residual fuel oil	63 831	38 747	34 500	29 031	29 095	25 821	25 966	24 253	11
Other petroleum products	27 094	20 764	21 174	21 350	22 916	25 576	23 795	22 637	10
Natural gas	51 418	46 450	50 129	51 090	50 340	57 033	57 649	61 264	28
Derived gases	12 118	10 689	11 364	11 974	10 809	11 071	10 626	11 112	5
Derived heat	1 197	2 005	2 075	2 288	2 286	2 759	2 306	2 217	1
Electrical energy	47 885	46 248	48 375	49 542	50 452	52 784	55 515	57 222	26

Source: Eurostat (Sirene)

Table 10
Energy
Gross inland consumption by type of primary energy

(1000 toe)	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Hard coal (1)	202 477	201 016	197 217	192 477	180 743	200 591	196 111	196 854	193 327	195 583
Lignite and peat (1)	35 470	37 436	37 331	37 768	38 661	38 344	35 550	32 297	33 709	35 200
Crude oil (1)	551 364	505 693	482 425	467 364	472 281	462 816	474 290	476 581	487 305	491 648
Natural gas	171 073	167 749	160 334	167 487	176 634	184 699	186 843	198 287	192 539	201 444
Other fuels	1 660	1 397	1 593	1 833	1 562	1 664	1 660	2 169	2 160	2 684
Nuclear/geothermal heat	46 094	61 144	68 280	80 934	104 443	125 711	132 888	138 583	148 735	158 848
Electrical energy	16 647	16 666	16 549	16 748	16 579	15 764	15 037	16 779	18 289	12 987

(1) Including the balance of foreing trade and stock changes of derived products
Source: Eurostat (Sirene)

Table 11
Energy
Share of coal in total primary consumption (%)

Country	1985	1987	1988	1989
Belgique/België	22.7	19.1	19.1	20.5
Danmark	39.6	39.2	36.3	33.2
BR Deutschland	31.0	28.1	27.6	28.0
Hellas	34.8	37.4	38.2	36.3
España	28.0	24.0	19.8	22.7
France	12.6	9.4	9.1	9.6
Ireland	29.5	38.1	39.1	38.4
Italia	11.4	10.5	9.7	9.2
Luxembourg	45.5	34.5	34.8	33.2
Nederland	10.8	10.5	12.7	12.5
Portugal	6.5	14.4	15.4	16.3
United Kingdom	30.8	33.0	31.7	30.7
EC 12	23.2	21.8	21.0	21.0

Source: Eurostat

industry is characterised by several phases:

- The implementation of management and energy-saving measures. These measures were implemented early on, coupled with the initial increases in energy prices in the mid 1970s. They only required small investments.
- Investments instigated exclusively by improvements in energy performance. These were made later by the energy-intensive industries, mainly because their market prospects, which were mediocre at the end of the 1970s and beginning of the 1980s, did not encourage them to make any capacity-increasing forms of investments.
- Investments for which improved energy efficiency is only a partial consideration in decision-making processes, coupled with the need to increase capacity, improve product quality and reduce other operating costs.

At the end of the 1980s, the control of energy within the industry of the Community no longer appeared to be an aim in itself. It became secondary in relation to the choices of production and constraints of pollution prevention.

Action for sweeping improvements in energy efficiency will be relaunched in 1991 by virtue of the SAVE programme (Specific Action for Vigorous Energy efficiency).

This programme, which was presented by the Commission in the Spring of 1990, is based on an annual budget of around 7 to 8 million ECU and consists of 3 parts:

- regulatory measures: Directives could establish for example, minimum standards of energy performance for boilers, household electrical appliances and, possibly, motor vehicles if manufacturers do not arrive at a voluntary agreement in this respect. Standardisation of individual hot water meters in the collective residential sector is another objective of the programme;
- incentive measures: by means of aids to those active in energy control (engineering offices, design offices,...) in addition to existing forms of national aid, as well as by training campaigns concerned with energy audits;
- informative: setting up of a Community data bank for studying energy control.

Level of achievement of the 1985-95 Community objectives concerning coal penetration

The objective was to increase the share of coal in energy consumption.

The coal reserves of the EC expressed in production years are over 300 years based on the 1989 rate. Oil reserves are only 7 years and natural gas reserves, 19. However, as a result of the low competitivity of EC types of coal in relation to imported types of coal and the risks of pollution by CO_2, the share of coal has continued to decrease slowly up to 1990 (-2.3% as against 1989).

Coal versus natural gas Natural gas represented 5% of Community energy consumption 20 years ago. In 1989, this share was 18% and is on the up and up. In the Netherlands, gas already accounts for 50% of energy supplies.

Markets in which the share of natural gas could increase are as follows:

- ❖ electricity production (especially in view of the prospects of high energy output, combined-cycle power stations);
- ❖ the heat requirements of industry;
- ❖ the heating of domestic and service sector premises.

Natural gas offers certain advantages in comparison with oil and coal. In particular, its cost effectiveness compared with oil and its "environmental" attraction compared with coal (cf. Energy Council of 29th October 1990).

Its market price is starting to become less oil-dependent: in the United States, in the Autumn of 1990, the spot prices of gas did not follow the upturn in oil products. For the EC, even if supply contracts are frequently still linked to fuel-oil prices, this

index-linking only focuses on a certain proportion of the price, and long-term provision has been made which tends to soften the effects of sudden price changes of oil products. Furthermore, British Gas has succeeded in obtaining "cost plus" type contracts in the North Sea which safeguard it from oil market fluctuations.

Natural gas is the least pollutant of the fossil fuels in use: no emissions of sulphur dioxide (natural gas is desulphurised if necessary before transport and distribution); ease of adjustment of burners to limit emissions of nitrous oxide; the lowest rate in terms of carbon dioxide formation of any fuel (with the exception of hydrogen, which has not yet reached the commercial stage). Lastly, the extent of Community resources (especially if Norway, whose main outlet is the EC, is included) makes natural gas an attractive form of energy. Additional Community production (including Norway, but not including Eastern Europe), of 100/110 billion m^3/annum is technically possible (proven and recoverable reserves) for 10 years. Demand for natural gas could therefore increase at the rate of 5% per annum up to the year 2000.

Table 12
Energy price for final consumption, 1988 (8)

	France	D	UK	I	NL	in % (1)
Premium gazoline (2) (ECU/litre)	0.71	0.50	0.59	0.90	0.68	80.00
Diesel oil (ECU/litre) (2)	0.47	0.46	0.53	0.49	0.37	43.00
Ordinary heavy fuel oil (3) (ECU/ton.)	115.83	98.70	74.24	80.14	N/A	56.00
Natural gas (ECU/kWh)						
Industry sector (4)	0.0116	0.0137	0.0161	0.0094	0.0109	71.00
Domestic sector (5)	0.0431	0.0394	0.0298	0.0373	0.0258	67.00
Electricity (Ecu/kWh)						
Industry sector (6)	0.0556	0.0792	0.0737	0.0742	0.0574	42.00
Domestic sector (7)	0.0819	0.1105	0.0907	0.1479	0.0959	81.00

(1) Maximum spread (in p.c) between the lowest and the highest price (in % of the lower price)
(2) Situation mid'88 - in ECU - all inclusive (source CPDP)
(3) Averaged prices mid'88 in ECU all inclusive (source Elf). The national taxe was 26.62 in France, 7.34 in Germany, 6.62 in Italy and 11.94 in UK. The VAT was 18.13 in France, 12.08 in Germany, 6.47 in Italy and zero rated in UK (figures by fuels tonnes)
(4) Price net of VAT in ECU by Kwh for industrial users consuming an average of 10 million Kwh a year (source Energy Advice) situation mid'88. The french TICGN tax and other respective equivalent country taxes are included.
(5) Price in ECU by Kwh for domestic user consuming an average of 5000 Kwh a year; all-inclusive mid'88 (source: Energy Advice)
(6) Price in ECU VAT free (calculation based on the parity of buying power); situation early '88 (source UNIPEDE)
(7) Price in ECU all-inclusive (calculation based on the parity of buying power); situation early '88 (source UNIPEDE)
(8) Figures converted from FF into ECU at the January 91 rate
Source: Elf, CPDP, Observatoire de l'Energie, UNIPEDE, from Energie Internationale 90/91, Economica 1990

Completion of the internal energy market

Many obstacles stand in the way of competition between producers and distributors of the different forms of energy within the EC Member States. Presented in a report by the Commission in May 1988, they were accompanied by an action programme designed to eliminate these impediments. This strategy was approved by the Energy Council in November 1988.

The Commission is continuing its efforts to assess the effect of this increased competition, which should benefit the consumer.

By way of illustration, in 1990 the task force created for that purpose undertook, inter alia, the following studies:

- Financial soundness of energy production and transport companies (oil products, gas, electricity) and the foreseeable consequences of increased competition;
- Analysis of variants regarding free access to the mains electricity network;
- Diagnosis of the distribution of gas and electricity in the Member States;
- Principles of remuneration for applying to electricity "in transit";
- Opportunities for strengthening trans-Community mains electricity and natural gas networks and obstacles to the financing of these infrastructures.

In May 1990, two Directives were presented by the Commission:

- ❖ the "Price Transparency" Directive obliges each energy supplier to publish its prices;
- ❖ the "Transit" Directive obliges each Member State to allow the conveyance of territory of electricity of another Member State over its own territory.

A further Directive in the field of electricity, the "Free Access" Directive, will enable an intensive user (industry or distribution company) to purchase the energy it needs from a Community supplier, other than the network upon which it is physically dependent. This Directive is expected to be approved during 1991.

With regard to gas, the "Transit" and "Free Access" Directives, which certain operators objected to, should be able to be published in 1991, the Gulf crisis having added power to the elbow of the Commission by dint of the improved guarantee for supply which will result from these Directives.

Prices paid by European consumers in 5 EC member countries could vary:

- by 80% for automotive fuels or electricity;
- by 70% for natural gas supplied to industry.

It must be pointed out that the prices compared do not include VAT when it is

recoverable by the user. These important divergences originate from the real economic conditions of access to the resource or from the production costs (natural gas), and from the fiscal policies pursued by the Member States (oil products).

It is therefore assumed that if the first set of divergences can be reduced by means of increased competition, reduction of the disparities between the fiscal policies of the EC countries will be another key factor in the unification of the energy market already under way.

Support to Research and Development

The main paths of research and development in new energy technologies are:

- alternative energy such as solar (thermic and PV), wind, biomass, etc.;
- energy efficiency techniques to be applied to existing technologies;
- new nuclear energy technologies.

Ever since the first oil shock of 1973, both the EC and its Member States initiated programmes for research, development and demonstration (RD&D) of alternative energy technologies and energy efficiency.

The amount of resources allocated to this sector have varied considerably over time, depending on a number of factors, among which are varying world oil prices, national economic policies and the general state of the economy.

Recently, a new impulse to increase public resources for this sector has come from the environmental concerns caused by the role played by $C0_2$ in generating phenomena such as the greenhouse effect.

The EC supports the research and development of new energy technologies through the JOULE programme (which has a budget of 122 million ECU for the period 1989-1992), while it finances their promotion through appropriate demonstration programmes under the recently adopted THERMIE programme (350 million ECU for the 1990-1992 period). In addition, since 1986 the Community has been promoting indigenous energy resources in disadvantaged regions of its territory (VALOREN programme). Through such co-operative ventures the European Community has a broader, more comprehensive and integrated approach to the R&D of non-nuclear alternatives to fossil fuels compared to any single Member State.

Areas of EC involvement are:

- rational use of energy;
- renewable energies (mainly thermal and photovoltaic solar energy, biomass, geothermal energy, hydropower, wind energy);
- clean coal technologies and other solid fuels;
- oil and gas field exploitation, transport and storage.

Research aims at improving the efficiency and resistance of existing technologies, such as the energy yield of photovoltaic (PV) cells.

Member States's involvement in these sectors varies considerably according to each state and which technologies one looks at. In general, all the member states have programmes and organisations which deal with the rational use of energy and energy technology, although the budgets and priorities vary considerably. Thus, Denmark has an extensive programme to improve wind turbine techniques and promote their concrete application by households and companies through grants and tax incentives, and Germany has pilot programmes under way for promotion of photovoltaic and wind energy. Germany, Italy and the Netherlands are also involved in more advanced technologies, such as fuel cells.

The state of technology in alternative energies is still at the initial stage, to the point that the question of their large scale use and integration into existing energy systems is still remote for most countries. Denmark leads the way in the concrete application of alternative energy, with over 5% of its total electricity being generated by renewables. The United Kingdom is the only Member State where a specific legislative provision (the Electricity Act of 1989) requires that a portion of the electricity supply by national generators be generated by non-fossil sources, which could encourage greater industry interest in alternative energies. The impact of renewable technology on total energy output is still marginal. Technology in many cases still needs considerable developments to make these sources cheaper and profitable. In addition to "pure" technical research, other questions such as how to integrate the electricity produced by alternative sources into national grids need more technical and legal developments.

For nuclear technology the European Community supports R&D programmes aimed at:

1. developing advanced remote operating systems in the nuclear industry, with the aim of increasing security and improving waste management techniques, and
2. developing thermonuclear fusion technologies.

Following the Chernobyl disaster of 1986, several Member States have initiated programmes for safer and more advanced

nuclear fission technology, involving the development of "passive safety systems" to markedly reduce core fusion risks. In the United Kingdom, for instance, development is under way of an underground nuclear reactor where the core, steam generators and coolant pumps are all located inside one large vessel filled with water. Italy is working on developing a PIUS (Process Inherent Ultimate Safety) reactor, while Germany is working on a helium-cooled reactor.

Energy and the environment

Increasingly in Europe and worldwide, governments, companies and the public opinion are becoming aware of the environmental consequences of the planet's increasing energy requirements. Since the mid-eighties concerns for the worrying problem of acid rain have prompted the Community to take action to reduce the contents of nitrous oxides (NO_x) and sulphur dioxide ($S0_2$) in gaseous exhausts through appropriate directives setting limit values for such emissions.

More recently, scientific reports of possible global climate changes brought about by human activity have added further concerns over the state of the world environment. The gases responsible for the heating of the world's atmosphere (greenhouse effect) are carbon dioxide ($C0_2$), methane, CFCs and nitrous oxide. Substantial quantities of all these gases are released through human activity, and in particular energy generation is the single largest responsible cause for the release of greenhouse gases. International action to reduce emission of these gases intensified in 1990, and some important results were achieved:

- in May a revision of the Montreal protocol was signed banning all CFCs by the year 2000;
- in autumn on the occasion of the UN-sponsored Second World Climate Conference in Geneva most industrialised countries with the notable exception of the United States committed themselves to stabilise or sensibly reduce $C0_2$ emissions over the next 10 to 20 years.

In both these areas the European Community has taken a leading role, setting targets which are in general more ambitious than those of its leading industrial competitors.

As both acid rain and the greenhouse effect phenomenons are closely associated with the burning of fossil fuels, any decisive response to these problems will inevitably require reconsideration of present energy production and consumption patterns. Since present nuclear power technology does not represent the sole response to the problem (because of the environmental implications inherent in its use and the bad reception it receives in sections of public opinion), major questions arise on how to combine environmental needs with continuous industrial development.

The need for a coordinated approach to this issue is increasingly felt by EC governments, to the point that in 1990 the first combined energy-environment ministerial Council took place, precisely to discuss common problems and devise common strategies. A Community approach to the problem, as outlined by numerous documents from the Commission and the European Parliament, rests on two basic principles: on one hand, industry and households will have to improve the efficiency of their energy consumption, through a programme of rationalisation and reduction of waste. On the other hand, more efficient energy production techniques must be found - both by improving the efficiency of existing technologies and developing new energy sources such as solar or wind, or biomass. Thus, on the one hand the Commission must develop programmes to promote energy saving, while on the other the present RD&D programmes need to be pursued with vigour.

On the legislative level the Community has already started taking some first steps in this direction. In 1990 it agreed to repeal a 1975 Directive forbidding the use of natural gas in power stations, while at present the Commission is considering the introduction of some form of energy taxation aimed mainly at curbing $C0_2$ emissions. In addition to these important initiatives, an "Energy Charter" is being discussed by the Community with the countries of East and Central Europe (including the Soviet Union), aimed at devising common goals and providing integrated solutions to energy and environmental problems shared by all the countries of the continent.

The issue is gaining momentum, and will undoubtedly be the object of increased attention in the coming years.

Prospects

Given the unforseen knock-on effects of the Gulf war on the political and energy situations, previous projections for the period 1990-1995 pointed to:

- an increase in final consumption: + 5.6%;
- stabilisation of gross consumption;
- an equivalent drop in energy production: -1.7%.

A situation whereby oil is stabilised at a

high price at the beginning of the 1990s would have the following impact:

(1) An increase in final consumption lower than that stated in this forecast, or even a reduction, relating to:

- increased energy control efforts;
- an expected slowdown in general economic activity;

(2) A more than proportional fall-of in gross consumption, relating to:

- improved energy efficiency within the energy sector itself;
- substitutions in favour of forms of energy or technologies with enhanced conversion efficiency, such as combined cycle power stations.

Table 13
Energy
Forecasts 1989-95

(million toe)	1989	1990	1995
Final energy consumption	711	720	760
Gross inland consumption	1 098	1 100	1 100
Imports	807	810	810
Exports	255	250	260
Net exports	- 522	- 560	- 550
Primary production	576	580	570

(*) Excluding Portugal; employment figures are for energy and water.
Source: Eurostat (Sirene), DG XVII, Sema Group Management Consultants

(3) Little effect on production. In fact, the effects of relaunching hydrocarbon exploration and development, a factor which will undoubtedly lead to increases in this respect, will only start to be felt around 1995, bearing in mind the technical lead times involved.

Compiled by: Sema Group Management Consultants and European Reasearch Associates

Solid fuels

Solid fuels accounted for 21.2% of gross energy consumption and 28% of primary energy production in EC-12 in 1989. The corresponding figures for 1980 were 23 and 41%. Over the 1980-89 period, the contribution of solid fuels to EC primary energy production declined substantially, the decline being entirely attributable to hard coal, while the contribution of lignite was virtually stable.

Electricity generation in thermal power stations is by far the dominant outlet for solid fuels (some 63.8% of total hard coal consumption and up to 90% of lignite consumption). The second largest market is for the production of coke in coking plants; 90% of the coke produced is used by the steel industry. The industrial market is in third position. This sector has experienced encouraging growth in the use of solid fuels since the second oil crisis with, however, a drop since 1985 due to the collapse in oil and gas prices. The last-ranking market is the domestic sector, where solid fuel consumption has been declining since the 1960s. This decline is likely to continue. Imports of hard coal have been meeting an increasing proportion of the demand. In 1989, indigenous production of hard coal satisfied 65% of EC hard-coal requirements and employed some 300 000 people.

Definition of the sector

NACE 11 "solid fuels" covers not only hard coal (NACE 111) but also brown coal or lignite (NACE 112). Solid fuels or "coals" are usually classified according to their rank, i.e. their degree of maturity, which ranges from peat, the lowest rank, to lignite, bituminous coal and finally anthracite, the highest rank. Although reference will be made to the total contribution of solid fuels to the Community energy balance, the emphasis in the following pages will mainly be on hard coal.

Some details about lignite production and use are also to be found in the section on production.

Table 1
Solid fuels
Hard coals
Main indicators 1980-1990

(million tonnes)	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989(1)	1990(1)
Apparent consumption	341.1	336.1	334.8	309.2	258.7	313.9	320.4	311.1	308.0	310.1	301.2
Net exports	-80.8	-75.5	-78	-64.3	-85.8	-96.5	-92.5	-89.4	-93.4	-101.4	-101.4
Production	260.3	260.6	256.8	244.9	172.9	217.4	227.9	221.7	214.6	208.7	199.8
Employment (thousands)	599.7	582.6	567.9	537.9	504.3	464.4	420.8	378.4	367.0	322.0	300.0
of which, underground	387.1	381.7	369.8	356.4	331.4	311.4	282	255.3	232.2	211	188.9

(1) Estimated.
Source: Eurostat (Sirene)

Current situation

The proportion of EC primary energy consumption accounted for by solid fuels fell only slightly between 1980 and 1989, from 23.2 to 21.2%. However, the trends were very different across countries (see Table 2). The proportion of energy consumption represented by solid fuels ranged from 9 (France and Italy) to 40% (Ireland) in 1989, depending on the country.

In 1989, total production of hard coal reached 209 million tonnes and apparent consumption 310 million tonnes representing respectively an average annual decrease of 2.5% and 1.1% compared to 1980.

In seven of the twelve Member States, the proportion of solid fuels increased over the period 1980-89. However, over the same period, the share of solid fuels declined in the major coal-consuming countries, which are also the producing ones (United Kingdom, Federal Republic of Germany, France and Belgium). In Spain, which is also a producing country, the proportion of solid fuels increased between 1980 and 1985 but declined thereafter. The explanation for these developments is to be found in the fact that the five coal-producing countries also had, until recently, important nuclear power programmes under way whereas the other EC countries had either opted against nuclear energy, or slowed down their orders.

At any rate, recent developments in solid fuel consumption are at variance with the Community energy policy objectives adopted in 1986, which called for an increase in the contribution of solid fuels in meeting the Community energy requirements.

Table 2
Solid fuels
Share of solid fuels in gross domestic energy
Consumption by country

(%)	1980	1985	1986	1987	1988	1989
EC	23.2	22.8	22.3	21.8	21.1	21.2
Belgique/België	24.0	22.5	19.8	19.1	19.1	20.5
Danmark	30.6	39.6	38.5	39.2	38.5	34.1
BR Deutschland	30.6	29.6	29.6	28.1	27.6	28.3
Hellas	20.9	34.8	36.4	37.4	38.2	37.7
España	21.3	28.0	25.6	24.0	19.5	22.9
France	16.8	12.6	10.5	9.4	9.1	9.7
Ireland	20.7	29.5	34.6	38.1	39.1	40.4
Italia	8.6	11.4	10.6	10.5	9.7	9.3
Luxembourg	50.7	45.5	42.1	34.0	34.8	35.3
Nederland	6.3	10.8	10.2	10.5	12.7	12.1
Portugal	4.5	6.5	10.0	14.4	15.5	16.5
United Kingdom	35.0	30.8	31.8	33.0	31.9	30.8

Source: Eurostat (Sirene)

Consumption trends

Table 3 illustrates how the use of hard coal changed in the Community over the 1980-89 period, dropping from 331 million tonnes to 315 million tonnes. (i.e. by 0.5 per annum on average).

Amongst coal-using sectors, coke manufacturing performed worst, with a decline in hard-coal consumption of 25% between 1980 and 1989 (from 94 million tonnes to 70 million tonnes). The Community steel industry - like the coal industry - underwent a major crisis during this period. Community quotas were introduced in 1980 on the production and deliveries of certain categories of steel products, the production capacity was reduced by almost 20% between 1980 and 1986 and crude steel output fell by some 16 million tonnes over the same period.

In addition to declining steel production, development of electric arc furnace (EAF) based steelworks and technological improvements contributed to the reduction in coke consumption, and therefore in coal consumption in coke manufacturing.

EAF based steelworks took a noticeable share of the European market of low-grade long products, recycling significant quantities of scrap. ECSC forecasts show that one third of the European gross steel production will come out from EAF based steelworks in 1992. By definition this

production method does not require coke. Technological improvements aimed at reducing production costs resulted in particular in a reduction in specific coke consumption per tonne of pig iron produced in blast furnaces. The major technical change has been the wider use of pulverised coal injection (PCI) in blast furnaces, thereby reducing specific coke consumption: as a result of the PCI technology, there has been a partial substitution of coke by coal in the production of steel. The full potential for use of PCI in Europe has not yet been realised and there is, therefore, scope for further reduction in coke consumption.

The decrease by some 24 million tonnes (- 25%) in the use of hard coal in coking plants was - with the exception of the Netherlands (+ 1.0 million tonnes) - spread throughout the Community, but the Federal Republic of Germany, France and Italy were most severely affected with cuts of 12.8 million tonnes, 5.2 million tonnes and 2.1 million tonnes respectively over the 1980-89 period. Although the European steel industry has benefited from a welcome recovery over the last three years, no growth in coke manufacturing and consumption is expected over the next few years, given the process and technological changes discussed above.

In contrast, consumption of hard coal in power stations increased by 3.5% over the 1980-89 period, to a total of 201 million tonnes in 1989. Notwithstanding this growth in absolute terms, the contribution of hard coal to electricity generation declined over the period from 32.1 to 29%. This was due to the rapidly increasing contribution of nuclear energy to electricity generation, from 11.6% in 1980 to 35.6% in 1989.

Table 3
Solid fuels
Hard coal
Production, trade and consumption by sector, 1980-89

(million tonnes)	1980	1988	1989(1)
Production	260.3	214.6	208.7
Imports	97.7	104.6	111.8
Exports	16.9	11.2	10.4
Gross domestic consumption	330.9	311	315.2
Transformation, of which	293.3	269.3	272.9
Electric power stations	194.2	195.4	201
Coking plants	93.8	71.1	69.9
Final consumption, of which	36.1	42.3	42.8
Industrial	17	28	29.4
Domestic	18.9	14.2	13

Energy, N° 6-1990
(1)For 1989, estimation from SOEC, Monthly statistics.
Sources: Eurostat (Sirene)

The power-generating sector accounted to 63.8% of total hard coal consumption in 1989 (58.7% in 1980). This figure clearly indicates the critical role of the sector in determining the future of hard coal consumption. Between 1980 and 1989 the trend towards increased coal consumption in power stations was seen almost everywhere throughout the Community. France and, to a lesser extent, the United Kingdom were two notable exceptions to the general trend, with a total reduction of 14 and 10 million tonnes respectively. In contrast, hard coal consumption in this sector was broadly stable in Belgium, Denmark and Federal Republic of Germany and increased in all the other EC countries, in particular in Italy (+ 4.4 million tonnes), in the Netherlands (+ 5.5) and in Spain (+ 13.3). In addition, there were positive developments in Portugal and Ireland, where the use of coal in power stations was virtually non-existent in 1980.

The use of hard coal in the industrial market (excluding power stations and coking plants) gradually increased over the 1980-89 period, from 17 million tonnes in 1980 to 29.4 million tonnes in 1989. The industrial sector consists of a large number of small and medium-sized consumers from various industries, such as cement, chemicals, food, engineering, with varying energy requirements (motive power, high-temperature heat, low-temperature heat, etc...). Following the second oil crisis, which had shown the need to reduce Community dependence on imported oil and gas, as well as to diversify energy supply, there was a revival in industrial coal consumption, prompted in some cases by government incentives offered to companies switching from oil and gas to coal. European coal producers also offered programmes to encourage conversion to coal. However, growth in the industrial use of coal was relatively slow and limited to a few countries, except in the cement industry, where coal has a clear-cut advantage even without government incentives. Given the higher capital cost of coal installations, industry has an incentive to switch from oil and gas to coal only if the price differential is sufficiently large. Since the oil price collapse of 1986, conversion from oil and gas to coal has virtually disappeared. The last sector where significant quantities

of hard coal are consumed is the domestic sector, which includes households, services and administrative bodies (essentially for space heating). This sector consumed 13.3 million tonnes of coal in 1989 within the Community, compared with some 19 million tonnes in 1980. With the exception of Denmark and Ireland, which consumed 0.5 and 1.1 million tonnes respectively in 1989, deliveries of hard coal to individual households were again largely concentrated in the producing countries and notably in the United Kingdom where they amounted to 7.5 million tonnes in 1989. The declining consumption mentioned above is very likely to continue in the future, due mainly to the relative lack of convenience in the use of coal and the pressure from competing fuels.

Production trends

Hard Coal Hard coal is currently being mined in the Community in five countries (see Table 4). Belgium however is to cease production in 1992 at the latest.

Small amounts of coal are also produced in Portugal and Ireland. Total EC output amounted to 209 million tonnes in 1989, a slump of 52 million tonnes (20%) compared with 1980. The three largest coal-producing countries - the United Kingdom, the Federal Republic of Germany and Spain - together accounted for 93% of total output. With the exception of Spain (opening of new open-cast mines), production declined in all Members States, particularly the United Kingdom (30 million tonnes) and the Federal Republic of Germany (17 million tonnes).

The drastic reduction in European coal production since the 1960s was due to the growing competitive pressure from cheap hydrocarbons (in the 1960s and since 1986) and to competition from imported coal. Indeed, because of poor geological conditions, European coal is expensive to produce and the gap between European production costs and international coal prices has been widening over the years. The fact that European coal is mostly produced from deep underground mines, as opposed to open-cast mines, partly explains the higher production costs. Approximately 7% of the European coal output is extracted from surface mines, compared to 50% in Australia, 60% in the USA and 85% in Canada.

Coal is the most abundant fossil fuel in the world and in the Community. EC proven hard coal reserves were estimated at the end of 1988 at 70 billion tonnes, enough to last more than three centuries at the present rate of production. However, because of the progressive exhaustion of easily accessible deposits, the geological conditions now prevailing in the Community are such that production requires: working at very great depths (sometimes over 1 000 m); and heavy-duty, sophisticated equipment, both for technical and safety reasons. This has a major impact on production costs and on the financial situation of the mining industry.

Besides high production costs, several other factors contributed to the poor financial situation of the EC coal industry since 1985:

- the 1986 collapse in oil prices, which triggered a decline in world coal prices;
- the depreciation of the Dollar compared to European currencies, which made imported coal cheap in European currencies; as a result, the gap between imported coal prices and European production costs increased;
- competition from large quantities of coal available on world markets, at prices which sometimes did not cover all production costs.

Although this is not a sustainable position in the long run, and should be seen as a temporary phenomenon, it had the effect of seriously worsening the financial situation of the Community coalmining industry. Faced with increasing financial losses due to growing competition from imported energy, the European coal industry had to rationalise, closing the most uneconomic mines ("pits"), reducing the workforce and increasing productivity. The number of underground pits fell from 479 in 1980 to 326 in 1989 (EC-12). Total personnel was cut by half to 322 000 in 1989 (see Table 1). Over the 1980-89 period, productivity substantially increased: 52% in the underground output per man-hour in EC-10. These developments were made possible by major rationalisation programmes and restructuring investments.

Lignite The main indicators illustrate the position of the lignite industry in the Community.

Lignite (brown coal and black lignite as well as peat for Ireland) accounted for only 3.2% of Community primary energy consumption and 5.9% of Community primary energy production in 1989. As far as individual countries are concerned, however, lignite contributed significantly to the achievement of the Community energy objective of diversification away from oil. It accounted for 33.9% of primary energy consumption in Greece in 1989, 17.6% in Ireland, 8.4% in the Federal Republic of Germany and around 3.6% in Spain.

The main indicators below also show that, unlike hard coal, lignite is hardly traded at

Table 4
Solid fuels - Hard coal output by country, 1980-89

(million tonnes)	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
EC	260.3	260.6	256.8	244.9	172.9	217.4	227.9	221.7	214.6	208.7
Belgique/België	6.3	6.1	6.5	6.1	6.3	6.2	5.6	4.3	2.5	1.9
BR Deutschland	94.5	95.5	96.3	89.6	84.9	88.8	87.1	82.4	79.3	77.5
España	12.9	14.8	15.6	15.4	15.3	16.1	16.1	19.3	19	19.3
France	18.1	18.6	16.9	17	16.6	15.1	14.4	13.7	12.1	11.5
United Kingdom	128.2	125.3	121.4	116.4	49.5	90.8	104.6	101.6	101.4	98.3

Source: Eurostat (Sirene)

all internationally (2.3 million tonnes in 1989, traded exclusively between East Germany and the Federal Republic of Germany). Because of the low calorific value of lignite, transport over long distances would prove too expensive. Accordingly, lignite is, for the most part, mined and consumed (or transformed) on the site, in nearby power stations or briquetting plants. Lignite is mined in six countries, with the following output in 1989 (in round figures): Federal Republic of Germany (110 million tonnes), Greece (50 million tonnes), Spain (17.5 million tonnes), Ireland (7.2 million tonnes), France (2.1 million tonnes), and Italy (1.5 million tonnes). The three biggest producers accounted for over 90% of total output in 1989. Between 85 and 90% of total lignite output is burnt in power stations, the remainder being used for the manufacture of briquettes as well as (more recently) for the preparation of pulverised lignite for use in the industrial market.

Although total EC output was generally stable between 1980 and 1989, around 180/190 million tonnes/year, production trends varied across countries: production declined by 20 million tonnes in the Federal Republic of Germany, more than doubled in Greece (from 23 million tonnes to 50 million tonnes) and remained virtually stagnant in France and Italy.

Most of the lignite mined in the Community is by surface ("opencast" methods, which give good productivity and yield a fuel that is competitive with other fuels used for electricity generation.

The long-term prospects for lignite will mainly depend on developments in the electricity market. In its 1988 report on the "Main findings of the Commission's review of Member States' energy policies" (COM (88) 174 final), the Commission expects the EC production of lignite and peat to grow from 34 million tonnes of oil equivalent (toe) to 42 million toe in 1995, with most of the increase originating in Greece and Italy. The contribution of solid fuels in general to electricity generation should, on those EC assumptions, increase from 149 million toe in 1986 to 186 million toe in 1995.

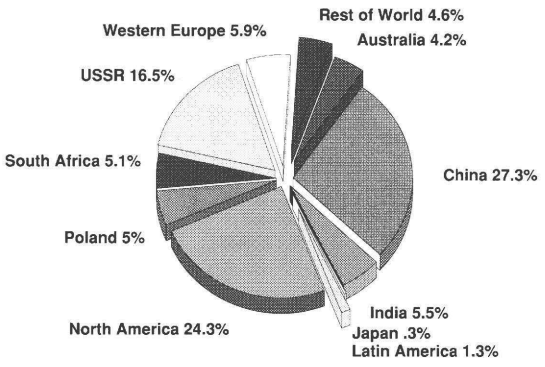
Trade

Indigenous coal production accounted for about 65% of gross coal consumption in 1989, the remainder being covered by imports. Over the 1980-89 period, intra-Community trade, mainly from the two largest producers, the Federal Republic of Germany and the United Kingdom, fell sharply from 17 to 8.5 million tonnes.

In 1989 Intra-community coal exchanges were practically stable (8.5 million tonnes against 8.6 million tonnes) as compared to 1988, after several years of decline.

Complete freedom in the movement of coal between Member States does not yet exist. In some countries, trade policy measures (such as autonomous national quotas with resulting mutual aid, or customs duties levied above certain tonnages on direct or indirect imports) remain an obstacle to free circulation. The Commission

Figure 1
Solid fuels
World hard coal production, 1989
(3.5 billion tonnes)



Source: Commission of the European Communities

Table 5
Solid fuels
Lignite
Main indicators 1980-1990

(million tonnes)	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989(1)	1990(1)
Apparent consumption	178.7	190.9	190.5	191.5	199.9	189.6	186	183	182	191.8	N/A
Net exports	-2.2	-2.8	-2.8	-3.0	-3.3	-2.7	-2.9	-2.4	-2.1	-2.3	N/A
Production	176.5	188.1	187.7	188.5	196.6	186.9	183.1	180.6	179.9	189.5	188.2

(1) Estimated.
Source: Eurostat (Sirene)

is examining these restrictions with a view to the Single Market.

In the meantime, however, extra-Community imports rose from 80 million tonnes in 1980 to 102 million tonnes in 1989.

Japan and Western Europe (especially the Community) are the two major hard coal importing areas in the world, accounting for more than 100 million tonnes each in 1989.

The world seaborne coal market although expanding over the period from 255 to 380 million tonnes, remains small, representing about 11% of world coal output.

By country of origin, almost three quarters (74%) of total extra-Community imports originated in 1989 from three countries only: the USA (40.4%), South Africa (20.2%), and Australia (13%).

In 1980, their total contribution was about the same although significant shifts among exporting countries occurred over the period. Already a leader on the European market in 1980 (with 31.6 million tonnes), the USA confirmed their role of "swing supplier" in 1989, exporting 41.2 million tonnes to the Community.

Deliveries from South Africa (the cheapest coal available) peaked in 1985 at 26 million tonnes and were then hit by the embargo decisions taken by France, Denmark and the Netherlands. As a result, they fell to 20.6 million tonnes in 1989. Australia rapidly increased its exports to 24 million tonnes in 1987 then turned back to other closer markets (Japan and South East Asia), so that its deliveries to the Community fell to 13 million tonnes in 1989.

Similarly, exports from Poland, which was the Community's third largest supplier in 1980 have been declining since 1984 (17 million tonnes) to 6.6 million tonnes only in 1989 and the future of those deliveries is highly uncertain.

The role of "newcomers" on the international coal market such as Columbia and China as reliable suppliers to the Community is progressively being confirmed (with 8.8 and 3.1 million tonnes respectively in 1989) although, in the case of the latter, massive internal demand is likely to limit considerably coal export possibilities.

France (22.6 Mt) and Italy (14.4 Mt) were in 1980 the major importing countries in the Community. Seven countries out of twelve imported more than 10 million tonnes in 1989 (Belgium, Denmark, Spain, France, Italy, Netherlands and United Kingdom). Indeed over the period, the trend towards increased imports was spread throughout the European Community, with the exception of France and the Federal Republic of Germany (where they dropped from 22.6 to 14.1 million tonnes and from 7.3 to 5.7 million tonnes respectively).

Imports of both steam (or thermal) and coking coal increased in the early 1980s. However, the bulk of the increase in imports was accounted for by steam coal to be delivered mainly to power stations, but also to the general industrial market.

Employment and productivity

The average yearly work-force employed underground was again reduced by nearly 22 000 people in 1989, after 23 000 jobs had already disappeared in 1988. More than half of this reduction again occurred in the U.K; British Coal's work-force has fallen from 220 000 in March 1985 to about 85 000 at present. The same trend exists in the other producing countries, though less marked, with the exception of Belgium where the movement is gaining momentum since the decision was taken to close the last mine by the end of 1992 at the latest.

In 1990 a new decrease in the work-force by nearly 22 000 people is foreseen, for the major part still in the UK.

Since the less productive mines are closed in the first place and underground preparatory work is reduced to a minimum in closing pits productivity increases.

At the Community level it increased indeed from 505 K, per man/hour in 1986, to 600 K, in 1989 (figures for Portugal not included). The most important productivity gains since 1986 were achieved in France: +38.2% and in the UK: +33%. No forecasts are available for 1990.

Capital expenditure

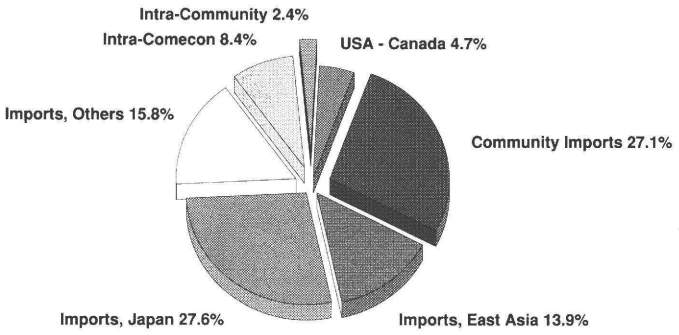
Capital expenditure has been engaged in

new coal mining technologies, the concentration of production in surface mines and in the opening up of new reserves, (United Kingdom and in the Federal Republic of Germany).

For 1989, capital expenditure (1367.8 million ECU) for the extraction and preparation of hard coal was 3.9% lower than the actual expenditures of the year before.

These investments are for 88% concentrated in three countries: the U.K with 48.1% (11.7% lower than in 1988), Germany with 25.3% (4.6% lower than the previous year) and Spain with 14.4% (35% higher than in 1988). Investments are decreasing substantially in France, and practically disappearing in Belgium and Portugal.

Figure 2
Solid fuels
World hard coal trade, 1989
(380 million tonnes)



Source: Commission of the European Communities

Research and development

Comprehensive research programmes are being carried out in the Community in the field of solid fuels, with the major objectives of:

- improving productivity in coal mines;
- improving safety and working conditions;
- opening up new markets for traditional and new products;
- protecting the environment and making solid fuels environmentally acceptable products.

The Treaty establishing the European Coal and Steel Community (ECSC) stipulates (Art. 55) that the High Authority shall promote technical and economic research relating to the production and increased use of coal and to occupational safety in the coal industry.

From 1959 onwards, the ECSC High Authority - and subsequently the Commission - granted financial aid to that end.

Although several programmes on health and safety in mines were successfully carried out over the period (also with the support of the ECSC), the emphasis below is mainly on technical research with its two key areas: mining technology and product upgrading.

Research in mining technology is concerned with improvement of roadway support techniques (with reference to ever-greater working depths), monitoring of ventilation, automatic steering of mining machines, new and safer transport systems for both personnel and materials. Important research efforts are also being made in the field of remote control, data processing and modern communication systems, which can contribute to increased safety and improved working conditions as well as to the optimisation of mining operations.

Product upgrading research is connected with coal preparation and handling as well as the coking of coal, with due consideration to improved environmental protection.

Both fundamental and applied research is being carried out by mining institutes, universities and laboratories, often on a joint - international - basis, and with ECSC financial support amounting to about 60% of total costs. In this context, total ECSC financial aid to coal research reached some 210 million ECU over the 1980-89 period, with a marked trend towards increased financial aid in recent years. For example, some 34 million ECU of ECSC aid will be spent in 1990 on coal research.

Interest grew after the first oil crisis in the conversion of hard coal and lignite into other energy forms as a way of avoiding excessive dependence on imported hydrocarbons. As a result, several pilot and demonstration programmes were launched by the Community in the following fields:

- gasification and liquefaction of solid fuels (including underground gasification);
- substitution of hydrocarbons by solid fuels with fluidised bed combustion, coal-liquid mixtures and combined cycles as key areas of research;
- utilisation of solid fuels within the framework of the EC R&D programme "JOULE" on non-nuclear energy and rational use of energy (1989-92);
- energy production from fossil fuels based on advanced technologies (notably combined cycles) within the recent "Framework programme" (1990-94);
- new or improved clean combustion methods for solid fuels, underground coal gasification and use, treatment or enhancement of wastes arising as a result of the use of solid fuels, within the new demonstration "Thermie" Programme

Table 6
Solid fuels
Hard coal
Output per man/hour underground

(kg per man/hour)	1988	1989(1)	1990(2)
EC	579	600	N/A
Belgique/België	334	321	369
BR Deutschland	630	645	660
España	333	328	340
France	534	590	N/A
United Kingdom	633	681	N/A

(1) Provisional
(2) Forecasts
Source: Commission of the European Communities

(European Technologies for Energy Management) which has been proposed by the Commission for the 1990-94 period - and still subject to formal adoption by the Council.

Environment

Like other fossil fuels, the production, transformation and use of solid fuels have an impact on the environment.

Hard coal and lignite being mainly used, as indicated earlier, for power and heat generation, environmental protection measures have always played a major role in these processes.

In particular, major efforts have been undertaken since the mid-1970s to reduce dust, sulphur dioxyde, and NOx emissions from coal and lignite-based power plants.

As a result of the flue gas desulphurisation (FGD) and NOx removal equipments, drastic reductions in the emissions of pollutants have already been achieved. Further improvements are expected in the medium term with the development of a large number of pilot plants using advanced technologies for clean coal utilisation.

It should be stressed at this stage that coal is often implicated as a major contributor to the increasing concentrations of some greenhouse gases, like CO_2 and methane. As compared to other fossil fuels, solid fuels do emit the highest amount of CO_2 per unit of energy.

In order to ensure that the future impact of greenhouse gas emissions from coal are minimised, it is important that wherever possible, the efficiency of coal utilisation is improved. During this century, the efficiency of coal-fire power generation has doubled due to technological improvements. Further efficiency gains are likely if the proposed combined cycle systems are developed and applied on a large scale. For such plants specific emissions of CO_2 could be reduced by a further 20% compared to conventional power generation equipment. The application of combined heat and power (CHP) plant offers the potential of reducing the specific emission of CO_2 by over 50%.

The further development and application of these technologies is a means of reducing greenhouse gas emissions while maintaining a balanced energy policy.

Table 7
Solid fuels - Investments in the coal industry
Coal extraction and preparation

(million ECU)	1988	1989()	1990(2)
EC	1 420.0	1 367.8	1 142.3
Belgique/België	11.7	2.7	N/A
BR Deutschland	362.8	346.0	257.0
España	155.4	209.8	169.7
France	58.7	41.4	36.9
Italia	40.5	67.6	68.1
Portugal	3.0	0.9	N/A
United Kingdom	791.9	699.4	610.6

(1) Provisional
(2) Forecasts
Source: Commission of the European Communities

Outlook

Though previous energy forecasts were frequently off the mark, there is growing recognition that solid fuels will have an important role to play in meeting future Community energy requirements.

This was confirmed by the Council in its 1986 resolution on the 1995 Community energy objectives. Against a background of continuing growth in economic and energy demand, but with limited potential for energy savings and renewables, the risks associated with imported oil and gas, and the uncertainty associated with the future acceptability of nuclear energy, an increased reliance on solid fuels is expected in the longer term.

This will particularly be the case for the power-station sector. Indeed the recent Conference on "Energy for a New Century" organised by the Commission clearly demonstrated that no significant growth in nuclear generation is to be expected in the EC in the next ten years. In addition, any increase in gas usage should fully take account of both the premium nature of the fuel and its limited availability. As a result, solid fuels consumption in power

Table 8
Solid fuels - Production forecasts for hard coal and lignite

(million tonnes)	1989	1990	1991/90	1992/91
Hard coal	208.7	199.8	-2%	-2%
Lignite	189.5	188.2	+1%	+1%

Source: Eurostat (Sirene) and Sema Group Management Consultants

generation will have to increase if the expected growth in electricity demand is to be met.

In the short term however, such an upward trend is not to be observed or at least not on the required scale.

Production of hard coals is expected to decrease from 209 000 tonnes in 1989 to 199 800 tonnes in 1990 and then by 2% in 1991 and 1992. In the meantime production of lignite is expected to decrease from 189 500 tonnes in 1989 to 188 200 tonnes in 1990 and then increase by 1% in 1991 and 1992.

Because of the very long lead times applying to the energy industry in general, this shows the need to develop and actually implement a coherent long-term policy. Indigenous and imported coal will therefore have to be combined in a reasonable way, providing an economically and strategically satisfactory overall supply of solid fuels to the Community as a whole. They will benefit from the introduction of the most modern clean coal technologies (such as fluidised bed combustion or combined cycle systems), supported by a major effort in R&D activities. This will contribute significantly to improving the environmental acceptability of the use of solid fuels.

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Reviewed by: Sema Group Management Consultants

Exploration and production of crude oil and natural gas

The United Kingdom and the Netherlands are the leading producers of hydrocarbons within the EC, accounting for a total production 80% and 71% of respectively. The Community imports 66% (in volume) of the whole of its consumption of hydrocarbons. Gas production should remain stable over the next few years, whereas an increase of 1.6% can be expected for oil production.

Current situation

Overall production of hydrocarbons (crude oil and natural gas) was estimated at 21 billion ECU in 1989, a 32% reduction in comparison with 1985. Net imports amounted to 38 million ECU i.e. a reduction of 38% over 1985.

Crude oil

Production Production of liquid hydrocarbons i.e. crude oil, condensates and other liquids resulting from gas-processing operations amounted to 115 million tonnes in 1989, i.e. a slight reduction compared to previous years.

The United Kingdom is the top producer within the Community, with 92 million tonnes of oil produced in 1989 i.e. 80% of the total production of the EC (table 2). Several platform incidents in 1988 and 1989, together with a fall-off in productivity of certain fields, resulted in a 20% drop in production between 1988 and 1989. Nevertheless, during the first few months of 1990, UK production increased, culminating in an annual rate of over 97 million tonnes.

In 1989, world production of oil amounted to 3 090 million tonnes, of which the EC produced 3.7% (table 3). The greater part of EC production originates from fields lying within the British continental shelf. Almost 90% of Community production is derived from offshore fields, which explains why the average price of Community oil is higher than that of countries with onshore resources. It is estimated that the average production cost of all the offshore fields of the United Kingdom at the end of 1987 was 13 US$ per barrel. With regard to the other EC countries, production costs vary between 9 and 15 US$ per barrel.

The knock-on effects of a possible increase in the world price of oil would be:

- the exploitation of fields incurring production costs which are considered to be prohibitive in the present situation. It would take a year to get these fields operational;
- a resumption of exploration activities. The impact of such a relaunch on EC production would be felt after 5 years.

Oil reserves World total reserves of oil increased from 73.2 billion tonnes in 1969 to 138 billion tonnes in 1989. The EC share is approximately 900 million tonnes i.e. 0.7% of the world total (figure 2).

In 1989, on the basis of proven oil reserves only, the remaining oil reserves over production, as expressed in the number of years at constant production, correspond to an average of six and a half

Table 1
Crude oil and natural gas
Main indicators, 1980-89

(million ECU)	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Apparent consumption	115 300	152 400	157 500	152 300	169 700	167 100	81 900	75 500	63 000	58 948
Net exports (1)	- 87 700	- 110 200	- 107 400	- 98 100	-105800	-100600	- 46 600	- 46 800	- 40 300	- 37 888
Production	27 600	42 200	50 100	54 200	63 900	66 500	35 300	28 700	22 700	21 060
Employment (2) (thousands)	N/A	N/A	N/A	N/A	110	110	100	94	95	95(3)

(1) Estimate based on BEICIP and BP Statistical Review
(2) Approximate
(3) Estimate Sema Group Management Consultants
Source: BEICIP, SEMA

years for the EC. Proven and probable reserves correspond to eleven years at the present rate of production.

Consumption In 1989, EC consumption was 511 million tonnes, which amounts to 16.5% of world oil consumption. The principal consumers are the Federal Republic of Germany, Italy, France and the United Kingdom (figure 3).

The EC therefore produces only 22% of the oil it consumes. It imports almost 78% of the volume consumed and its main suppliers are the Middle East (42%), North Africa (20%) and the USSR (17%) (figure 4). Table 4 enables the energy dependence of the members of the Community on the Middle East, our main supplier of oil, to be assessed. The Commission has calculated that cumulative imports of crude oil originating from Iraq and Kuwait in August 1990 represented 10.9% of the overall EC imports of crude oil i.e. 9.6% of Community consumption.

Natural gas

Production Production of natural gas in the Community amounted to 152.5 billion m^3 in 1989, or the oil equivalent of 128 million tonnes.

The Netherlands are the main producer within the Community, with 41% of total production. Onshore production accounts for 73% of the total and comes from the gas fields of Groningen, Leeuwarden, Wanneperven and De Wijk.

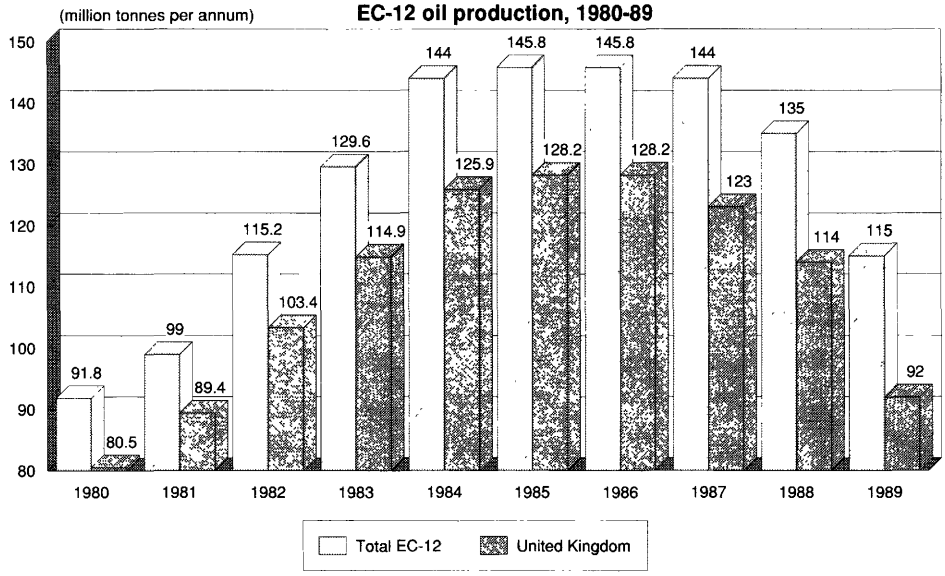
The United Kingdom is the second largest producer within the EC, with 30% of the total. The production of the other EC countries is shown in Table 5.

Gas reserves The proven reserves of the EC represent 2.8% of world reserves. They are basically concentrated in the Netherlands (56% of Community reserves), United Kingdom (19%), Italy (11%) and the Federal Republic of Germany (6%). From a strategic point of view, the EC can also take into account the large reserves of Norway (43%).

In 1989, the ratio of proven reserves to production corresponded to 20 years. However, an effort to exploit reserves falling within the "possible" category, especially in the British area of the North Sea, would eliminate any risk of dependence in terms of the energy supplies of the EC. In fact, the proven reserves of the United Kingdom are 500 billion m^3, whilst maximum reserves in the "possible" category are 1,800 billion m^3.

Consumption Between 1979 and 1989, world consumption of gas increased by 34%. In 1989, EC consumption represented 207.5 million tonne oil equivalents i.e. 12% of world consumption. In the past ten years, EC consumption has increased by 12%. Figure 6 indicates that the United Kingdom and the Federal Republic of Germany are the largest consumers within the Community.

Figure 1
Crude oil and natural gas
EC-12 oil production, 1980-89



Source: BP stastical review; Eurostat; Era calculations

Table 2
Crude Oil
EC oil production by country, 1989 (1)

	mill.t.	% of total	1988/89
Belgique/België/Luxembourg	0	0	0
Danmark	5.5	4	+16.8
BR Deutschland	3.8	3.5	-4.1
Hellas (1)	0.9	1	-18.8
España (1)	1.3	1.1	N/A
France	3.6	3	-2.7
Ireland	0	0	0
Italia	4.5	4	-6.4
Nederland (1)	3.7	3	-11%
Portugal	0	0	0
United Kingdom	91.9	80	-19.7
EC-12	115.2	100	-17%

(1) Include crude oil, shale oil and NGL (natural gas liquid - the liquid content of natural gas when this is recovered separately)
Excludes liquid fuel from other sources such as coal derivatives
Source: BP ; Eurostat ; ERA calculations

Table 3
Crude oil
World production, 1989
(million tonnes)

World Product (1)	Total	%	1988/89
North America	514	16.6	-6.1
Latin America	346	11.2	+0.7
CE+12	115	3.7	N/A
Rest of World	78.9	2.5	+30
USSR + East Europe	627.4	30.3	-2.7
Asia	280.3	9.1	+2.0
Africa	287	9.3	+7.9
Middle East	814	26.3	+10.3
Australia + New Zealand	26.5	0.8	-4.9
World	3 089.8	100	+1.7

Source: BP, Eurostat, ERA Calculations

Table 4
EC oil import by country, 1990

	Total Imports (mill.ton)	from (mill ton)	Iraq %	from (mill ton)	Kuwait %	Percentage of total import (Iraq + Kuwait)
Belgique/België	26.6	2.3	8.6	-	-	8.6
Danmark	5.0	-	-	2.7	54.0	54.0
BR Deutschland	51.4	0.4	0.8	0.7	1.4	2.2
Hellas	15.3	2.4	15.7	0.4	2.6	18.3
España	50.1	5.3	10.6	0.2	0.4	11.0
France	67.8	6.1	9.0	-	-	9.0
Ireland	0.07	-	-	-	-	-
Italia	78.1	6.3	8.1	2.4	3.1	11.2
Luxembourg	-	-	-	-	-	-
Nederland	47.1	4.9	10.4	6.5	13.8	18.7
Portugal	11.1	1.0	9.0	-	-	9.0
United Kingdom	45.3	1.7	3.8	0.2	0.4	4.2
Total CE	397,87	30,4	7,6	13,1	3,3	10,9

Source: Eurostat

In terms of trade within the Community, the Netherlands are the leading suppliers of gas vis-à-vis other members of the EC. In 1989, the EC produced 64% of the gas it consumed. It therefore had to import 36% of its consumption i.e: 71.64 million tonne oil equivalents, or 84.68 billion m^3 of gas. Table 7 shows that the USSR is the principal supplier of gas to the EC, responsible for 48% of the Community's imports. The other three supplying nations are Norway (32%), Algeria (18%) and Libya (2%).

Technological development

Important R&D programmes in this sector were based on the significant proportion of offshore operations in relation to total activity within the sector. The high price levels of crude oil which were maintened throughout the whole of 1985, also stimulated research in the field of enhanced recovery. Other programmes were aimed at improving the tools and operating efficiency of exploration and production, with a view to reducing costs. The majority of these programmes have produced excellent results and have, at least in 1985, generated significant growth in terms of services and equipment installation activities not only within the EC, but elsewhere in Europe and throughout the world. This branch of activity now plays an important role in the oil industry of the EC and lies in second place, behind the American sector, but is well ahead of other countries. Given the depth and operational environment in the North Sea, the Community oil companies, together with the services and equipment sectors have acquired unique experience of offshore operations. Furthermore, they continue to act as an international reference point in respect of certain oil field

peak technologies and practices. The following technical improvements have, inter alia, been achieved:

- the development of new systems for gathering, processing and interpreting geophysical data;
- the development of dynamically positioned drilling vessels, capable of operating at depths of 2 000 metres, and completion in the Adriatic of the first commercial horizontal drilling operation;
- the development of new platform concepts including tension leg platforms (TLPs) and floating production systems;
- the development of deep-diving techniques and submarine vessels for underwater activities;
- the implementation of pilot oil and gas enhanced recovery projects (injection of $C0_2$, polymers, etc.).

Other R&D programmes are under way within the above sectors, including the "Poseidon" programme, focusing on enhancing multiphase production and pumping technology in order to eliminate the need for costly support installations in offshore operations.

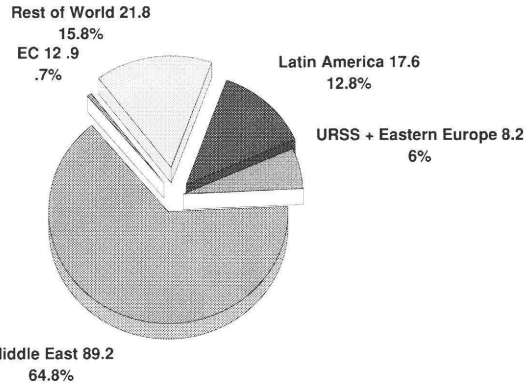
Structure of the industry

There has been less direct participation in oil operations on the part of governments. The privatisation of the British National Oil Company (BNOC) in 1981 signified a turning point in this respect.

There is currently growing competition to obtain exploration licences: increasingly smaller areas are being allocated to a growing number of companies, including small independent operators.

Despite this trend, which is particularly prevalent in exploration, certain major groups are continuing to play an important role in the sector of exploration and production

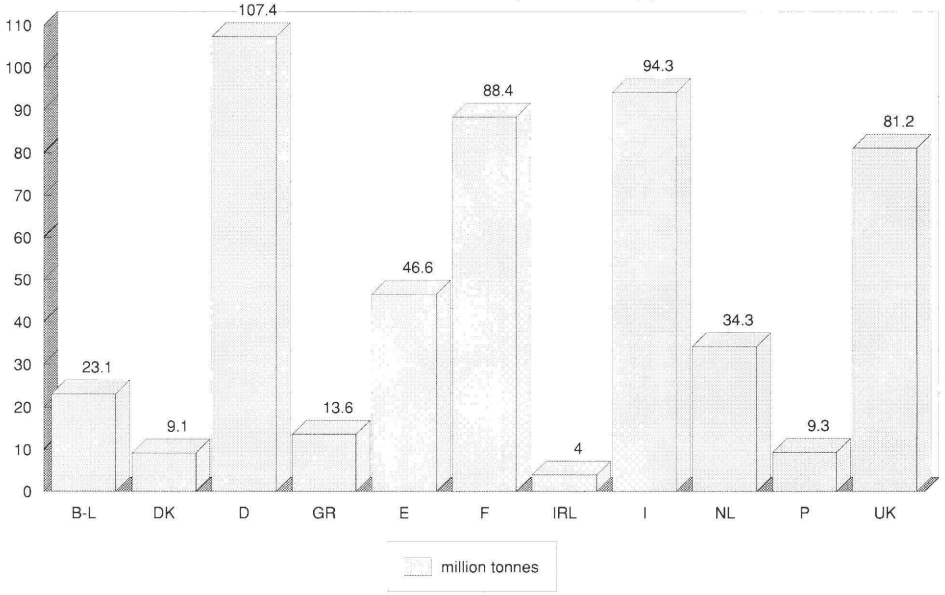
Figure 2
Total world oil reserve, 1989
(billion tonnes)



World reseve: 137.8

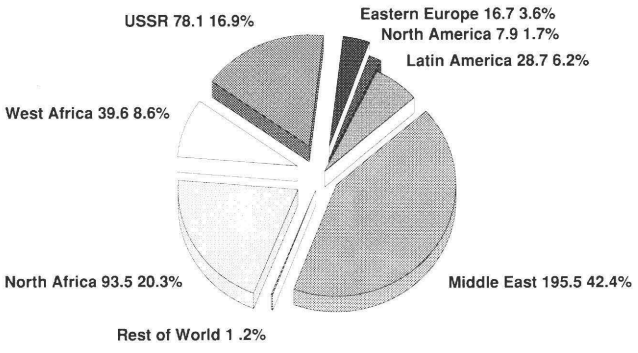
Source: BP statistical review + Eurostat + ERA calculations

Figure 3
EC-12 oil consumption, 1989 (1)



Total EC-12: 511.3
Total World: 3097.8
(1) Note: differences between world production and consumption are accounted for by stock changes, statistical differences and oil "destination not known"
Source: BP SR, Eurostat, ERA calculations

Figure 4
Origin of oil EC import, 1989 (1)
(million tonnes)



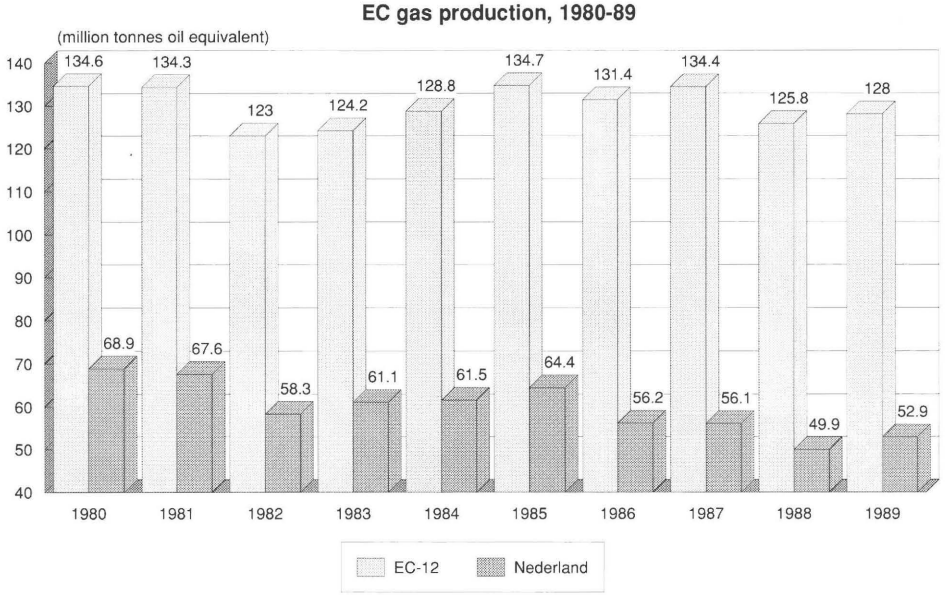
(1) Estimated
Source: BP statistical review, Eurostat, ERA calculations

Table 5
EC gas production in 1989, by country

(million tonnes oil equivalent)	1989	1988/89 (%)	%
Nederland	52.9	+6.2	41.3
United Kingdom	37.9	-3.4	29.6
Italia	15.3	+2.4	11.9
BR Deutschland	13.6	-3.5	10.6
France	2.6	-1.9	2.0
Danmark	2.5	+69.0	1.9
Ireland	1.91	+15.0	1.5
España (1)	1.37	+67.0	1.0
Hellas	0.13	+1.0	0.1
Belgique (1)	0.01	-21	0
Luxembourg	0	0	0
Portugal	0	0	0
EC-12	128.2	+2.4	100

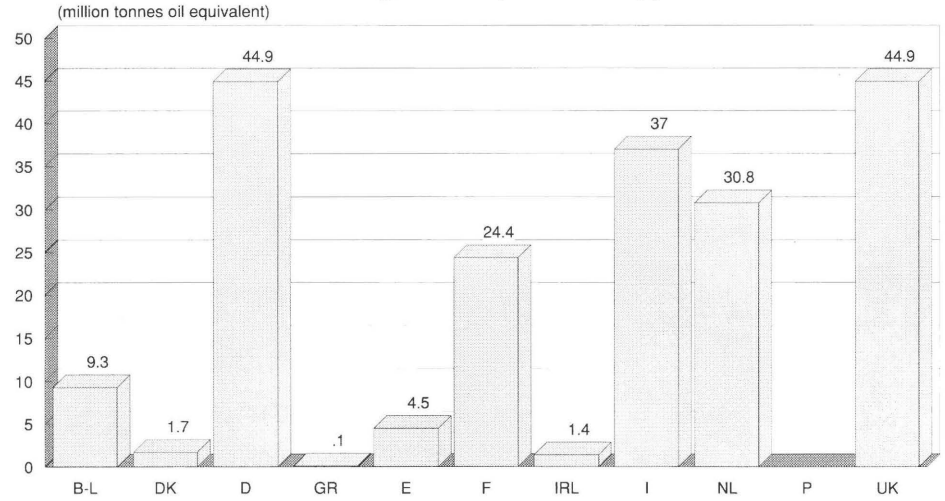
Source: BP statistical review, Eurostat, ERA

Figure 5
EC gas production, 1980-89



Source: BP statitical review, + ERA calculations

Figure 6
EC gas consumption in 1989 (1)



(1) Discrepancy between the consuption figures and production statistics includes gas consumed in field operation, material impurities and statistical measurement deviation.
Source: BP statitical review, Eurostat, ERA calculations

within the EC. These include Shell and Esso (more especially with their joint 50/50 ventures in the British area of the North Sea, in the Netherlands (NAM) and in the Federal Republic of Germany (BEB), and BP, with a "large slice of the action" in respect of the British area of the North Sea, as well as certain national oil companies such as ELF, DSM, AGIP and Repsol, which are deeply involved both in operations in their domestic base countries and throughout the rest of the EC. Countless other international and Community companies are also involved in exploration and production activities.

Table 8 shows the top eight oil companies in the EC. In 1988, the consolidated turnover of these companies was 264 billion ECU and they employed approximately 891 000 people. Recent changes in the activities of these companies are characterised by:

– An attempt to achieve an optimum size:

❖ the takeover of British "independents", frequently by companies of Community origin, has culminated in a certain concentration of exploration/operating licences;

❖ as borne out by the fact that some major companies have already abandoned exploration activities in certain countries (e.g. BP in France), there is a tendency to loose interest or withdraw completely if

Table 6
Natural gas
Intra EC trade, 1989
(billion m3)

Importing country	From NL	DK
Belgique/België	4.1	
BR Deutschland	18.8	0.5
France	4.3	
Italia	5.7	
Luxembourg	0.6	
EC-12	33.5	0.5

Source: BP statistical review, Eurostat, ERA

the critical size is not attained.

Employment

In 1985, employment in the sectors concerned with the exploration of oil and natural gas was estimated at over 200 000 people (including 100 000 to 120 000 in the United Kingdom alone, where indirect employment is three to four times higher than direct employment). Large reductions, of 30% to 35%, or more, were recorded following the cutbacks arising from the 1986 crisis. In 1989, overall employment within the sector was estimated at 95 000 people. The activities of exploration and production, including allied activities and spin-offs, play a major role within the EC in terms of the employment of highly skilled, experienced personnel.

Exploration and development

Between 1988 and 1989, the total number of wells drilled in the EC fell by 5%, from 807 to 769, reprensenting 1.45% of the world total (with the exception of Russia and the Eastern European countries).

The overall depth drilled corresponded to 2 300 km as against 57 500 km in the United States. Drillings in 1989 include 259 gas wells i.e: 34%. World averages are 47% and 19% respectively. Relatively-speaking, this illustrates how rich the EC is in natural gas (figure 7).

The offshore activities of the EC are concentrated in the North Sea. After a sharp fall-off in exploration activities in 1986, the number of exploration drillings started to increase, rivalling 1984-85 levels in 1989.

For two years now, based on higher oil price predictions, the world's major oil companies, have been investing increasingly large sums of money in operations and production. Figure 8 shows the increase in

Table 7
EC gas import 1989
(billion m3)

Importing country	From USSR	Norway	Algeria	Lybia	Total
Belgique/België	-	0.2	3.7	-	3.9
BR Deutschland	21.1	8.2	-	-	29.3
España	-	-	2.7	1.2	3.9
France	8.4	5.6	9.0	-	23
Italia	11.4	-	-	0.3	11.7
Nederland	-	2.3	-	-	2.3
United Kingdom	-	10.5	-	-	10.5
EC 12	40.9	26.8	15.4	1.5	84.6
%	48	32	18	2	100

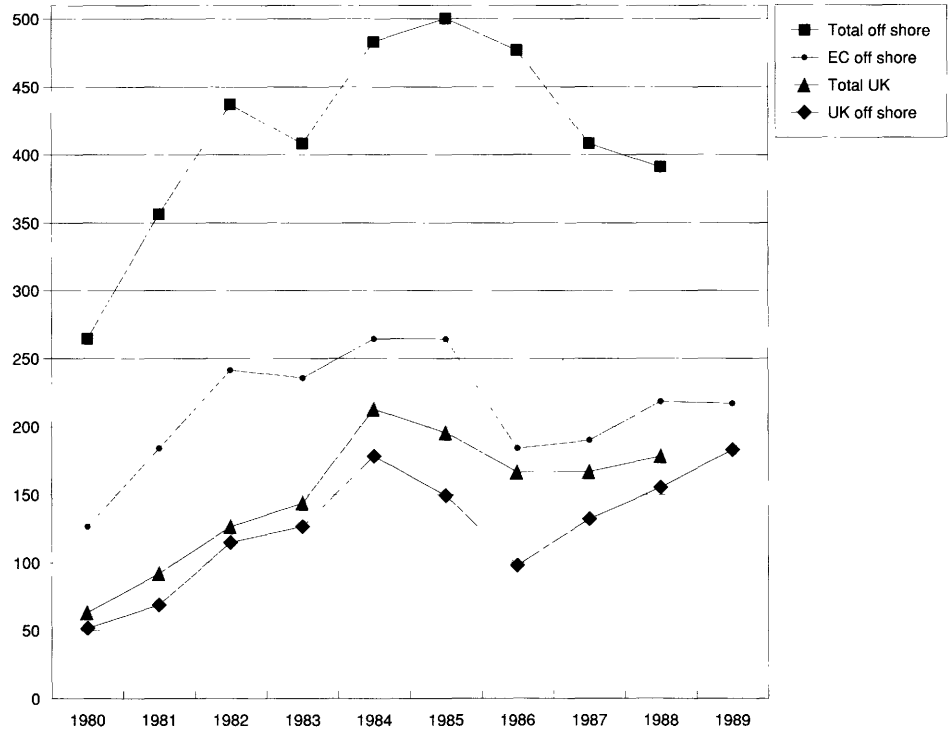
Source: BP statistical review, Eurostat, ERA

Table 8
Crude oil and natural gas
Leading European Firms in the petroleum industry, 1989

Enterprise	Country	Turnover (million ECU)	Employment (1988)
Royal Dutch Shell	NL	66 371	134 000
British Petroleum	UK	39 098	125 950
ENI	I	21 404	116 364
VEBA	D	20 594	84 715
Elf Aquitaine	F	17 953	72 200
Total CFP	F	11 858	41 862
Petrofina	B	11 232	23 900
Repsol	E	6 745	18 583

Source: Le Nouvel Economiste

Figure 7
Crude oil and natural gas
Prospective drills (1)
Number of wells drilled per year



(1) Includes evaluation drills
Source: BEICIP

Table 9
Crude oil and natural gas
Number of wells drilled, 1980-1989

(thousands)	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
EC	0.62	0.73	0.83	0.78	0.88	1	0.85	0.72	0.79	0.77
(%)	0.7	0.7	0.8	0.9	0.8	1.3	1.4	1.3	1.3	1.5
USA	64.8	80.6	79.5	67.1	83.6	69.7	39.4	34.5	33.7	31.8
(%)	76	82	80	77	78	72	66	60	55	60
World (1)	85.3	98.7	99.9	87.6	107.2	96.6	60.1	57.1	60.9	52.7
(%)	100	100	100	100	100	100	100	100	100	100

(1) USSR and East Europe countries not included
Source: BEICIP, CPDP

operating and production expenditure by the top six companies over the past five years.

Outlook

Production EC demand for oil should increase during the next few years by 0.8% per year. This increase in demand will basically originate from the sectors of transport (road and air) and the chemical industry. In contrast, the energy intensity of oil i.e: the correlation between the amount of oil consumed and G.N.P., should continue to decrease within the EC at a rate of 2% per year, due to energy saving policies and the increasing tendency to substitute oil by other, less pollutant, sources of energy.

.1990 oil production projections for the United Kingdom are between 85 and 110 million tonnes. Table 9 shows a production range forecast for the next few years. An increase in production is expected due to the envisaged increase in new exploration projects.

Providing there are no significant macro-economic upheavals, Community gas production should remain stable in the next few years. Growth in consumption should be around 1.2% per annum between 1990 and 1995 and peak at 1.6% per annum between 1995 and 2005. This phenomenon will be accompanied by corresponding increases in imports.

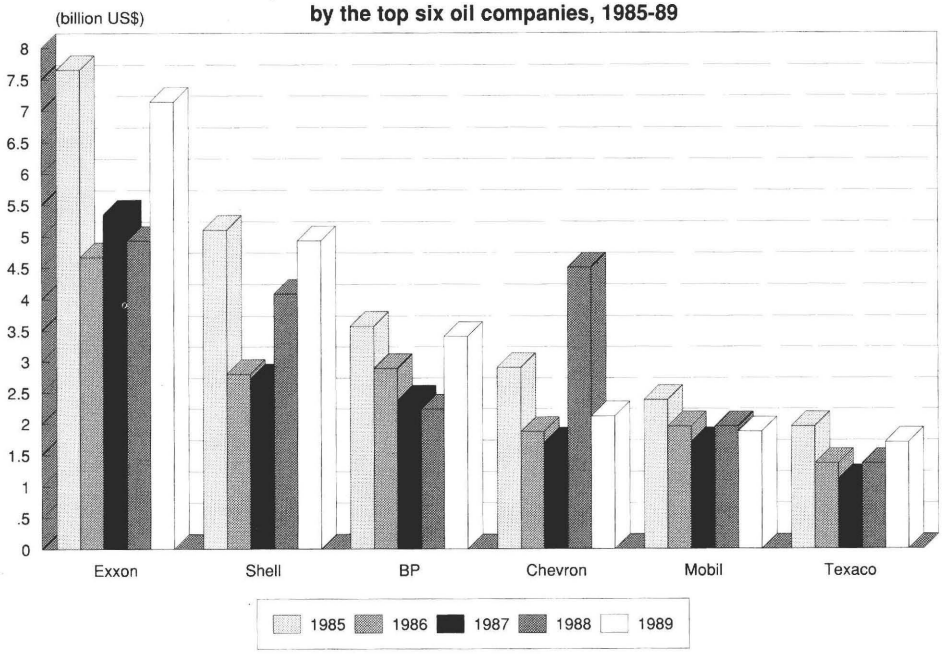
Table 10
Crude oil and natural gas
UK oil production range forecasts

	million tonnes
1990	85-110
1991	80-110
1992	80-110
1993	80-115
1994	80-120

Source: IEA

Strategy Heightened cooperation between the major companies and the governments of the oil and gas producer countries is expected, in order to create new markets and benefit from economies of scale. The alliance between BP and Statoil (the Norwegian national oil company) reflects this type of cooperation. The top companies will also increasingly seek joint ventures with the USSR, Venezuela and other major producer countries.

Figure 8
Crude oil and natural gas
Capital expenditure on exploration and production by the top six oil companies, 1985-89



Source: Petrochimical 1990

Written by: Sema Group Management Consultants
Revised by: European Research Associates

Refining and distribution of oil

The general situation in the refining industry has substantially improved since the period of crisis from 1975-1985. Refinery production remained stable in 1989. The Community is a net exporter of petrol and kerosene and a net importer of naphtha, fuel oil and heavy gas oil.

The chief exporters of refined petroleum products are the Netherlands, the United Kingdom and Belgium. In 1989, restructuring of the distribution network continued: the number of points of sale fell by 3% compared with the previous year.

The rate of substitution of leaded by unleaded fuels has accelerated.

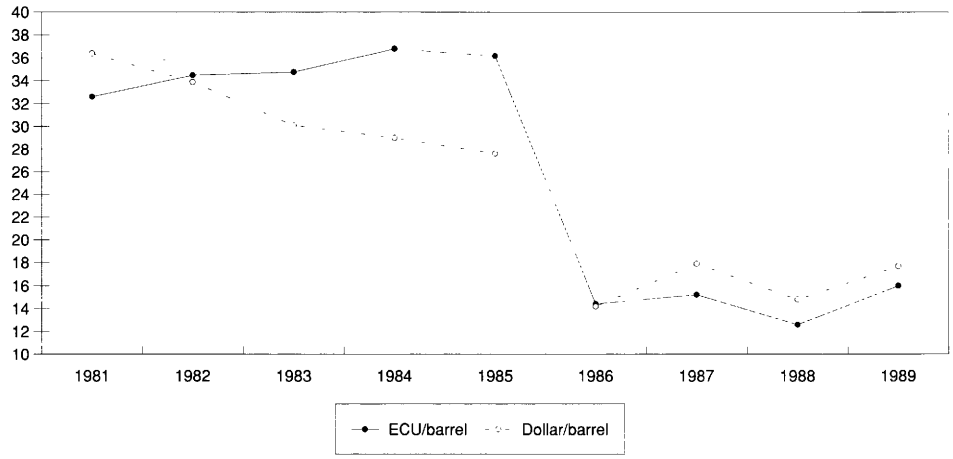
The petroleum market

Prices for crude oil and petroleum products Following the upward trend in the prices of crude oil caused by the two oil crises of 1973 and 1980, in turn aggravated by the continued rise in the value of the dollar during the period from the end of 1980 to early 1985, the situation underwent a radical turnaround in 1986. A crude oil surplus deeply depressed prices to around 8 dollars per barrel. The lowest point was reached in July 1986, the average for that year being 14 dollars per barrel. For the Community, the drop was further accentuated by the loss in the value of the dollar (cf. charts below). The fall in output by the OPEC countries and the return to the quota system for those countries led to a recovery in oil prices to a level of 18 dollars per barrel in early 1987. Following a period of relative stability, crude oil prices plummeted again to around 10-12 dollars per barrel at the end of October 1988 due to a huge surplus following the end of the Iran-Iraq war and to the difficulties of OPEC in agreeing on a production policy. The period from the end of 1988 to mid-1990 was marked by a series of price rises and falls: the conclusion of a production agreement within OPEC accompanied on the one hand by a strong world demand and cuts in production by certain non-OPEC members on the other (North Sea for example) brought about a recovery in prices which reached its climax (over 20 dollars per barrel) in April 1989. The resumption of production in the North Sea plus an over-production by OPEC countries reflected the precarious position of production quotas fixed for the second half of 1989 and caused the price per barrel to drop by 4-5 dollars in August. The excess of supply over demand was temporarily absorbed by a sustained demand that pushed the price of crude up until October, a situation further encouraged by the early arrival of a harsh winter in North America, with Brent crude topping 22 dollars per barrel in early January 1990. This situation did not last however, given the mild winter in Europe;

prices again collapsed to a level of 12-15 dollars per barrel by June, due to an overproduction that the OPEC members were unable to control. Following a gradual recovery in July the crisis which erupted in the Gulf helped Brent crude to break the 42 dollar per barrel barrier in September 1990.

In 1989 the rise in the value of the dollar throughout the first half of the year noticeably pushed up the price of crude as expressed in ECU; by contrast a substantially weaker dollar further accentuated the downturn during the latter months of the year and mitigated the price rises during the second half of 1989 to a certain extent.

Figure 1
Refining
Cost of EC Crude Oil Purchases, 1981-1989



Source: CPDP

Trends in the prices of petroleum products The prices of oil products whose general level has long been linked to that of crude nevertheless appear more volatile, first because of their increased sensitivity to the vicissitudes of the market due in particular to a greater number of operators, and second because of seasonal fluctuations in demand.

At international level: since 1985 variations in finished products have fairly faithfully reflected those of crude oil, both upward and downward. However a particularly strong seasonal demand for a product can break this parallel development: we need only mention the sudden rises in the price of petrol at the beginning of 1989 and fuel oil at the end of the same year, both due to the considerable demands of the American market.

Figure 2 traces the variations in the differentials of the main refined products compared with Brent crude; it shows that the prices for refined products, unlike those for crude oil, include freight costs which slightly exaggerate the difference. These trends in differentials have a direct influence on the profitability of refineries.

At Community level: Calculated in dollars per tonne, the costs of the Community's oil supplies closely parallel international quotations; the picture is different however, when they are expressed in ECU per tonne, the dollar factor being capable of accentuating an increase or decrease in the prices for products or to neutralise them.

Crude oil supplies

One fifth of the crude oil supplies to the Community come from within the EC itself (90% from the North Sea) and the remaining four fifths from third countries.

The table below shows developments from 1988 to 1989.

The following factors were typical of developments in the course of 1989:

1) In overall terms a drop of 17% in the production of Community crude was due primarily to a drop of 20% in UK North Sea production

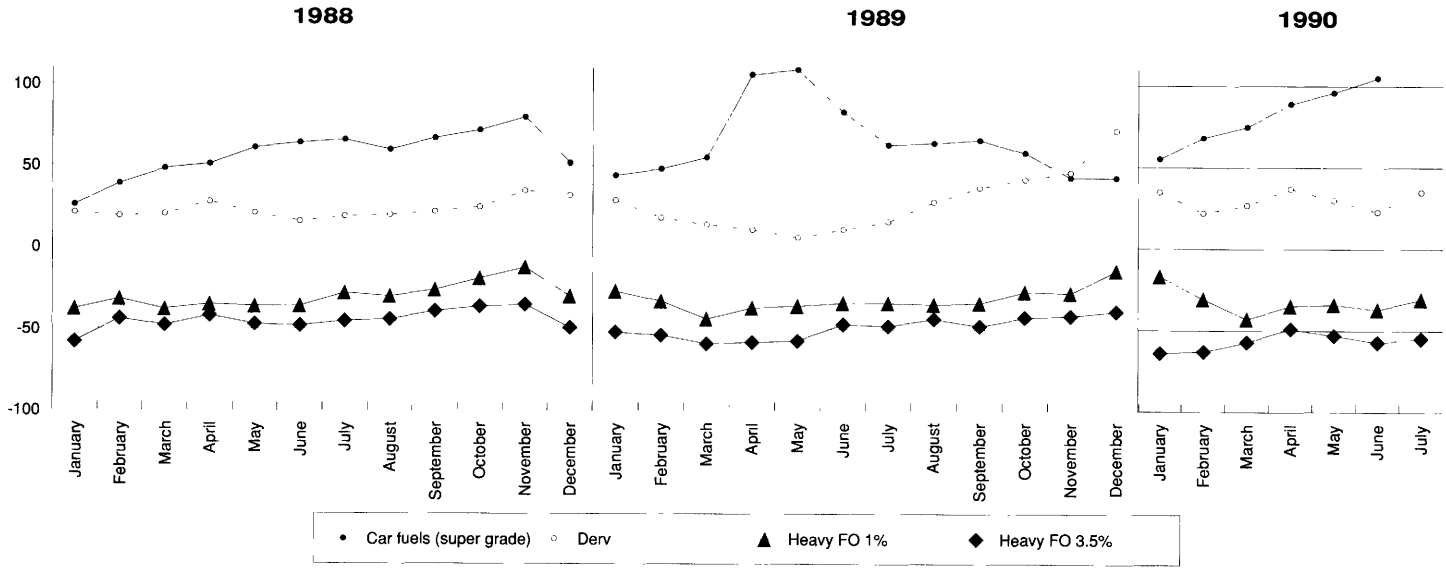
2) A slight increase in the total imports of crude and feedstocks for the Community: 431 million tonnes en 1989 or +7 million

Table 1
Refining
Main indicators, 1980-1989

(million tonnes)	1980	1981	1982	1983	1984	1985	1986	1987	1988	1990(1)
Gross Community consumption of petroleum products (4)	577.1	515.5	492.8	474.0	482.8	471.4	502.3	507.1	504.0	N/A
Net exports (2)	-12.7	-10.1	-22.0	-16.1	-42.4	-40.0	-31.2	-39.4	-22.2	-24.0
Production (3)	531.6	475.6	442.4	429.5	433.1	421.2	445.8	442.7	456.5	460.0
Employment (thousands)	157.9	149.5	151.6	145.4	144.0	140.0	126.6	122.2	120.4	118.6

(1) Includes consumptions of refineries and stocks
(2) Refined products, all destinations and sources
(3) Refinery: net production
(4) Estimated
Source: Eurostat (Sirene)

Figure 2
Refining
Trends in price differentials for refined products



Source: CPDP

tonnes (+1,8%) compared with 1988.

3) Near-stability in Community refining (+1%).

4) At the outset an appreciable slowdown in intra-Community imports (50 million tonnes in 1988, 35 in 1989), especially of UK oil, for the part of France and West Germany this was accompanied by a notable increase in imports from the Middle East (161 million tonnes in 1989 as against 140 in 1988).

5) Among the EC member countries the balance of foreign trade varied widely in terms of volume: the only country to achieve a balance was the United Kingdom with 50 million tonnes of imports and exports; all other members except Denmark are in broad deficit, with exports of crude oil being either very low or nil.

6) The total exports of crude oil by EC members, including intra-Community exchanges, would seem to be sharply downward (60 million tonnes in 1989 as against 80 in 1988) owing to the fall in UK exports (50 million tonnes compared with 72); Community exports to third countries only fell by 6 million tonnes.

Imports and exports of refined products

a) The total imports of refined products by EC members attained 169 million tonnes in 1989 which is 8 million tonnes (up +5%) more than in 1988. Intra-Community imports have hardly varied from year to year, remaining steady at around 79 million tonnes; growth has been solely in imports from third countries: 91 million tonnes in 1989 against 82 the year before. Statistics show that the OPEC countries accounted for 26 million tonnes in 1989 or 28% of total imports from outside the Community. Trends by country varied widely during 1989. This situation is indicated in the table below which highlights the total imports, imports from third countries and imports from within the Community itself: of particular significance is the rapid overall increase recorded in 1989 for Greece, Italy and Portugal.

The same table also shows the level in

Table 2
EC Oil Overview in Brief

(million tonnes)	1988	1989	Variations %
Production of crude oil and feedstocks (1)	134	112	-16.7
Total imports (crude and feedstocks)	424	431	1.8
of which ex third countries	374	396	6.1
Total exports (crude and feedstocks)	81	60	-25.6
of which ex third countries	31	25	-19.4
Refinery inputs	487	492	1.1

(1) Feedstocks: petroleum products that have undergone initial transformation and are used as feedstocks in the refinery. The residues from primary distillation sold to refineries with conversion resources are an example of this.
Source: Eurostat

Table 3
Refining
Imports and supplies of refined products in 1989

(million tonnes)	Imports total	Imports % 89/88	of which ex third countries total	of which ex third countries % 89/88	of which ex Community total	of which ex Community % 89/88	Total internal supplies total	Total internal supplies % 89/88
Belgique/België	11.9	5.2	2.8	48.6	9.2	77.0	17.2	-3.3
Danmark	4.1	-17.4	3.3	-11.1	0.8	19.0	8.4	-5.3
BR Deutschland	42.5	-5.4	15.0	-5.8	27.5	65.0	101.9	-7.0
Hellas	3.7	24.3	3.1	29.8	0.6	17.0	11.4	3.7
España	7.5	-3.5	6.0	0.7	1.5	20.0	40.4	6.0
France	23.1	6.0	11.3	11.7	11.8	51.0	80.4	3.5
Ireland	2.7	-4.4	0.1	-	2.6	97.0	3.7	1.1
Italia	21.6	15.3	17.2	9.1	4.4	20.0	85.5	4.1
Luxembourg	1.5	9.4	-	-	1.5	100.0	1.4	8.7
Nederland	38.1	10.8	27.3	20.5	10.8	28.0	19.7	-1.7
Portugal	3.6	87.0	0.8	98.0	2.8	78.0	11.3	26.0
United Kingdom	8.9	9.0	4.0	28.2	4.9	55.0	72.5	1.4
EC	169.2	5.0	90.8	10.9	78.4	46.0	453.8	0.7

Source: Eurostat

1989 of the internal market for all refined products, facilitating a comparison of the total or ex-third country imports with a country's total consumption.

For the Community, intra-Community imports represented 46% of the total and imports from third countries represented 54%, the split being obviously very different from country to country; imports from third countries in 1989 ranged from 0% for Luxembourg through to 22% for Portugal, 23% for Belgium and 80% for Spain, Italy and Denmark and 83% for Greece.

b) In 1989 total exports by Community members attained 145 million tonnes which was 4% (or +6 million tonnes) up on 1988. In descending order of importance the principal exporters of refined oil products in 1989 were as follows:

Table 4
1989
Refining
Principal exporters of refined oil products

(million tonnes)	Exports total%	89/88
Nederland	57.8	6.7
United Kingdom	17.4	2.9
Belgique/België	15.8	10.4
Italia	12.5	-8.1
France	11.7	1.7
España	11.5	-8.4
BR Deutschland	7.2	12.7
Hellas	5.1	1.00

Source: Eurostat

c) For 1989 the corrected net balance of Community members is illustrated in Figure 3. This is subject to the difficulties of interpretation posed by the problems of feedstocks - partly grouped under imports of refined products - and allowing for adjustments carried out afterwards by some member countries.

The countries with the largest deficits are broadly the same as the year before: West Germany (-25.9 million tonnes), France (-12.8) and Italy (-9.1). The Netherlands (+19.7) and to a lesser extent the United Kingdom (+8.6), Belgium (+4.7) and Spain (+4.0) continued to enjoy a surplus.

Compared with the volume of consumption inside the country, the net deficit balance on foreign trade represented 25% of consumption in Germany, 16% in France and 11% in Italy; the net surplus represented 27% of Belgian consumption, 10% of Spanish, 12% of British and 100% of Dutch.

Consumption of petroleum products

Table 5 contains the figures per product of each of the EC members in 1989 and the change over 1988. This relates solely to the domestic market and does not take account of marine stocks or refinery consumption.

Overall consumption of petroleum products in the Community which had increased slightly over the previous three years (rising from 427 million tonnes in 1985 to 453 million tonnes in 1988) remained stable in 1989, with growth in some countries (Greece, France, Italy, Portugal, United Kingdom) offsetting a reduction of consumption in others (Belgium, Denmark, Germany, Spain).

In terms of individual products we note at Community level a slight growth in car fuels (due to the sharp increases recorded in Spain, Portugal and Greece), a slight drop in the gas oil/FO sector (vehicles and heating) despite an increase in vehicle consumption (representing approximately half of the total and increasing from 6 to 7%) and finally a growth of 3.5% in the requirement for heavy fuel oils in France, Portugal and Greece (exceptional demands by power stations).

A single feature typical of developments in the economy of the Community in 1989, is

that trends compared with 1988 showed very little movement in most sectors: overall consumption hardly changed, refinery output remained steady as did the net foreign trade balance; only the production of crude oil shows any substantial variation (-17%) over the previous year, and this was due to a number of incidents in the North Sea.

Trends in consumer prices

The consumer prices ruling in the member countries vary widely, as Tables 7, 8 and 9 show, due to the diversity in the levels of taxation on the one hand and existing differences between the pricing systems on the other. Differences between the prices before tax are far less marked.

Refining

Changes of ownership In 1989 and the first half of 1990 important changes came about in the structure of the oil refining industry within the European Community. Three changes of ownership again signalled further withdrawals from the EC market by oil companies chiefly based in the United States.

In Germany the refinery at Burghausen in Bavaria was sold by the Marathon group to the Oesterreichische Mineralöl-Verwaltung (ÖMV). In Italy the group constituted by Mobil Italiana (with a refinery in Naples and a network of over 2 300 service stations) was bought by the Kuwait Petroleum Cy, whose Italian subsidiary now occupies third place on the Italian market after AGIP and Esso Italiana.

In the UK Amoco sold its 70% stake in the Milford Haven refinery and its distribution network to the Elf-Aquitaine group.

Elsewhere, in Spain, under the partial privatisation scheme of the publicly-owned Repsol group, the latter acquired the 33% holding of the Mexican Pemex company in Petronord SA, which owns the Bilbao refinery. In return Pemex now have an interest in Repsol's capital.

Finally, and more recently, the Elf-Aquitaine group has acquired a 20% holding in the Spanish oil and petrochemical group CEPSA, in which IPIC (International Petroleum Investment Corporation), a body based in the United Arab Emirates, acquired a 10% holding in 1988 following an increase in the company's share capital.

Changes in State monopolies The process of change in State monopolies is currently ongoing in three countries: Greece, Spain and Portugal. In Greece the State monopoly on supplies to the domestic market has been or is about to be effectively abolished. However there are still a number of measures - financial, pricing and the commitment of stocks - that are intended to ensure the priority of supplies to the domestic market by local refineries. The Spanish government has pursued its policy of relaxing the monopoly by adopting fresh measures such as access to the retail market for heating oils and the distribution of heavy fuel oils as well as the complete lifting of restrictions on trade in lubricants; at the same time, prices and the tax system have been modified: the Renta of the Monopoly has been abolished, consumer taxes have been streamlined and a maximum price system has been introduced. Other new provisions could well benefit petrol stations and infrastructures.

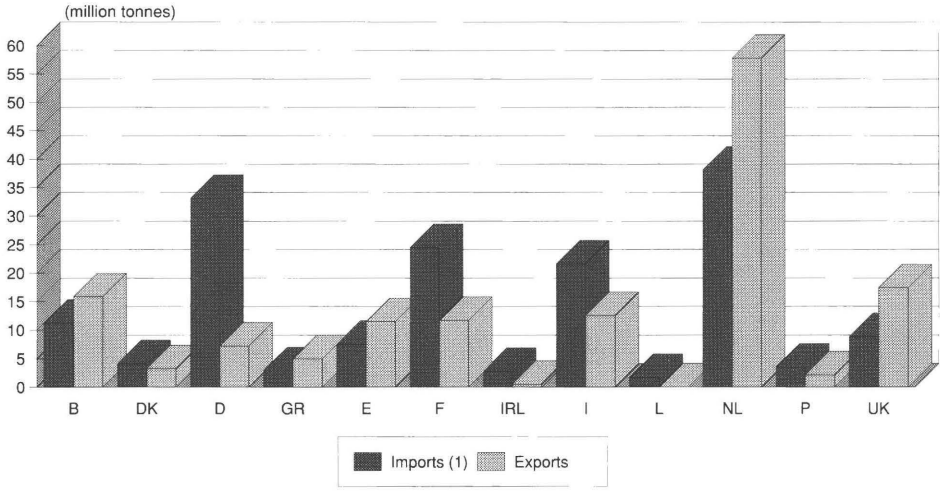
In Portugal a reform on the tax system for oil products is under consideration with a view to harmonisation in line with Community non-discrimination rules.

Technical developments in refining

a) Latest reductions in distillation capacity

The capacity for primary distillation underwent a drastic reduction over the past decade. Since 1980 the decrease has been in the order of 35%, more than anywhere else in the world. The wave of closures has now passed however, although a number of shut-downs by individual refineries, particularly in the south of the Community, cannot be ruled out if the heavy fuel oil market continues to shrink.

Figure 3
Refining
Exchanges of refined products by country, 1989



Total EC imports: 159.5
Total EC exports: 145.0

(1) Includes transfers made by some EC members between crude oil, condensates and refined products which accounts for the difference from Table 3.
Source: Eurostat

Table 5
Refining
Consumption of petroleum products in the EC, 1989

	TOTAL		Distribution by product							
(million tonnes)	All products	% 89/88	LPG	% 89/88	motor fuel	% 89/88	Heating GO/FO	% 89/88	Heavy FO	% 89/88
Belgique/België	18.7	-2.4	0.5	1.2	3.3	-0.2	8.9	-1.4	2.3	-10.8
Danmark	8.1	-4.6	0.1	-14.3	1.5	-1.1	4.2	-5.6	1.0	-14.0
BR Deutschland	103.3	-6.8	2.5	2.9	26.0	-0.2	45.6	-13.5	6.7	-16.5
Hellas	11.4	3.9	N/A	N/A	2.3	8.7	4.6	6.9	2.9	9.2
España	39.6	-3.6	2.4	-7.5	7.9	6.8	14.2	3.5	7.1	-12.8
France	80.8	4.1	2.8	-2.1	18.5	-2.1	33.5	2.9	7.5	17.4
Ireland	3.7	1.1	N/A	N/A	0.9	3.9	1.5	6.5	0.7	-11.6
Italia	85.5	4.1	3.2	5.2	12.9	3.8	27.0	0.2	27.9	10.0
Nederland	18.3	-2.1	2.4	-2.6	3.4	1.9	5.6	6.1	0.4	25.7
Portugal	10.1	17.6	N/A	N/A	1.3	9.0	2.5	5.6	4.5	86.5
United Kingdom	73.0	2.1	1.9	-1.0	23.9	2.9	19.8	2.1	9.7	-5.3
EC	452.5	-0.1	N/A	N/A	101.8	1.6	167.5	-2.8	70.7	3.5

Source: National Statistics

Table 6
Refining and distribution of oil
Main indicators 1989

(millions of tonnes)	1989 tonnes	Change over 1988/1989 %
Production of crude oil and feedstocks	112	-16.7
Imports of crude oil and feedstocks	431	1.8
Net production of refineries	460	0.7
Total imports of refined products (1)	169	5.0
Total exports of refined products (1)	145	4.1
Foreign trade balance of refined products (2)	-15	5.8
Total supplies on domestic markets	454	0.7
Marine reserves	31	-2.6

(1) Includes intra-community exchanges
(2) This balance includes adjustments by certain EC members for transfers between products and feedstocks
Source: Eurostat

Developments in EC countries during the last three years and in comparison with 1980 are shown in Table 10.

The reduction in 1989 over 1988 is attributable to Germany and France and is chiefly due to:

- the closure of the refinery at Mannheim (3.5 million tonnes/year) which was operated by Wintershall A.G., a subsidiary of the BASF chemicals group;
- the provisional shut-down - for an indefinite period - of distillation units (5.8 mil-

Table 7
Developments in selling prices including tax of petroleum products
(Mean monthly value)
(ECU/m3 for super and diesel, ECU/t before VAT for heavy fuel oil)

		B	DK	D	GR	E	F	IRL	I	L	NL	P	UK
Super leaded	1988 Dec	557	821	492	445	548	689	757	885	480	677	691	570
	1989 Dec	639	845	605	480	601	727	808	938	508	711	729	547
	1990 May	682	798	599	544	616	740	792	948	520	731	717	593
Hgv derv	1988 Dec	366	545	436	217	407	455	646	481	299	356	429	518
	1989 Dec	601	810	531	454	571	714	787	906	457	681	718	512
	1990 May	462	545	447	247	460	479	665	609	328	433	464	536
Heating oil	1988 Dec	149	489	165	217	237	264	206	454	166	240	N/A	165
	1989 Dec	225	558	269	200	266	324	264	553	213	323	N/A	198
	1990 May	167	500	194	247	273	286	222	573	189	263	N/A	161
Heavy fuel oil	1988 Dec	71	345	95	140	99	88	101	75	78	120	129	95
	1989 Dec	113	383	123	129	123	127	136	137	117	151	140	119
	1990 May	84	352	97	119	100	94	107	120	94	122	138	93

N.B.: The prices are not subject to control in Germany, Denmark, France, the Netherlands or the United Kingdom, they are subject to state controls in the other countries.
Source: EC Petroleum Bulletin

Table 8
Amount of taxes specific to petroleum products
(value May 1990)
(in ECU/hl for super and diesel, ECU/t for heavy fuel oil - normal usage)

	B	DK	D	GR	E	F	IRL	I	L	NL	P	UK
Super leaded	327.8	419.0	318.3	229.0	323.3	456.2	398.2	581.2	235.7	384.1	447.6	301.2
Unleaded 95	293.5	318.3	419.0	N/D	323.3	404.3	376.1	539.2	212.0	351.2	447.6	261.2
Hgv derv	191.7	226.2	217.5	95.3	205.2	234.8	292.7	326.9	101.8	175.7	216.8	254.9
Heating oil	0.0	226.2	28.5	95.3	72.3	60.5	48.9	326.9	0.0	53.6	0.0	15.8
Heavy fuel oil	0.0	254.5	14.7	46.4	13.1	19.7	10.1	53.3	2.4	20.7	26.5	11.0

N.B.: The above amounts include both excise duties and other fiscal taxes and special levies as well as the ISP in Spain and the Renta in Portugal; the latter tax was abolished from the 10 July 1990 and merged with excise duty.
In Denmark the tax on heavy fuel oil can be recovered by industrial consumers. It is also necessary to add a tax of - currently - 2.5 % for all products calculation identical with that for VAT.
Source: EC Petroleum Bulletin

lion tonnes/year) at the Gonfreville refinery in the French region of Basse-Seine, owned by the Total-CFP group.

b) Substantial increases in conversion capacities in 1989 and 1990.

The inauguration in April 1989 of the Shell hydroconversion unit (hydrocracking of heavy residues) at Pernis in the Netherlands and the commissioning of new visbreakers in the refineries of Porto-Marghera (Venice) and Sardinia have further increased conversion capacity. This has been boosted even further by the expansion in Germany of two hydrocrackers and a coking plant:

- DEA Mineralöl, Wesseling: Hydrocracking is up from 850 000 to 1 500 000 tonnes/year;
- Shell A.G. Godorf: Hydrocracking is up from 1 000 000 to 1 500 000 tonnes/year;
- Esso A.G. Karlsruhe: Coking is up from 880 000 to 1 100 000 tonnes/year.

Elsewhere, a number of changes have also come about: increased capacities through the decongesting of existing facilities, especially catalytic cracking, as well as some decreases such as the shutdown of thermal cracking plants (at Godorf) and a drop in the capacity of visbreakers.

Finally the current levels of conversion capacities are presented in Table 11:

Overall growth is by 6 million tonnes/year of equivalent FCC as at the 30 June 1988, which is approximately 4.5%. The rate of conversion (ratio of conversion capacities to distillation capacities) is around 26% for the whole Community, ranging from 8% in Portugal to over 41% in Germany.

Refinery Output Following the 4.4% rise in 1988, production by refineries has remained relatively stable at around 3.3 million tonnes, 0.7% above the previous year's level. The output of products has also stayed close to the previous year's levels with a slight rise in the percentage of petrol and a slight drop in heavy fuel oil, while the middle distillates (kerosene + diesel oil) have stayed unchanged at just over 42% as illustrated in Table 12.

In overall terms the Community continues to be a net importer of refinery products as shown by the refining statistics summarised in Table 13.

The Community is however a net exporter of petrol and kerosene (7 to 8 million tonnes/year) and a net importer of naphtha, gas oil, (6 to 10 million tonnes/year) and heavy fuel oil (10 to 15 million tonnes/year).

Again the position varies widely from one country to another bearing in mind the equipment available to the refineries.

The production structures are also different. Table 14 below indicates the percentages of the products turned out by the refineries in each country. A high percentage of light products (petrol) indicates substantial conversion capacities, while a significant percentage of heavy fuel oil on the other hand points to the fact that most

Table 9
Rate of Value Added Tax
(End of May 1990, in %)

	B	DK	D	GR	E	F	IRL	I	L	NL	P	UK
Super	25	22	14	36	12	18.6	23	19	12	18.5	8	15
Derv	25	22	14	8	12	18.6	23	19	12	18.5	8	15
Heating oil	17	22	14	8	12	18.6	10	19	6	18.5	0	0
Heavy fuel oil	17	22	14	8	12	18.6	10	9	6	18.5	8	0

Source: EC Petroleum Bulletin

Table 10
Capacities of primary distillation (1)

(million tonnes/p.a.)	1986	1987	1988	1989
Belgique/België	54	35	35	35
Danmark	11	9	9	9
BR Deutschland	150	85	82	78
Hellas	20	19	19	19
España	70	62	62	62
France	168	97	91	85
Ireland	3	3	3	3
Italia	177	125	117	117
Nederland	90	67	67	67
Portugal	18	15	15	15
United Kingdom	130	91	90	90
EC	891	608	590	582

(1) At the end of each year,
National statistics,
Data rounded to Mt/year.
Source: CPDP

of these refineries have no more than just basic plant resources (hydro-skimming, without conversion).

These statistics demonstrate the clear difference between the northern members of the Community (Denmark and Ireland excepted) and the countries of the south where outputs of heavy fuel oil remain high (from 26 to 33%).

Greece and Spain had surpluses of heavy fuel oil in 1989 while Italy continued to be an importer in structural terms owing to the persistence of strong demand on the part of electricity generating stations and industry. The Italian market alone absorbed 39% of heavy fuel oil supplies within the Community, excluding stocks, (30% stocks included). The position of Portugal in 1989 was exceptional given a strong demand for fuel oil by the generating sector, itself caused by that country's limited hydroelectric resources.

Operating level of refineries Evaluating the utilization rate of primary distillation plants raises a statistical problem due to the increase over the past ten years in the percentage of semi-finished products in refinery inputs. One part of these semi-finished products is redistilled while the other part goes directly into treatment or conversion installations. The split between the two categories is only partly recorded statistically in some countries, if at all. This is why in a previous communication to the Council on "the petroleum market and the refining industry in the Community (Doc. Com (88) 491 dated 23.09.1988)", the Commission presented a basket of utilisation rates including a maximum, calculated by comparing all refinery inputs with distillation capacities, and a minimum evaluated by taking into account treated crude oil only.

The significance of this basket varies from country to country and year to year since refiners switch from crude oil to semi-products depending on the relative prices (cf. below, chapter on "Trends in gross

Table 11
Conversion capacities in the EC in 1990

(million tonnes/p.a.)	C.C	H.C	V.R	C.T.	C.K.	C.H.	FCC eq. 1990	CONV/D.A en %
Belgique/België	5.4	(1)-	4.0	-	-	-	6.7	19.0
Danmark	-	-	3.5	0.2	-	-	1.2	14.0
BR Deutschland	10.5	6.1	8.2	3.7	4.8	-	31.7	41.0
Hellas	2.7	(1)-	2.1	-	-	-	(1)3.4	18.0
España	7.1	0.7	7.6	-	0.7	-	11.7	19.0
France	17.4	0.7	9.2	-	-	-	21.3	25.0
Ireland	-	-	-	-	-	-	-	-
Italia	14.8	(1)-	16.9	2.5	1.5	-	24.6	21.0
Nederland	6.4	1.5	7.0	0.5	1.6	1.5	16.6	25.0
Portugal	0.5	0.5	-	-	-	-	1.2	8.0
United Kingdom	19.3	2.2	2.8	2.0	3.4	-	30.2	34.0
EC	84.1	11.7	61.3	8.9	12.0	1.5	149.0	26.0

(1) The hydrocracking plants in these countries are designed for "soft" treatment intended for desulphurisation and not conversion and have therefore been ignored here.
Notes :
C.C : catalytic cracking
H.C. : hydrocracking of distillates in vacuum
V.R. : visbreaking (soft thermal cracking)
C.T. : thermal cracking
C.K. : coking
C.H. : hydrocracking of heavy residues
CON./D.A: ratio between capacities of conversion and primary distillation
Source: CPDP

margins from refining", the margin on distillation). Monitoring the "maximum" level in the statistics presented by Eurostat has revealed a slight improvement in utilisation rates in the course of the past four years.

The position is less favourable in the south of the Community however.

In 1989 the utilisation rates varied between 50 and 98% depending on the country. Improvements since 1985 are nevertheless indisputable.

Operating levels naturally vary as a function of demand, in other words they depend on the prevailing economic, seasonal and climatic conditions and on export opportunities, especially to the United States. During the first quarter of 1989 the slack demand for fuels due to the mild weather brought about a marked drop in the utilisation rates in a number of countries: the monthly processing of crude dropped from 40 million tonnes to 33 million tonnes from January to February to settle at 30-35 million tonnes/month by May; it then progressively recovered to attain 42 million tonnes by December.

In 1990 the same phenomenon occurred in February but the recovery in activity was far speedier than in the previous year, with a level of 41 million tonnes/month being achieved by May-June.

Table 12
Production by community refineries
(million tonnes/p.a.)

Proportions in %	1987	1988	1989	1988	1989
LPG	14.1	14.8	14.6	3.2	3.2
Naphtha	14.7	16.2	17.2	3.5	3.7
Petrol	103.4	108.1	110.5	23.7	24.0
Kerosene	30.0	32.9	34.6	7.2	7.5
Derv	150.6	160.6	159.5	35.2	34.7
Heavy F.O.	95.1	91.6	91.4	20.1	19.9
Other products	29.1	32.3	32.0	7.1	7.0
TOTAL	437.0	456.5	459.8	100.0	100.0

Source: CPDP

Table 13
Summarised refining statistics

(million tonnes/p.a.)	1987	1988	1989
Net refinery production	437.0	456.5	459.8
Supplies to internal markets	442.6	450.6	453.8
Marine reserves	30.4	31.9	31.1
Total requirements (1)	472.0	482.5	484.9
Import difference	35.0	26.0	25.1

(1) Excludes internal consumption and refinery losses
Source: CPDP

Trends in gross margins from refining

Gross margins from refining calculated as a function of the quotation of products on the Rotterdam market and the prices for crude oil on the futures markets swung widely in the course of 1989.

For a complex refinery (carrying out distillation, reforming, cracking, visbreaking), gross margins fluctuated between covering variables costs and overheads and covering the complete cost (including return on capital), only attaining the latter (25 to 28 dollars/million tonnes) in April following a keen demand for petrol in the United States, then falling back at the start of 1990 and eventually recovering to 30 dollars/million tonnes; over the year as a whole, gross margins still lagged behind total costs.

Table 14
Structure of production by product
(Outputs as % of refinery inputs)

	LPG	Petrol	Naphtha	Kerosene	Derv	Heavy fuel oil	Others	TOTAL
Belgique/België	2.0	20.0	6.0	6.4	36.3	19.8	5.0	95.5
Danmark	1.7	15.7	3.4	5.9	39.1	25.1	4.4	95.3
BR Deutschland	3.0	24.9	4.1	2.6	41.9	8.1	9.8	94.4
Hellas	2.4	19.1	3.7	11.3	22.7	32.1	3.2	94.5
España	3.6	17.4	3.3	7.7	25.2	26.5	8.3	92.0
France	3.5	23.7	2.3	6.6	37.0	15.0	5.1	93.2
Ireland	1.9	22.0	3.2	-	34.7	32.5	0.5	94.8
Italia	2.6	19.7	1.3	4.9	31.5	26.5	6.4	92.9
Nederland	4.7	16.2	8.0	10.0	30.1	17.7	6.5	93.2
Portugal	3.5	16.1	7.7	7.1	27.1	32.2	1.1	94.8
United Kingdom	1.9	31.4	2.1	10.9	26.8	14.3	5.4	92.8
EC	3.0	22.5	3.5	7.0	32.4	18.6	6.5	93.5

Source: Eurostat

Table 15
Utilisation rate of refining capacities in 1989

	Refinery inputs (Mt)	Distillation capacities (Mt/yr)	Rate %
Belgique/België	26.7	35.0	76.3
Danmark	8.4	9.0	93.3
BR Deutschland	80.5	(1)82.0	98.2
Hellas	16.4	19.0	86.3
España	51.6	62.0	83.2
France	74.5	(1)88.5	84.2
Ireland	1.5	3.0	50.0
Italia	80.9	117.0	69.1
Nederland	54.2	67.0	80.9
Portugal	11.4	15.0	76.0
United Kingdom	86.8	90.0	96.4
EC	493.0	588.0	83.8

(1): Arithmetic average of capacities at the beginning and end of the year
N.B.: These are maximum rates of utilisation based on "crude+feedstocks" inputs
Source: CPDP

For a simple refinery (distillation-reforming only), the margin was negative in the first quarter and did not climb above the coverage of variable costs and overheads until the third quarter, only to plummet back down below zero again in January 1990. The margin on simple distillation is currently (mid-1990 before the events in the Gulf) hovering around zero, having been negative (between 0 and 1 dollar/barrel) during the first three quarters of 1989 and attaining a spectacular but short-lived climax at the end of the year.

With the fall of the dollar against EC currencies the cost of Community refining expressed in dollars/tonne has naturally risen: the total costs of a complex refinery in mid-1990 were approximately 30 dollars/tonne and around half that amount for a simple refinery.

In view of the uncertain margins therefore, the continued operation of a number of simple refineries (distillation-reforming, no production of lubricating oils, bitumen or special chemical products/BTX) can only be explained by state protection or by contract refining. There are at present five refineries of this type in the whole of the Community. As a result, contract refining (refining for the account of a third party) is viable without any commercial risk on crude oil and its products.

To sum up, the situation in the refining industry in the Community has improved significantly since the crisis years of 1975 to 1985:

- the utilisation rates of distillation plants are currently close to normal (i.e. 85 to 90%) in nearly every country;
- generally speaking, conversion plants are operating at full capacity;
- the gross margins of complex refineries can only cover total costs for very short periods but release an overall surplus of operating capacity which is nevertheless characterised by marked fluctuations and still insufficient, on average, to offer an adequate return on invested capital.

The volatile nature of the oil markets, both petroleum products and crude oil itself, continues to leave the industry exposed to the whim of market forces.

However most of the refineries belong to petroleum groups that are integrated both upstream (crude oil producers) and downstream (distribution of petroleum products) of them. This means that the financial position of the refineries is frequently a function of internal selling prices, themselves determined by fiscal constraints.

Otherwise, with the Community now a habitual net importer of semi-finished products, naphtha (especially for petrochemicals), gas oil and heavy fuel oil, pressures on product prices can arise due to the non-availability of producer refineries: this can only be offset by an increase in crude oil treatment and an associated rise in outputs. This actually happened in August 1990 during the Gulf crisis.

Table 16
Utilization rate of distillation capacities

(maximum %)	1985	1986	1987	1988	1989
Noth	74	81	82	88	89
South	61	70	67	70	75
EC	74	76	76	81	84

Source: CPDP

Distribution

Control of reserve stocks in the Community The reserve stocks consist of quantities of petroleum products which can be called upon at any time by a country to bridge a temporary shortage situation or difficulties in the sourcing of hydrocarbons.

Directive No. 68/414 of 20 December 1968 required the creation and maintenance of reserve stocks at Community level representing initially 65 days; this was then increased from 1 January 1975 to 90 days' consumption for three categories

of product: petrol, jet propulsion fuel and diesel, and heating and heavy fuel oils. Since the Directive merely imposed the obligation to achieve an end result, the EC members have over the years established systems quite different from one another and which can be divided into two categories depending on the existence or otherwise of a centralised stockpiling authority.

EC Countries with a central reserves administration Four countries have a central reserves administration.

Denmark Denmark has had legislation governing reserve stocks for over 30 years now; the reserves are administered by the Foreningen Danske Olieberedskabslager (FDO), a non-profitmaking foundation established in 1959 with voluntary membership. The 1959 legislation related chiefly to fuels and was amended when Denmark joined the Community by the law of the 24 May 1972 which widened the stockpiling commitment to the three product categories specified in the Community directive. The FDO is financed by contributions from its members. Today, Denmark has 120 days' reserves of stocks.

The Netherlands In the Netherlands the collective administration of stocks was entrusted in 1977 to a caretaker body (ICOVA) which was eventually succeeded in 1986 by the Central Organ Vorraadsvorming Ardolieprodukten (COVA), a public body which maintains 70 days of reserves of the light and medium distillation fractions; this body is financed out of a levy on petroleum products additional to excise tax.

The refineries are required to maintain a 50 day stockpile and sixteen and two-thirds days are maintained by the independents. The stockpiling of heavy fuel oils has been administered since the 1 January 1987 by the Union of electricity generators (SEP).

FR Germany The lion's share of the stockpiling requirement of 80 days' consumption is administered by the Erdölbevorratungsverband (EBV), a national body with public corporation status financed by means of a special tax. 90% of the reserves stocked by the EBV are its own property.

The refineries themselves ensure an additional 15 days on their own initiative. In addition, the Federal government has amassed stocks of crude oil equivalent to 30 days' supply.

France France long ago established legislation requiring the stockpiling of oil reserves (the commitment to create and maintain safety reserves can be traced back to the law of the 10 January 1925).

More recently (1988) France established a central reserve administration, the Société Anonyme de Gestion des Stocks de Sécurité (SAGESS). This is a private limited company with a special fiscal and legal status. Its shareholders must be all those companies (refiners and independents) who hold a special licence to import and market petroleum products; its operating costs are defrayed by the contributions paid by the shareholders. SAGESS is responsible for half the total legal stockpiling requirement, i.e. 45 days, twelve of which it actually owns and the balance being covered by allocations; the remaining 45 days are the responsibility of special licensees.

EC countries with no central reserves administration

Belgium In Belgium compulsory stockpiling represents one quarter of domestic supplies made during the previous calendar year; the responsibility is assumed by refineries and importers who are both required to maintain 90 days.

Spain The requirement to hold 90 days of oil reserves is spread evenly between the refinery companies and Campsa, a distribution company created by state monopoly (the statutory order of 28 June 1927 introduced compulsory stockpiling of 4 months' reserves).

Greece The distributors are principally required to maintain 90 days' reserve stocks, however this obligation may be assumed by the local refineries which supply the distributors. Distributors only commit themselves to the products which they actually import.

Ireland Stockpiling is ensured by importers by means of coverage contracts signed with the state refinery company located at Whitegate.

Italy In Italy the compulsory 90 day reserves are administered by various different bodies: the refiners, importers, ENEL - the national electricity generating company - as well as the government itself whose strategic stocks are handled by ENI.

Portugal The Portuguese oil reserves are administered by import licence holders (refineries, importer-distributors) and represent 120 days of consumption although part of these may be provided by the state corporation Petrogal.

United Kingdom The target of 90 days of oil reserves is cut by 15% in the U.K. owing to its status as an oil producer. Two groups of operators are required to maintain reserves: first the refineries - 76.5 days; second, importers, distributors and consumers importing more than 50 000 tonnes per annum for their own account are required to maintain 66 days' reserves.

Distribution of motor fuels and diesel Motor fuels and diesel are supplied either through a network of outlets or directly to

Table 17
Trends in the number of petrol retail outlets

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Variations 1989/80 %
Belgique/België	8 637	8 258	7 575	7 068	6 742	6 207	5 633	5 448	5 306	5 030	-41.7
Danmark	4 397	4 208	3 985	3 631	3 733	3 622	3 515	3 364	3 253	3 154	-28.3
BR Deutschland	26 145	24 864	23 219	21 049	19 288	18 448	20 320	19 501	18 658	18 271	-30.1
Hellas	5 500	5 500	5 500	5 500	5 500	5 800	5 800	6 000	5 950	5 000	-9.1
España	4 606	4 602	4 608	4 621	4 622	4 616	4 799	4 855	4 821	4 978	8.1
France	40 400	39 500	38 600	37 100	36 000	34 600	33 200	31 100	29 000	27 700	-31.4
Ireland	3 957	3 874	3 828	3 702	3 544	3 428	3 375	3 300	3 250	3 150	-20.4
Italia	38 570	38 255	37 672	36 716	38 500	35 800	35 300	34 700	34 300	33 900	-12.1
Luxembourg	475	473	461	469	447	448	442	420	400	392	-17.5
Nederland	10 889	10 366	9 554	8 982	8 492	8 106	7 858	7 560	7 355	7 109	-34.7
Portugal	2 120	2 100	2 060	2 010	1 970	1 900	1 880	1 830	1 770	1 849	-12.8
United Kingdom	25 527	24 760	24 108	23 097	21 705	21 140	20 641	20 197	20 016	19 756	-22.6
EC	171 223	166 760	161 170	153 945	150 543	144 115	142 763	138 275	134 079	130 289	-23.9

Source: National Statistics

the end user (industries, road hauliers in particular).

Generally speaking most car fuel sales are made through retail outlets; the percentage of diesel sold at the pump is far lower although it is currently tending to rise as a result of the growing number of private cars running on diesel.

Trends in the number of points of sale

In 1989 there were around 130 000 points of sale in the twelve Members States of the EC, 24% fewer than in 1980 and 35% fewer than in 1975, the year when the retail outlet networks attained their maximum size. Since then the extent and timing of the process of restructuring has varied from country to country; it continued in 1989 but at a slower pace than during the 1980-1985 period, with the loss of some 3 800 points of sale in the twelve EC members: 1 300 in France, 587 in Germany, 276 in Belgium and 260 in the United Kingdom. A certain increase in the size of retail sales networks has been observed in Spain and Portugal where the distribution sector is beginning to open up to competition from other EC members.

Unleaded fuel The sale of unleaded fuels has necessitated the creation of new logistics involving additional distribution costs, especially in countries where the point-of-sale volumes are still low.

Table 19 shows that Germany, the Netherlands and Denmark are the three countries which lead the way in the sale of unleaded fuels. The percentage of unleaded fuels in terms of total sales volume is also high in the United Kingdom, Belgium and Luxembourg. It continues to be low in the other EC countries but is set to rise rapidly. This uneven development is due to three main factors:

- Tax incentives introduced some years ago in a number of countries (Germany, Denmark, the Netherlands) and more recently in the UK, Luxembourg, Ireland, Belgium, France and Italy.

Nevertheless the amount of tax incentives in favour of unleaded fuel varies from one country to another: it stands at around 5% in Belgium, Italy and the Netherlands, 6 to 7% in Germany, the United Kingdom and France and 9% in Denmark. With the same aim in mind, a number of countries have introduced tax benefits that work in favour of vehicles fitted with catalytic converters.

- Statutory measures, like the abolition of leaded two-star petrol and its replacement by unleaded fuel in Denmark in 1986, the Netherlands in 1987, Germany in February 1988 and Belgium in June 1989.

The sale of leaded two-star was also discontinued in the United Kingdom from the end of 1989.

- A greater or lesser degree of awareness by national public opinion of ecological problems.

In 1989 the rate at which unleaded petrol superseded leaded grades accelerated. Over the year as a whole sales of unleaded petrol represented 12% of all car fuel sales in the 12 countries of the EC. Germany was in the forefront of this trend: the percentage of unleaded petrol in total car fuel sales went up from 44.5% in 1988 to 58.5% in 1989 and reached 66.5% in the spring of 1990. In the United Kingdom the rise of unleaded fuel has been spectacular, increasing from 1.1% in 1988 to 19.4% in 1989, even topping 32% by May 1990 following on from government

Table 19
Share of unleaded petrol in total car fuel sales (1)

	1986	1987	1988	Sales 1989	% of Total Sales	Remarks
	%	%	%	(1000t)		
Belgique/België	0.1	0.2	0.5	442	15.4	22.2 % Feb. 90
Danmark	10.3	29.7	33.0	607	41.4	
BR Deutschland	10.9	25.7	44.5	15198	58.5	66.5 % March 90
Hellas	e	e	e	10	e	
España	e	e	0.1	32	0.4	
France	e	0.1	0,2	435	2.3	18.4 % July 90
Ireland	e	e	e	55	6.0	
Italia	e	0.2	0.7	274	2.2	
Luxembourg	1.0	1.8	10.2	77	20.5	26.6 % Feb. 90
Nederland	15.3	20.4	26.0	1208	36.3	48.8 % Feb. 90
Portugal	e	e	e	2	e	
United Kingdom	e	0.1	1.1	4639	19.4	32.3 % May 90

(1) e = infinitesimal amount
Source: National

advertising campaigns and an increase in tax incentives. In France the breakthrough by unleaded was very substantial in early 1990: the percentage of sales increased from 2.3% for the whole of 1989 to 10% in the first half of 1990 and 18% by July 1990. This growth is explained primarily by the appearance of a new grade of additive super of 98 octane capable of powering all recent models, whether fitted with a catalytic converter or not. This grade of unleaded petrol is also sold in Germany, Belgium, the Netherlands and the United Kingdom.

Table 18
Number of points of sale of unleaded fuels (position at end of year)

	1986	1987	1988	1989	% of total
Belgique/België	50	105(1)	700	4 000	80
Danmark	900	2 000	2 930	3 154	100
BR Deutschland	13 000	19 200	18 658	18 271	100
Hellas	50	215	215	393	8
España	65	82	98	255	5
France	89	330	1 200	7 500	27
Ireland	N/A	30(2)	400	1 350	43
Italia	72	1 258	5 120	16 000	47
Luxembourg	21	179	375	376	96
Nederland	7 500	7 500	7 300	7 109	100
Portugal	N/A	35	50	350	19
United Kingdom	174	715	4 157	18 173	92

(1) May 1988
(2) June 1988
Source: National

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Nuclear fuels

In 1989, nuclear energy represented 14.5% of total energy consumption and 35.6% of electricity production in the EC. Representing 27.4% of primary energy production, it is also the biggest single source of energy produced in the Community. However the situation varies greatly from country to country; in France and in Belgium, about 70% of all electricity is produced by nuclear power stations, whilst in Denmark, Greece, Ireland, Luxembourg and Portugal this form of energy is not used at all.

Description of the sector

The Community energy objectives for 1985 take account of the importance of the nuclear industry in supplying energy to the community and they insist on the need to guarantee that design, construction and the operation of nuclear facilities satisfy the highest standards of safety in every respect.

To a far greater extent than other energy sources, nuclear energy relies on a complex combination of industrial activities. These include obtaining nuclear fuel, and building proper power stations.

These characteristics are reflected in the cost of electricity. Only 28% of the costs relate to fuel, 11% are linked to natural uranium and 17% to the various processing stages of the nuclear fuel cycle. However, the largest percentage, being 57%, is represented by the amortisation of the nuclear power station investment costs. The remaining 15% represents the power station's operating costs.

Table 1
Nuclear fuels - Maximum nuclear output capacity and share in electricity production

(GWe)	1989 Capacity	1989 Share (%)	1990 Capacity	1990 Share (%)	1995 Capacity	1995 Share (%)
EC	102.3	35.6	105.3	35.2	111.8	34.9
Belgique/België	5.5	60.8	5.5	58.5	5.5	53.5
BR Deutschland	22.7	34.3	22.9	37.5	22.9	35
España	7.5	38.4	7.4	34.3	7.4	30
France	52.6	74.6	55.5	74.4	62.5	77.6
Italia	1.2	0	1.3	0	1.3	0
Nederland	0.5	5.4	0.5	5.2	0.5	4.2
United Kingdom	12.4	21.7	12.1	19.8	11.7	19.6

Source: Eurostat, DG XVII of the European commission

Current situation

Uranium production The EC's annual consumption is about 14 000 tonnes of natural uranium (tU). The Community's uranium requirements will remain more or less constant during the next decade, despite a slight increase in the electro-nuclear capacity available. This phenomenon is due to better fuel management, plutonium recycling and reprocessed uranium. The Community's annual uranium production is about 3 800 tU. The remainder is imported from ten countries. Electricity producing companies diversify their sources of supply in order to ensure regular supplies, and have built up stockpiles which can vary from two to four years' consumption.

It is as costly to stock the equivalent of three months' petrol and coal consumption as it is to stock the equivalent of two years' consumption of natural uranium.

In 1988 the Community paid about 70 ECU per kgU ($ 87 U.S.per kgU) for uranium supplied on long term contracts (Source:1988 annual report of Euratom's supply agency). At this price, the value of uranium used in the Community is about 260 million ECU.

Uranium is produced by five Member States; France, Spain, Portugal, Germany and Belgium.

FRANCE In France there are six uranium production facilities, the details of which are shown in table 2. These facilities extract uranium from ore from thirty or so sites, generally located in the same region as the facilities. France is by far the leading producer, with an annual production of more than 3,400 tU.

Already discovered uranium resources, recoverable with costs up to $80 U.S. per kgU ($30 U.S. per English pound of U308), could still maintain production at the present rate for a period of 20 to 30 years. At present there are no projects aiming at increasing annual production.

SPAIN In 1988, Spain's annual production was about 220 tU. Almost all this uranium (200 tU) was produced in the Selices el Chico facility at Cuidad Rodrigo from ore extracted from the uranium deposits at Fe. The surplus was produced by the small experimental facilities of Haba at Don Benito (which have an annual output of 30tU). The government organisation Empresa Nacional del Uranio SA (ENUSA) owns and manages the uranium production centres. Resources have been discovered in Spain which can be recovered at costs of up to $ 80 U.S. per kgU, representing a total of 27,000 tU. The majority of these resources are situated in or around the Sealices el Chico production facilities. Projects exist to increase the capacity of this facility and raise it to about 950 tU per annum in 1991.

PORTUGAL In 1988, uranium production in Portugal has been about 120 tU. This uranium has been produced in the Urgeiria facility from ore extracted from several

Table 2
Nuclear fuels - Uranium production centres in France

Name	Location	Annual capacity (tU/yr)	Owner
L'Ecarpière	Vendée	650	SIMC
Bessines	Haute Vienne	1 500	SIMC
Le Cellier	Lozère	200	CFM
Bertholène	Aveyron	70	TCFM
Mailhac/Bernardan	Haute vienne	500	TCFM
St. Martin du Bosc	Hérault	1 000	SIMC

SIMC: Société industrielle des minerais de l'Ouest (subsidiary of cogema)
CFM: Compagnie française de MOKTA (subsidiary of cogema)
COGEMA: Compagnie Générale des Matières Nucléaires (owned by the Commissariat à l'énergie atomique)
TCFM: Total Compagnie Minière France (Total's mining operator in France)
Source: DG XVII of the European commission

deposits in the Upper-Beira region. The facility's output is 170 tU per annum.

Work has started on a new production centre, Nisa, in the Upper-Alentejo region. This plant, aimed at processing ore from several deposits in the region, should have a capacity of 200 tU per annum. Start-up is planned for 1990. Responsibility for uranium production in Portugal lies with the public organisation Empresa Nacional de Uranio (ENU). Any other company wishing to engage in uranium prospection or processing must first conclude an agreement with ENU.

In Portugal, discovered uranium resources which can be recovered at a cost of $80 per kgU or less are sufficient to maintain a production output calculated at 370 tU per annum for at least twenty years. As Portugal does not have a nuclear programme, it exports its uranium, some of which goes to other Member States.

FR GERMANY About 50 tU per annum are produced in the Federal Republic of Germany in the Ellweiler facility which process ore from underground exploration activities (as opposed to industrial-style extraction) in the uranium deposits of Menzenschwand and Grobschlopen. The Ellweiler facility production capacity is 125 tU per annum, but this capacity is under-utilised due to limited ore supplies. The factory is run by the Gewerkschaft Brunhilde company which also extracts ore from the Menzenschwand deposits. Another company, Interuran, (previously Saarberg Interplan Uran), actively prospects the Grobschlopen deposits. There are no plans to increase uranium production in the Federal Republic of Germany, despite the fact that the Grobschlopen deposits could supply a processing facility with an output of 250 tU per annum. The discovered resources, with a recovery cost of up to $80 U.S. per kgU, are about 2,500 tU.

BELGIUM About 40 tU per annum are produced in Belgium from imported phosphates. Belgium has no known uranium resources.

The nuclear fuel cycle After the extraction and refining operations, nuclear material passes through many processing stages before being loaded as nuclear fuel in the reactor: conversion, enrichment, fuel assembly fabrication. After having been irradiated in the reactor, the fuel is then stored or reprocessed with the aim of recovering the recyclable material and separating the radioactive waste. Companies within the Community have developed industrial know-how applicable to all these activities.

CONVERSION OF URANIUM Conversion results in an uranium compound (uranium-hexaflouride) which lends itself to subsequent processing (enrichment and fabrication) and which possesses the required chemical purity. Conversion plays a small part in the cost of fuel, about 3%.

At present, two companies carry out conversion operations in the Community: British Nuclear Fuels in the United Kingdom and Comurhex in France. The other converters in the western world are in Canada and the United States. The conversion capacities are shown in Table 3. The Community's requirements for conversion are about the same as those for natural uranium, which is about 14 000 tonnes per annum. They will remain static for the next decade. At world level the conversion sector is characterised by a considerable and lasting over-capacity (about 45%).

Table 3
Nuclear fuels - Conversion capacities and requirements in the EC

(thousand tU)	1989	1990	1995
Comurhex	12	14	14
BNFL	5.5	5.5	9
Total	17.5	19.5	23
Requirements	14	14	14

Source: NEA

One of the uranium producing countries has a policy of only exporting uranium in converted form. This limits the portion of the community market accessible to national suppliers. Also, community companies only cover 75% of the EC's requirements. However, despite very strong competition, they have been able to conquer a significant proportion of the market in non-EC European countries and ensure adequate usage of their installations.

The average conversion cost is about 6.5 ECU per kgU and the turnover in the community market is about 90 million ECU.

The EC attaches more and more importance to the idea of converting recycled uranium. In France, Comurhex and Cogema have linked together to form the Urep marketing company with the aim of offering samples of their range of services in this field. In the United Kingdom, BNFL has converted recycled uranium, recovered from Magnox fuel, in its existing installations.

ENRICHMENT Enrichment is a stage in the fuel cycle which consists of increasing the fissile isotope content of the uranium. This stage is necessary in the case of fuel destined for LWR reactors (either pressurised or boiling) and for advanced gas cooled reactors. These types of reactor using enriched uranium as fuel represent 90.4% of the nuclear capacity installed in

Table 4
Nuclear fuels - Enrichment-service requirements and capacity in the European Community

(thousand SWU)	1989	1990	1995
Eurodif	10 800	10 800	10 800
Urenco	2 500	2 700	3 500
Total	13 300	13 500	14 300
Requirements	8 600	9 000	9 500

Source: NEA

the Community.

Uranium enrichment is an important stage, on the one hand because it requires advanced technology with a high level of specialised knowledge and, on the other hand, because this operation accounts for about 27% of the total cost for the fuel cycle. Consequently, security of enriched uranium supplies at an acceptable cost constitutes a capital element in running nuclear programmes. Production in the Community is in the hands of two competing multi-national groups, Eurodif and Urenco.

Cogema is responsible for marketing the services supplied by Eurodif in the area of enrichment. In the Eurodif installations the gaseous diffusion process, perfected by the French AEC is used. France has joined with several European partners (Belgium, Italy and Spain) in deciding, in 1973, to built a large factory. The decision to go for high capacity was taken with the aim of obtaining maximum benefit from economies of scale, which are considerable in the case of gaseous diffusion. This choice was also influenced by the optimistic climate which reigned after the first oil crisis in 1973 on the subject of nuclear energy development.

The Tricastin plant, which at present is named after its founder, Georges Besse, is one of the biggest in the world; it has an annual capacity of 10,8 million separative work units (SWU). The enrichment potential is measured in separative work units per annum. Supply from a LWR reactor of 1 gigawatt of "electricity" requires annually about 25 tonnes of uranium enriched with 3% U235 and the production of 25 tonnes requires in turn about 150 of natural uranium and 95,000 SWU. Products from the Tricastin plant at present satisfy about 40% of the world's requirements. After the plant reached full production capacity in 1982, it had to adapt its rate of production to a reduced market demand.

Urenco Ltd. (U.K.) was formed on the basis of an equal share split between Uranit GmbH (German Federal Republic), British Nuclear Fuels Plc (BNFL - U.K.) and Ultracentrifuge Nederland (UCN - Netherlands). The objective was to perfect and apply on an industrial basis the technique of enrichment by means of ultra-centrifugation; Urenco Ltd. coordinates group production and marketing of the enrichment supplies. The Centec company for coordinating research and development programmes and the exchange of technical information amongst the associates. The construction and operation of the installations in each of the countries is the responsibility of three national companies comprising the partners of Urenco Ltd., the national partner in each case having the majority shareholding. The present output of the Urenco group installations reaches 2,2 million SWU per annum. Projects exist to increase this output up to 2,5 million SWU in 1990 and to continue to increase it in relation to orders obtained.

The centrifugation technique does not require the construction of vast installations. The installation's output can be gradually increased by adding modules as and when necessary. This can be achieved quite quickly if so required. This enables investment to be planned in relation to contracts obtained and as such, ensure a high usage level for the installations.

It is forecast that the Internal Community requirements for enrichment services will increase gradually to go from 8,5 million SWU in 1988 to 9,5 million SWU in 1995. Contrary to uranium requirements, there should be only a moderate increase in enrichment requirements. In practice, technical progress on better usage of uranium in the reactors does not reduce the need for enrichment services as much as it reduces the need for natural uranium. In addition, recycling reprocessed uranium has no appreciable repercussions on enrichment requirements. At present 14% of the Community's needs are covered by imports from the U.S.A and the Soviet Union on the basis of long-term contracts. In future it will be possible to satisfy the requirements for favourable economic terms by turning to the enrichment installations situated in Europe. The Community enrichment industry has also conquered a considerable slice of the export market.

Present world production capacity is considerable and will continue to outstrip requirements until the end of the century. This situation increases competition. The cost of enrichment services gradually diminishes in real terms further to the amortisation of older installations and commercial competition. The unit value of the SWU is estimated at about 130 ECU, and the community turnover is thus 1 100 million ECU. The application on an industrial basis of a laser enrichment

process which is being developed in the USA, in Japan, in France and in other European countries, could modify the market perspectives towards the end of the century.

PRODUCTION OF FUEL ELEMENTS This stage comprises the operations during which uranium fluoride, enriched or otherwise, is used to produce complete fuel elements ready to be introduced into the reactors. This stage represents 11% of the fuel cost price.

At Community level, the industrial structures are of a mainly national character. In the German Federal Republic, the Siemens company is capable of producing annually 900 tU of fuel for LWR in its installations in Hanau, Karlstein and Lingen. Siemens acts as the designer, seller and manufacturer of fuel elements.

In Spain the ENUSA company has, in Salamanca, a factory with an annual capacity of 200 tU.

In France, The Cogema, Framatome and Pechiney companies are associated with fuel production, whilst Fragema, a subsidiary of Framatome and Cogema (who possess equal shareholdings), is responsible for overall marketing. Production is ensured by the FBFC factories (Franco Belge de Fabrication de Combustible) at Romans and Pierrelatte in France and at Dessel in Belgium. The annual output of the plants is 1 600 tonnes. The Dessel plant is owned by FBFC International, a wholly-owned subsidiary of the French company FBFC, in which Cogema and Framatome are associated with Pechiney (the respective shares being 25,25 and 50%).

In Italy, Agip manages Fabbricazione Nucleari, which has, at Bosco Marengo, a factory with an annual output of 50 tonnes.

In the UK, up until now, BNFL has mainly deployed its activities in producing fuel for British Magnox and AGR (Advanced Gas Reactors), but the company also owns a factory producing fuel for LWR. This plant has an annual output of 200 tonnes.

It is clear that at present a considerable over-capacity exists in the fuel production sector. Total capacity is 3 450 tonnes per annum, whilst annual community requirements in fuel for LWR are about 2 300 tonnes. This over-capacity also exists on a world scale. Despite fierce competition, European producers have managed to obtain orders for about 200 tonnes per annum on export markets.

At present electricity producers have varied and special demands with regard to finished products to be able to continue to ensure supplies and achieve higher combustion rates. These demands call for perpetual innovation on the part of the producers, but enable users to achieve savings on the cycle cost. However, the progressive tendency towards high combustion rates results in a reduction in the number of fuel elements necessary to produce a given quantity of electricity and this limits the growth rate of the fuel market.

The average cost of producing fuel elements is about 230 ECU per kg., which means a community market turnover of about 530 million ECU.

Because of the development of plutonium reprocessing and recycling, the production of plutonium fuel elements is becoming increasingly important. Special plants created in the Federal Republic of Germany, in France and in the United kingdom deploy a total annual output of about 100 tU of mixed oxides.

They have enabled the necessary technical experience to be acquired to be able to construct larger installations. A plant with an annual output of about 115 tonnes of MOX is going to be built in France and this investment of 1,500 million FF should be operational in 1994. A total output of over 200 tonnes of MOX fuel will become, little by little, necessary during the 1990s to satisfy the requirements of the plutonium thermal recycling programmes.

Table 5
Nuclear fuels - Requirements and capacities for the fabrication of LWR fuel elements in the European Community

(tU/year)	1989	1990	1995
SIEMENS	1 450	1 400	1 250
ENUSA	250	250	250
FBFC	1 500	1 500	1 500
AGIP	100	100	100
BNFL	200	200	200
Total	3 500	3 450	3 300
Requirements	2 715	2 586	2 717

Source: NEA

STORAGE AND REPROCESSING OF DISCHARGED FUELS Reprocessing is a complex operation performed on spent fuel discharged from nuclear power stations; this fuel is a mixture of reusable products (unconsumed uranium and plutonium created during the fuel irradiation in the power station's reactor) and fission product which are highly radioactive and can be considered as the ashes of burning fissile material. The reprocessing operation enables the various products to be separated. In the medium term, reprocessing guarantees a reduction in natural uranium needs by recycling material recovered from thermal nuclear power stations. In the long term, it offers a perspective of achieving almost total independence from outside uranium supplies, thanks to the fast breeder concept, i.e. reusing plutonium in fast breeder reactors.

Finally, to separate the fissile products

Table 6
Nuclear fuels
Reprocessing requirements and capacities of uranium oxide in the EC

(tU/year)	1989	1990	1995
Cogema	400	700	1 600
BNFL-Thorp			400
Total	400	700	2 000
Requirements (1)	2 100	2 350	2 500

(1) Tonnage of fuel discharged annually
Source: NEA

from the spent fuel elements enables them to be treated and processed for risk-free removal. The majority of EC countries (France, UK, Federal Republic of Germany, Belgium, Italy and the Netherlands) have adopted a fuel reprocessing solution after a period of interim storage on the power station site, either in special installations for dry storage or storage under water. Spain and certain countries outside the EC have opted for interim fuel storage over a longer period (from 20 to 50 years) awaiting reprocessing or direct elimination of the spent fuel elements in deep-lying geological formations.

Fuel reprocessing and waste management represent a considerable proportion of the fuel cost price; almost 20%, if account is taken of the recovered fissile material value, and 30% if this is not taken into account.

Present experience in the field of reprocessed stems mainly from metallic fuels reprocessing from gas cooled reactors powered by natural uranium. This reactor type has been initially adopted by France and the UK, but no stations of this type are being built at present. To date, more than 40 000 tonnes of uranium from spent fuel of this type have been processed.

Regarding uranium oxide fuel from LWR and AGR reactors, reprocessed tonnage is 2 850 tU. Of this tonnage, 2 500 tonnes were processed in the only commercial plant at present in service, i.e. the UP2-400 plant at La Hague in France, managed by Cogema. This plant annual output is 400 tonnes. France has decided to enlarge the La Hague installations. A new plant UP3 with an annual output of 800 tU was partially commissioned in 1989. The UP2 plant's output will be increased to 800 tonnes per annum. The first new processing areas are being built. The extension will be commissioned in 1992.

Reprocessing output over and above that necessary to cover national needs will be offered to other electricity producers established in EC countries (German Federal Republic, Belgium and the Netherlands) as well as in other countries outside the EC (Japan and Switzerland). In the UK, BNFL is building Thorp at Sellafield which will be capable of reprocessing 7 000 tonnes of irradiated fuel during its first ten years of operation. It is due to be commissioned in 1992. Its output is aimed at covering national requirements as well as those of the Community countries' electricity producers (German Federal Republic, Italy and the Netherlands) and those of non-EC countries (Japan, Switzerland and Sweden).

The German Federal Republic has abandoned its construction project for a nuclear reprocessing plant at Wackersdorf and has accepted to step up its cooperation with France for the joint processing of spent uranium fuel. Germany has also signed a reprocessing offer from the BNLF complex at Sellafield.

On the basis of the launch programmes for the three installations mentioned above, it is forecast that about 12 000 and 27 000 tU of oxide fuel would have been reprocessed in the Community by the end of 1995 and 2000 respectively. The total quantity of fuel discharged by Community nuclear power stations for those same years will be, respectively, about 25 000 and 38 000 tU. Taking account of quantities to be reprocessed from countries outside the Community, it can be estimated that interim storage requirements will be about 20 000 tU over the period between 1995 and 2000. The necessary storage capacity to cover these requirements is already available.

The reprocessing contracts foresee a financial contribution from the customers as soon as plant construction is started. Taking this practice into account, the present average Community cost price is around 950 ECU per kgU, including waste transport and conditioning costs.

Electro-nuclear power station construction

The following analysis covers mainly the construction industry for LWR type electro-nuclear power stations; this being the most prevalent type within the Community.

The electro-nuclear power station construction industry represents a very varied picture within the Community. It is necessary to distinguish between the following functions:

- the industrial architect's function which covers the design services, often covering complete power stations and general project coordination. Industrial architects play an important intermediary role between all the various parties, mainly between the electricity producer, the other suppliers and the authorities responsible for safety;
- the supply of the nuclear island, i.e. the supply of the specifically nuclear portion of the power station, which includes the

Table 7
Nuclear fuels - The LWR power plant industry in the EC

	Architects/ engineers	Nuclear Steam Supply system	Heavy nuclear components	Steam turbines	Alternators
Belgium					
- Tractebel	X				
- CMI			X		
- ACEC					X
Germany (FR)					
- KMU-Siemens	X	X		X	X
- GER			X		
Spain					
- Empresas Agrupadas	X				
- Initec	X				
- Eusa			X		
France					
- Framatome	X	X	X		
- Alsthom-Atlantique				X	X
Italy					
- Ansaldo	X	X (1)	X	X	X
United Kingdom					
- GF Ltd/NNE	X			X	X
- Nei-Rolls Royce			X		
- Babcock Power			X		

(1) under licences
Source DG XVII of the European commition
Source: NEA

nuclear stream supply system in which the majority of nuclear technological know-how is concentrated;

- the manufacture of non-nuclear heavy equipment such as the steam turbine, the alternator and other traditional equipment with a weight double that of the nuclear equipment and the quality of which is essential for plant efficiency. To these large items can be added the supply of numerous goods and services from a wide variety of companies of varying size; companies which are sometimes very diversified or specialised. This companies possess expertise in fields such as soil mechanics, civil engineering, piping, electrical equipment (cables, motors etc.) and mechanical equipment (valves, pumps etc.), handling equipment, project management, construction site management as well as quality assurance and control.

The list of the major companies present in the nuclear sector appears in Table 7. Their activities are not necessarily limited to the nuclear sector. Notably they might also include traditional power station construction and heavy mechanical component manufacture, areas in which these companies were often originally active. As such, these industries possess a true diversification potential and, consequently, they are protected to a certain extent from possible market fluctuations. However, nuclear energy is characterised by such technological specificity that special analysis is warranted. During the last decade, the major EC companies have managed to break into export markets and compete with American companies, whilst originally the latter companies had developed the basic technical knowledge in the nuclear industry sector (Table 8). At the production stage, the technical quality and reliability of the community industry is wholly satisfactory. If the European industry has been capable of conquering an important world position, it is also thanks to its know-how in the field of electro-nuclear power station specialised maintenance operations.

Finally, to affirm its development, the European nuclear industry has undertaken and carried out considerable research, development and demonstration work. Notably, achievements in the field of fast breeder reactors, a field in which the European industry is by far and away ahead of the U.S.A. and Japan, could play a major role in satisfying the push towards new requirements which can be expected when the present generation of nuclear power stations have to be replaced. Until recently, the community industry has benefitted from a high degree of protection. However, the penury of orders in the EC and the entire world has placed even greater pressure on the industry in the sense of ra-

tionalisation, and the industry is undergoing rapid evolution.

A series of mergers and partnership agreements is creating a framework of relationships amongst the large companies. The fundamental reason for creating these associations is the wish to achieve direct access to numerous contracts because of the geographic spread of the manufacturing installations, to reduce costs by rationalisation and to develop a whole range of both conventional and nuclear electricity production equipment.

The operation which launched the wave of mergers was the formation, in 1987, of ABB with the participation of the electrotechnical interests of ASEA in Sweden and Brown Boveri in Switzerland. Apart from this base, which is outside the EC, ABB possesses production facilities in the German Federal Republic and other EC countries. This operation has been counterbalanced by the merger, at the end of 1988, of the electrical energy and other interests of GEC (General Electric Company) in the UK with Alsthom in France. The newly-formed company, GEC-Alsthom is owned, in equal shares, by GEC, the French telecommunications administration and the heavy engineering group CGE (Compagnie Générale d'Electricité).

In the nuclear sector, the main European suppliers, Framatome in France (40% owned by CGE) and Siemens-KWU in the German Federal Republic have recently signed an agreement with the aim of developing and marketing pressurised water reactors for the international market. By the terms of this agreement, Framatome and Siemens-KWU with equal shareholdings: Nuclear Power International - NPI, which will handle the sales and marketing of pressurised water reactors (PWR) from the mother companies and will coordinate the perfection of common PWR technology for the world market. It is generally admitted that this agreement could pave the way to a wider cooperation between the French and German nuclear industries.

The far-reaching French nuclear programme has lead to high quality nuclear developments and appreciable economies of scale. The electricity producer Electricité de France (EdF) plays an important role to the extent that it is responsible for all the industrial architect tasks. Alsthom has been, in the non-nuclear part of the plant, the exclusive supplier of turbo-alternators as well as associated equipment and services. Framatome is the exclusive supplier of nuclear islands and the manufacturer of major nuclear components.

Apart from its agreement with Siemens-KWU, Framatome is negotiating the creation of joint venture companies with Babcock and Wilcox in the U.S.A. in the field of nuclear services, maintenance and perhaps, the development of a reactor. The two companies already cooperate in the nuclear fuels field with two other French companies, Cogema and Pechiney. Framatome is actively seeking, amongst other things, to diversify in non-nuclear sectors and has purchased the American company Burndy, a connector specialist as well as the French company, Souriau.

In the German Federal Republic, the electro-nuclear power station industry is grafted onto the traditional power station industry around Siemens-KWU. Almost all the electro-nuclear power stations from Siemens-KWU have been delivered on a turnkey basis. Siemens-KWU fulfills the role of industrial architect and is also the nuclear island supplier, but it subcontracts the manufacture of heavy mechanical equipment to a highly qualified and very

Table 8

Nuclear fuels - Structure of exports of nuclear power stations during the 1975 - 88 period

Importing country	Reactor type	Project	MWe (grass)	Date of order	Exporting company
Argentina	PWR	Atucha	745	1980	KWU
Belgium	PWR	DCEL 4	1 059	1975	Westinghouse
	PWR	TINANGE 3	1 048	1975	Westinghouse
Brazil	PWR	ANGRA 2/3	2 x 1325	1976	KWU
China	PWR	GUANDONG 1/2	2 x 936	1986	Framatome
korea	PWR	KCRI 3/4	2 x 950	1978-1980	Westinghouse
	PWR	Y'Kang 1/2	2 x 996	1979	Westinghouse
	PWR	ULJIK 1/2	2 x 950	1982	Framatome
South Africa	PWR	KCEBRG 1/2	2 x 965	1976	Framatome
Spain	PWR	Vandelecs 2	982	1975	Westinghouse
	PWR	Valdeca-Hailero	2 x 975	1975	GE
	PWR	Trillo 1	1 040	1975	KWU
Taiwan	PWR	Manshan 2	951	1973	Westinghouse
United Kingdom	PWR	Sidewell 5	1 182	1987	Westinghouse

Source: DG XVII of the European commition

diversified manufacturing industry under its supervision. This practice is one of the main reasons which help to obtain contracts in countries which are capable of building but are not sufficiently advanced in the design field. Siemens-KWU benefits from the experience gained by Siemens in the traditional electric power station sector, i.e. with turbines and alternators. Apart from this recent agreement with Framatome, Siemens-KWU has signed an agreement with ABB to create a joint venture company, HTR GmbH, with the aim of intensifying the development and marketing of high temperature gas reactors.

In the U.K., having built locally designed Magnox and AGR (Advanced Gas-cooled Reactor), the industry is at present developing, with American cooperation, its know-how in the field of PWR (Pressurised Water Reactor). The CEGB (Central Electricity Generating Board) is taking the role of industrial architect for the first British pressurised water reactor at Sizewell. Westinghouse is supplying the nuclear island, the reactor vessel is coming from Framatome and the other major nuclear elements have been subcontracted by Westinghouse to the British manufacturing industry. The turbines and the alternators are supplied by GEC. GEC has also become the sole owner of NNC (National Nuclear Corporation), which has an agreement with Westinghouse for the introduction of pressurised reactors in the United Kingdom. NNC and Westinghouse each own 50% of PPP (PWR Power Project Company). The present agreements envisage equipping PPP with the necessary resources to, in future, assume the role of a nuclear pressurised water reactor designer and manufacturer. At subcontractor level, Rolls-Royce has recently purchased NEI (Northern Engineering Industries). Apart from the potential advantages linked to a wide range of traditional techniques, the new structure with help to reinforce the two companies' potential in the field of nuclear design and construction. The British industry is also actively involved in the export of conventional electric power stations and has links with foreign nuclear island suppliers (GEC with Westinghouse and Framatome) with the aim of supplying the traditional elements of electro-nuclear power stations.

In Belgium, Italy and Spain, the industry is also suffering from the slowdown in nuclear activities and it is in the throes of partially losing its independence.

In Belgium, the detailed study and project design, construction management and commissioning of electro-nuclear power stations are entrusted to design offices associated with the electricity producers, at present merged within Tractebel. More specific studies on the nuclear steam supply system are entrusted to a foreign supplier, up until now to Framatome or Westinghouse. Further to a government decision not to build an additional electro-nuclear power station proposed by the electricity producers, Tractebel will concentrate its nuclear activities on the supply of services to existing reactors. Amongst the subcontractors who usually participate in equipment manufacturing, ACEC has been bought by ALSTHOM and CMI is seeking a partner.

In Italy, Ansaldo is capable of supplying a LWR nuclear island under license from General Electric and Westinghouse. However, further to a moratorium on the Italian nuclear programme, the national industry has faced limited perspectives in the nuclear sector, but could draw benefit from a recovery in the traditional electric power station market, a market in which export successes have already been achieved. ABB has taken over Franco Tosi and Marelli has created joint venture companies in certain traditional sectors with Finmeccanica, which is State-owned and controls Ansaldo.

The Spanish nuclear programme has lead to the development of an industrial structure along American lines. Several companies are active in this sector, the biggest being the nationalised company, ENITEC (Empresa National de Ingernieria Tecnologica) and the private company Agrupados. Nuclear islands for Spanish electro-nuclear power stations were initially supplied by the American companies General Electric and Westinghouse, and then by the German company KWU. The major manufacturer of heavy equipment, ENSA (Equipos Nucleares), is also a nationalised company. Spanish companies are withdrawing from the activities of maintenance, spent fuel and waste fuel management.

It should be noted that ABB has formed a new company with Westinghouse which brings together the existing European operations of both companies in the LWR sector. The new company's headquarters will be in Brussels with operating units in Madrid and Mannheim.

Outlook

In the medium and long term, the community nuclear fuel and electro-nuclear power station construction industry will continue to adapt itself to the needs of the electricity producing industry. It is forecast that nuclear energy production capacity

will continue to increase until 1995 (1.2% per annum on average). At this time nuclear output should attain 112 GWe (Table 1).

The nuclear fuel industry should derive benefit from this moderate increase in community needs, by satisfying the greatest proportion of this extra demand. It should maintain its development and technical know-how in order to reinforce its share of world markets. As for the electro-nuclear power station construction industry, whilst it has shown its aptitude in developing remarkable industrial know-how and successfully competing with American and Japanese companies, it will continue to feel the need to diversify and simplify its structures to take account of the persistent low order level within the EC and the world in general. On this point, the nuclear sector perspectives are similar to those prevailing in the sector of traditional power station construction.

Revised by: Sema Group Management Consultants

Since 1986, sector growth has slowed down, partly due to the fall in the price of fossil fuels, and partly due to the saturation effect. In the future, the rise in electricity consumption should be slower than GDP growth.
Although nuclear energy has played an increasing part in electricity generation, the prospects for further nuclear expansion are limited.
The rising demand for electricity will probably benefit natural gas, which is becoming more attractive owing to increasing interest in environmental issues.
Following EC unification, the structure of the electrical energy distribution sector will undergo considerable modification.

Definition of the sector

The NACE 161 category includes the generation of electrical energy destined for public use and produced by thermal energy (161.1), hydro-electric energy (161.2) and nuclear energy (161.3), energy distribution (161.4) and electricity generation destined for its own consumption. (161.5 - 161.7)

Consumption

Between 1970 and 1985, the EC's electricity consumption has risen by 60% (or an average of 3.2% per annum). This growth has continued over the last three years but at a slightly slower rhythm (an average of 3% per annum during the 1985-89 period).
With the exception of a short period at the beginning of the 1980s (during the recession), the increase in electricity demand was greater than the growth in the GDP and consequently, between 1970 and 1985, the percentage of electricity in the GDP rose by an annual average of 1.1%.

The countries where the percentage of electricity rose more rapidly than the annual average are those where nuclear energy usage increased the fastest between 1970 and 1985, or those whose state of economic development was the weakest in 1970. At EC level, the percentage of electricity in the GDP has been practically static since 1985. Several factors explain the lack of progress of electricity as a percentage of GDP after 1986:

- the sharp fall in the price of oil and the general fall in solid fuel prices, whilst electricity prices remained much more stable: electricity became less competitive;
- a slow down in nuclear energy expansion, which was partly due to the Chernobyl accident: the proportion of nuclear energy in electricity generation increased rapidly in the 1970s and at the beginning of the 1980s to attain 31% by 1985 (versus only 5% in 1970). Since then, growth has

Table 1
Electricity supply industry (1)
Main indicators, 1980-90

(billion kWh)	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990(3)
Apparent consumption	1 418	1 424	1 422	1 460	1 518	1 585	1 626	1 677	1 727	1 774	1802
Net production (2)	1 209	1 206	1 203	1 230	1 420	1 486	1 524	1 568	1 611	1 655	1732
Electricity consumption as % of final energy consumption	14.7	15.3	15.7	16.2	16.6	16.7	16.8	17.1	17.5	N/A	N/A

(1) Electricity delivered to market (excludes electricity consumed and losses within power stations).
(2) 1980-83 EC-10
(3) Estimated
Source: Eurostat (Sirene), DG XVII of the european commission

slowed down.

- the saturation effect in certain applications and certain countries; this phenomenon is more noticeable in the more economically developed countries, whilst in the Mediterranean countries the market penetration of electrical appliances can still be increased;
- the improvement of appliances and processes in general.

Most of these factors will continue to limit the growth rate of electricity consumption in the future. Saturation effects will be more widespread as member countries achieve an advanced stage of development. Consequently, the percentage of electricity in the GDP should remain stable up to 1991 and then start to decrease.

Electricity has increased its market penetration. The proportion of electricity in final energy demand has in fact grown from 14.7% in 1980 to 17.5% in 1988. The residential and commercial sectors are the main markets for electricity at EC level. As shown in Table 3, this proportion varies substantially according to country, reflecting such diverse factors as industry structure (the size of industries which are heavy electricity consumers), the level of industry automation, the degree of electricity used for heating buildings and the rate of use of electrical appliances in the domestic sector. Electricity can still increase its market penetration in the industrial sector and in the domestic sector.

Table 2
Electricity intensity of GDP (1)

(kWh per thousand ECU)	1970	1985	1986	1987	1988	1989	Change 1985/70(%)
EC	377	443	444	446	442	439	17.5
Belgique/België	398	500	503	518	516	510	25.6
Danmark	272	363	365	382	388	389	33.5
BR Deutschland	387	467	459	459	450	441	20.7
Hellas	N/A	607	622	641	668	673	N/A
España	N/A	542	537	528	525	528	N/A
France	300	438	450	457	450	444	46.0
Ireland	400	442	462	452	447	449	10.5
Italia	323	349	347	354	358	360	8.0
Luxembourg	807	839	804	800	787	776	4.0
Nederland	324	394	394	406	414	413	21.6
Portugal	N/A	759	758	752	778	777	N/A
United Kingdom	509	456	455	447	439	436	-10.4

(1) At 1980 constant prices for GDP. Consumption is defined here as electricity available for the internal market
Source: Eurostat (Sirene, Sec1)

Table 3
Share of electricity in total final energy consumption, by sector and by country

	1980			1988		
(%)	Total	Industry	Households	Total	Industry	Households
EC	14.7	19.6	18.5	17.5	25.3	23.6
Belgique/België	11.7	15.8	12.1	15.2	22.6	17
Danmark	12.8	15.3	16.6	17.8	25.4	23.6
BR Deutschland	15.2	19.6	18.3	17.5	25.3	21.2
Hellas	16.1	21.3	31.7	18.2	26.3	35.1
España	17.6	24.3	28.7	19.6	28.5	37.3
France	14.2	18.1	18.4	19.6	26.4	28.4
Ireland	12.9	17	19.5	14	13.4	19
Italia	14.3	21.2	15.7	16.9	27.1	20.8
Luxembourg	8.9	9	15.6	11.7	13.9	19.4
Nederland	11.4	17.9	18.8	14	20.7	16.2
Portugal	17.3	22.6	34.8	20.9	28.9	41.6
United Kingdom	15.8	19.7	22	16.8	24	24

Source: Eurostat (Sirene)

Production

Three countries generate two thirds of the total EC electricity production: Germany (25%), France (23%) and the United Kingdom (18%) - and five countries (with the addition of Italy and Spain) cover 90%.

Over the past 8 to 10 years, France has considerably increased its share of total electricity generation in the EC. This increase is the consequence of the French energy policy aimed at the massive develop-

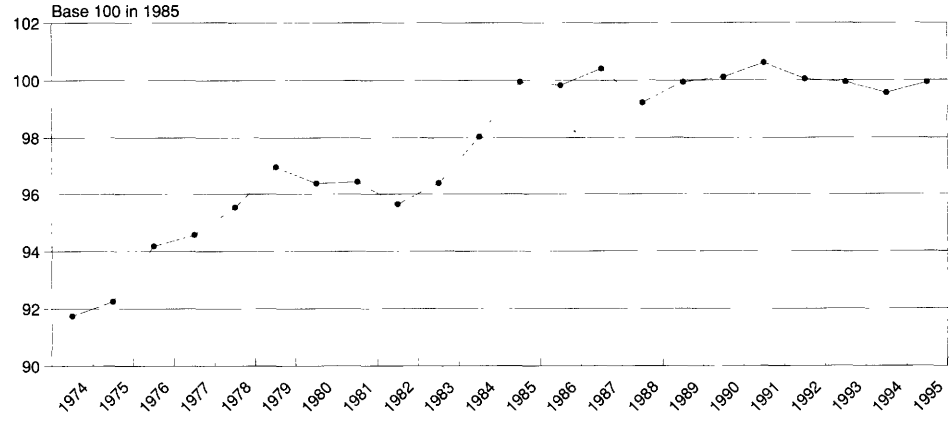
ment of nuclear energy and the promotion of electricity. Other countries in which electricity generation has noticeably increased are those where the economic development level was low at the end of the 1970s.

Used in conventional thermal power plants, fossil fuels continue to dominate energy consumption for electricity generation. However, their contribution to electricity generation has noticeably declined during the 1970s and 1980s to reach 55.9% in 1989 (compared with 83% in 1973). This fall in the use of fossil fuels for energy generation has only been possible due to the strong penetration of nuclear energy, of which the contribution to electricity generation has increased from just 5% at the beginning of the 1970s to 35.6% in 1989. Hydro-electric energy, including geothermal energy, has maintained a relatively stable share of electricity generation of around 8.8%.

Amongst fossil fuels, oil represented a smaller and smaller proportion of energy consumption for electricity generation, with a share of 9.4% in 1988. The sharp fall in oil prices in 1986 led to the slight return to oil as a fuel for the energy generation sector in certain countries, but this phenomenon does not appear in the overall EC statistics as it is compensated for by progressive declines in consumption by other countries. To date, the natural gas contribution is relatively small in the EC overall (although one country, the Netherlands, is heavily dependent on natural gas for electricity generation). However, the growing interest in environmental issues could favour the use of gas in future, if its price is competitive. In fact, natural gas is the least polluting fuel, with very few impurities (notably very little sulphur) and the lowest production of carbon monoxide. In the 1970s, coal and other solid fuels replaced oil for energy generation, but they were confronted by increasing competition from nuclear energy at the beginning of the 1980's. Over the last five years, their contribution to electricity generation has remained static. The price ratio between coal and natural gas will be an essential element in determining the future role of coal in the energy generation sector.

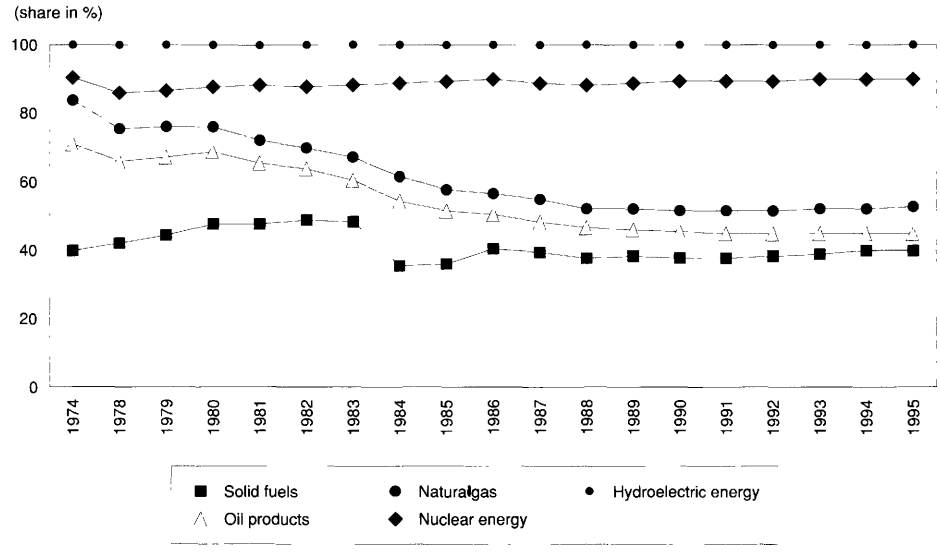
The growth rate of nuclear capacity should decrease and it is forecast that nuclear en-

Figure 1
Percentage of electricity in the EC GDP



Source: DRI

Figure 2
Energy generation sector structure in the European Community



Source: Sema Management Group Consultants

Table 4
Breakdown of electricity consumption by sector

(%)	1973(1)	1980(2)	1986	1987	1988
Industry	50.6	47.1	43.6	43.3	44.8
Households	25.7	28.6	30.4	30.3	29
Other	23.7	24.3	26	26.4	26.2

(1) EC9
(2) EC10
Source: Eurostat (Sirene)

Table 5
Electricity sector
Breakdown of final electricity consumption by country and by sector, 1988

(%)	EC	B	DK	D	GR	E	F	IRL	I	L	NL	P	UK
Industry	44.8	53.3	30.2	48	43.5	52.8	38.8	37.6	52.8	63.4	45.8	52.2	36.6
Households	29	27	31.8	26.5	32.6	24.2	32.6	39.2	24.9	15.4	22.7	24.6	34.8
Other	26.2	19.7	38	25.5	23.9	23	28.6	23.2	22.3	19.2	31.5	23.2	28.6

Source: Eurostat (Sirene)

ergy's contribution to electricity generation will peak in the first half of the 1990s. However, the structure of the thermal power plant park varies greatly according to Member States. France alone posesses 55% of the total nuclear energy capacity of the EC; 70% of French electricity is generated by nuclear power stations. At the other end of the scale, countries such as Denmark and Greece have no nuclear energy and depend entirely on thermal power plants for their electricity generation (refer to Table 8).

Electricity exchange between Member States

Due to the very nature of electricity generation, this must be transmitted to its point of use in zones, regions and Member States as well as across borders. This requirement demands compliance with technical constraints, enabling operational management of electricity transmission, in order to reduce the inevitable energy losses to a practical minimum, and to do this with a view to cost-saving and energy efficiency. For many years, electricity interconnection has developed outside national borders as a logical extension of local, regional and national interconnections, brought on by the technical and economic advantages which a more profitable use of generation facilities provides, and greater reliability with regard to energy supply. In the EC, this trend has brought about the creation of high-tension international networks which are the most highly integrated in the world, even though Ireland and Greece are not yet directly linked to other Member States. Table 9 shows, for 1989, balanced exchanges with other countries (including countries outside the EC) and net exports and imports of electrical energy for each Member State. International exchanges are managed, without executive power, by public electricity authority cooperatives. These organisations are UCPTE (Austria, Belgium, France, Germany, Italy, Luxembourg, the Netherlands, Switzerland, Greece, Portugal, Yugoslavia), UFPTES (France, Iberia), Sudel (Austria, Italy, Yugoslavia) and Nordel (Denmark, Norway, Sweden, Finland and Iceland).

The UCPTE announced in March 1990 the creation of a computerised exchange grouping surplus capacity and electricity needs of member organisations. This system will enable the daily management of exchanges instead of the present weekly sessions. UCPTE thus hopes to contribute to exchange development within the EC.

Table 6
Electricity sector
Net electricity production by country

(billion kWh)	1988	1989	% change
Belgique/België	51	64	25.5
Danmark	26	22	-15.4
BR Deutschland	347	411	18.4
Hellas	21	31	47.6
España	104	140	34.6
France	247	388	57.1
Ireland	10	12	20.0
Italia	177	200	13.0
Luxembourg	1	1	0.0
Nederland	62	70	12.9
Portugal	15	24	60.0
United Kingdom	266	292	9.8

Source: Eurostat (Sirene)

Table 7
Structure of electricity production

(%)	1973(1)	1980(2)	1988
Hydro	11.5	12.3	12.5
Nuclear	5.4	12.4	33.9
Thermal	83	75.3	53.4
Oil	31	21.9	9.4
Natural Gas	10.3	8.9	6.5
Solid Fuel	38.5	42.2	35.5
other	3.2	2.3	2
Total (billion kWh)	98	120	161

(1) EC-9
(2) EC-10
Source: Eurostat (Sirene)

Public utilities themselves signed commercial agreements for the exchange and transfer of electrical energy. From a commercial point of view, the transfer agreements are of three types:

- hourly exchanges on a cost basis, including back-up in the event of grid difficulties;
- contracts, generally short term, for net transfers;
- permanent contracts for energy transfer coming from a generation facility jointly owned in a neighbouring country.

Furthermore, it should be noted that all the elements of the international interconnection system are held by monopolies and that transfer contracts are of a co-operative nature and not obligatory. Interconnections in no way represent a common transfer system. The development of electricity exchanges within the EC is a priority objective for the European Commission. The Council of Ministers on 21st May 1990 adopted two major directives on this subject:

- the "Transit" directive obliges a company managing an electricity transport network to transport energy flows corresponding to the exchanges of two other companies situated either side of its territory (unless this is technically impossible). For the moment this text only covers companies managing interconnection networks;
- the directive on price transparency obliges gas and electricity distributors to inform the Brussels statistics office of their scale charges twice a year. The statistics office will publish the average of these charges.

At present, electricity supply between EC countries and non-Community countries is very low. In 1986, it barely reached 14 TWh (being less than 1% of EC consumption). This volume corresponds to that of electricity supplied by Austria and Switzerland to Italy and Germany, as well as by Norway and Sweden to Denmark.

Table 8
Electricity industry
Power generating capacity by country, 1988

(MW)	Nuclear	Thermal	Hydro	Total
EC	100 494	252 442	77 528	430 464
Belgique/België	5 500	7 194	1 335	14 029
Danmark		8 245	10	8 255
BR Deutschland	21 488	68 149	6 854	96 491
Hellas		5 967	2 151	8 118
España	7 600	20 618	15 497	43 715
France	52 430	23 536	24 651	100 617
Ireland		3 302	512	3 814
Italia	1 120	37 175	17 939	56 234
Luxembourg		106	1 132	1 238
Nederland	508	16 905		17 413
Portugal		3 631	3 282	6 913
United Kingdom	11 848	57 614	4 164	73 626

Source: Eurostat (Sirene)

The supply of electricity between member States has noticeably increased over the last fifteen years. The volume of electricity supplied has increased twice as fast as consumption and at present represents almost 7% of electricity consumption. In 1988, the supply of electricity between Member States increased to 188 TWh (in relation to the figure for Western Europe which, in 1973, was only 58 TWh). France is the only net exporter of electricity in the EC. This situation is the result of the surplus nuclear capacity in France, a capacity which was calculated on the basis of a far greater electricity requirement than that which has actually materialised. In 1988, France exported 39 TWh. France's main export markets are the United Kingdom (13 TWh in 1988), Italy (13 TWh), the German Federal Republic (6.4 TWh) and Switzerland (5.2 TWh). The aim of EdF (the French public electricity utility) is to increase exports up to 40-50 TWh by the middle of the 1990s. This aim is not unrealistic in view of the surplus capacity available in France, and the creation of the internal energy market which should encourage electricity exchanges.

Industry structure

The electricity supply industry (generation, transmission and distribution) of the EC is characterised by the existence of national monopolies which are either de jure monopolies or de factor monopolies (for example, by contracts signed between municipalities in Germany). Electricity supply includes numerous differing activities: fuel supply, energy generation, transmission, transmission network maintenance and local distribution. Competition could potentially increase at each of the vertical levels, with the exception of local distribution.

The electricity supply sector in the Member States can be divided into three major categories:

- integrated State-owned;
- decentralised mixed ownership;
- mixed ownership, State-dominant.

France has the highest level of vertical and horizontal integration, whilst at the other extreme Germany and the Netherlands have the most decentralised structures.

In Belgium, the three private generators

Table 9
EC electricity trade, 1989

(GWh)	Total	B	DK	D	GR	E	F	IRL	I	L	NL	P	UK
Total exports	91.8	7.6	2.2	22.5	0	4.6	51.3	0	0.7	0.7	0	1.3	0.9
Total imports	111.7	5	11.7	22	0.4	2.8	9.3	0	34.5	4.6	5.5	2.4	13.5
Net exports	-19.9	2.6	-9.5	0.5	-0.4	1.8	42	0	-33.8	-3.9	-5.5	-1.1	-12.6

Source: Eurostat (Sirene)

(Ebes, Intercom, Unerg) have grouped together since 10th July 1990 to create a new entity: Electrabel. This grouping is the result of a sector rationalisation process under way since the 1950s and will enable them to better confront foreign competition. Several organisations play a coordinating role:

- the "calory pool" ensures efficient supply of fuel to all electric power stations;
- the electricity company management committee (CGEE) is responsible for investment planning and establishing tariffs;
- the company for the coordination of electrical energy generation and transport (CPTE) coordinates generation and transmission at national level.

The municipalities are responsible for the distribution of electricity destined for lighting and domestic use, as well as to manufacturers who consume less than 1000 kW.

In Denmark, electricity generation is in the hands of twelve companies, all private with the exception of two which are owned by municipalities. The public electricity generation companies are grouped into two associations, ELSAM and Elkraft, which are responsible for coordination and planning generation and transmission capacity, and daily operational coordination of fuel purchases for electric power stations. The transmission grid is used by 28 companies including 5 of the 12 public generating companies. Electricity distribution is provided by 111 companies: 5 of which are also generating companies, 54 are municipal companies and 52 are co-operatives or foundations.

In France, the monopoly for electricity generation, transport and distribution was given to Electricité de France (EdF) in 1946. EdF covers 88% of installed generation capacity and 96% of electricity distribution.

In Germany, the electricity supply industry is highly decentralised, with some 960 individual public electricity companies. However, the sector is tightly controlled and public companies are some way from operating in an open market. Several federal and regional organisations are responsible for coordination and regulation. Nine large public companies "first division" (two of which are nationalised) own and operate the majority of generation capacity, including all the nuclear power stations and almost all the national high-voltage grid. The 74 regional public companies "second division" have some generation capacity and cover certain transport and distribution activities. The "third division" municipal public companies only distribute electricity over the low-voltage grid.

Within the framework of privatising the old East German network, it was decided in August 1990 that 60% of the network would be taken over by the three main German electricity generating groups (RWE, Preussen Elektra and Bayernwerk) brought together within a new organisation.

The remaining 40% will be taken over by independent regional operators and by a coalition of Community electricity organisations.

In Greece, the Public Power Corporation holds the monopoly for generation, transmission and distribution. The situation in Ireland is the same with the Electricity Supply Board.

In Italy, the Ente Nazionale per l'Energia Elettrica (ENEL) is a state company responsible for electricity generation, import and export, transmission and distribution throughout the country. The only exceptions to the ENEL monopoly are the following:

- the municipal companies in existence before 1962;
- generating organisations which consume more than 70% of their own production;
- production by combined electricity and heat generating plants which produce less than 3MW;
- generation from renewable resources.

In the Netherlands, electricity generation, transmission and distribution is in the hands of municipal and provincial companies. After the sector re-organisation in 1987, there are now 7 provincial companies and one municipal company responsible for electricity generation and transmission. They are grouped within the electricity generators cooperative (SEP), which is responsible for capacity planning and inter-provincial and international electricity exchange coordination. 67 municipal companies distribute electricity and are grouped within VEEN.

In Portugal, Electricidade de Portugal (EdP) has the quasi-monopoly for generation and transmission. Independent generation and transmission is permissible in those areas not covered by the EdP distribution grid.

In Spain, the electricity industry is composed of a large number of public companies. 21 of them generate electricity and are grouped within Unidad Electrica (UNESA), which is responsible for coordinating generating and transmission activities. The electricity grid was nationalised in 1984 and is operated by REDSA.

In the United Kingdom, the 1983 Energy Act confirmed the role of four bodies for electricity supply:

- CEGB in England and Wales;
- SSEB in Southern Scotland;
- NSHEB in Northern Scotland;
- NIES in Northern Ireland.

SSEB, NHSEB, and NIES are fully integrated, whilst the CEGB is only responsible for generation and transmission; distribution and sales being covered by the twelve Area Boards. None of these entities enjoys in law the monopoly of generation, sales or grid usage.

The United Kingdom has undertaken a privatisation programme which should take place in December 1990 (sale of the 12 Area Boards), in February 1991 (sale of English, Welsh and Irish companies) and in May 1991 (sale of the two Scottish companies).

From these sales three generating entities should emerge in England and Wales:

- National Power (half of generating capacity);
- Power Generating Co.;
- Nuclear Electric (will only be responsible for nuclear power stations and will remain public, being considered as unsaleable).

The transmission grid will be owned by the Area Boards but its operation will be independent. Local entities will be able to generate electricity themselves or purchase it from another supplier. National Power, PowerGen, the Scottish public companies, Electricité de France, local entities, industrial co-generators and all those who generate electricity will compete for the supply of energy to local entities as well as to large consumers under contract. Responsibility for final electricity delivery to consumers rests with the local entities.

These operations should increase competition in the generating sector, alongside that which already exists in the distribution sector. The new entities' scope of action is limited, however, by constraints in terms of coal purchases from British Coal and the use of nuclear electricity generating capacity, for example. The new companies are focussing particularly on electricity generation from mixed gas/coal power stations.

It is worthwhile increasing the transparency of this competition at European level. Thus, in 1990, when German industrialists intend purchasing their electrical energy in France, German electricity generators complain of the subsidies received by EdF for the development of its nuclear capability. For its part, EdF denounces the considerable subsidies accorded to German coal and lignite used in thermal power stations.

Consequences of EC unification for the electricity industry

To achieve a more open internal market in the field of electricity, the Commission has identified a certain number of potential obstacles which must be eliminated.

Amongst these, a lack of harmonisation of KWH prices between Community members can be noted. Table 10 shows the price per KWh in each country.

These prices are strongly influenced by certain elements that the electricity generating companies do not control, such as national and regional policy in the field of energy, the environment and taxation. Within the Community, these various policies can be strongly interlinked and sometimes contradictory.

Another major consequence of the establishment of the internal energy market is the opening up of tenders for the supply of equipment ordered by the public electricity companies. As from now, these companies must open up their bid procedures in order to treat on an equal footing all Community suppliers. These measures have contributed to the acceleration in the concentration/restructuring of the European electro-mechanical industry.

Environmental issues

The Directive on emissions control from Large Combustion Installations (LCI) was adopted by the Council in November 1988, after 4 years of animated debate. The Directive comprises two parts and is based on the use of better available techniques at a reasonable cost. Applying this technical constraint contributes to ensuring the evolution of new and better technologies aimed at reducing pollution. The first part of the Directive covers combustion installations built before 1st January 1990 and exceeding 50 MWh. Further to this Directive, all new large combustion installations will be subject to an authorisation procedure in order to guarantee that they comply with the emissions limits for

SO_2, NOx and dust.

The second part applies to existing fixed combustion sources (those authorised before 1st July 1987) and to specific target values for emission reduction based on the 1980 level. SO_2 emissions must be reduced by a total of 60% to reach 1980 levels in three stages (10% by 1993, 40% by 1998 and 60% by 2003). Installations authorised before 1987 and built before 1990 must either comply with the standards for new installations, or be accounted for in the new overall emissions levels without increasing the overall value limit.

Although the emission standards for new installations have been unified, standards relating to overall objectives vary from one country to another.

Furthermore, exceptions have been included at the request of specific countries. Countries can request a certain flexibility with regard to their objectives for technical reasons or for "substantial and unexpected changes in energy demands or the availability of certain fuels or of certain generating installations".

Emission limits recently by the EC for LCI favour the development of natural gas in the energy generating sector and the construction of small electric power stations.

Despite the fact that limits imposed for new installations for NOx emissions can be met without the need for expensive NOx emission reduction equipment, the proposed SO_2 emission limits are relatively restrictive as regards the use of coal.

Strict compliance with the Directive could double the quantity of natural gas burnt in electric power stations at the end of the 1990s (in relation to a situation of unchanging legislation in 1988).

The impact of emissions control on electricity prices is greater in Denmark, the Netherlands, Germany and the United Kingdom. However, even if emission reduction costs should be spread equally amongst all electricity users, consumer prices before tax would be affected by less than 7%.

Employment

Overall employment in the EC remained static during the 1980s at around 900 000 employees, thus translating productivity gains. A fall in manpower in the United Kingdom was compensated by small increases in other countries.

Outlook

For the future, it is forecast that electricity demand will continue to increase, but at a slower rate than in the past, and at a lower rate than that of GDP for the reasons mentioned above. From an average of 3.1% between 1970 and 1988, the average growth rate for electricity demand should fall to 2.6% between 1988 and 1995 (Table 11). Amongst the user sectors, it is the domestic sector which should register the highest increase because of growth in consumer expenditure and wider ownership of electrical appliances in certain Member States. Amongst the Member States, growth will be strongest in Greece, Ireland, Portugal and Spain.

Apart from installations under construction or already planned, nuclear capacity should increase very little. The major part of this increase in capacity will be in France. Consequently, it is forecast that nuclear contribution to electricity generation will peak at 37% at the beginning of the 1990s and then slowly decline. The only country in which the share of nuclear energy should continue to increase is France, where it could reach 80% by the middle of the 1990s. France should export increasing volumes of electricity, notably to Portugal across the Spanish grid. The interest generated in atmospheric pollution and the greenhouse effect could improve prospects for nuclear energy, but the impact will not be felt before the end of the century, taking account of the long time-scales for planning and building new nuclear

Table 10
Price of electricity in the EC countries, 1989

Industrial use (EC/100 Kw) (1)	B	DK	D	GR	E	F	IRL	I	L	NL	P	UK	spread (2) (%)
1989	7.67	6.47	10.82	6.80	9.05	6.89	7.86	8.89	8.32	7.16	7.68	7.63	67
1988/89	-1.7	22.7	0.3	0.8	13.8	0.2	-4.9	6.6	0.9	-3.3	-1.2	14.9	
1980/89	2.8	4.1	6.2	5.9	12.7	4.1	5.4	6.7	6.6	1.3	11.1	4.8	
Domestic use (ECU/100 Kw) (3)													
1989	17.43	14.34	18.88	8.69	13.99	13.01	11.88	9.03	14.57	12.06	11.42	13.88	109
1988/89	-0.4	12.3	0.3	0.8	14.6	-1.0	-0.2	4.7	1.3	-5.0	-1.2	16.9	
1980/89	4.0	7.4	6.8	6.6	10.1	3.1	7.1	7.2	3.3	2.6	10.7	6.4	

(1) Data refers to an annual consumption of 1,250,000 Kwh
(2) Difference of the highest and the lowest price in percentage of the lower price
(3) For an annual consumption of 1200 Kwh which corresponds to a 70 m2 house
Sources: Eurostat , ERA calculations

power stations. According to forecasts, electric power station oil consumption will continue to decline and oil's contribution to electricity generation will be further reduced. Turning to solid fuels and natural gas will enable further generation requirements to be satisfied. Between 1988 and 1995, electricity power station gas consumption could increase by 50% - or even more in a price/environment scenario which is particularly favourable to natural gas - thus raising gas's contribution to electricity generation to the level of 8-10% (versus 6% at present). Despite the fact that during the same period solid fuel consumption in the energy generating sector will increase by 14%, the proportion of solid fuel in the fuel supply of electric power stations should remain almost static. The two directives on price transparency and electricity transit favour competition and the liberalisation of exchanges within the EC.

An increase in interconnections and electricity exchanges is forecast. The future could bring the integration of the former GDR, Hungary and other Eastern European countries within the Community distribution system, as well as new links with the USSR.

In the Mediterranean basin (across new cables Spain - Morocco, Italy, Tunisia, Italy - Greece and towards the East), more than 3000 MW should be available before the end of the century for the first North-South exchanges.

Table 11
EC electricity production forecast (1989 constant price)

(million ECU)	1989	1990	91/90	92/91
Production	222	229	+3.1	+3.0

Source: Sema Group Management Consultants

Revised by: Sema Group Management Consultants

Transmission and distribution of natural gas

Provisional data for 1989 show an increase in gross EC consumption with corresponding increases in both Community production and imports.

1988 was a less buoyant year for gas than 1987, largely because of milder temperatures and heavy competition from oil arising from depressed crude prices.

This reduced demand level was met by a reduction in supply of Community primary production (-8%), and a very modest increase in imports from third countries (+1.8%). Presently, natural gas accounts for about 18% of total energy consumption. There was an apparent decline in domestic sector consumption (-5%) for the first time in years although on a temperature corrected basis, estimates show a stable market. In the Member States with relatively young gas industries, growth was evident.

In 1988 there was an increase in investment levels, in both the transmission and distribution sectors. Significant decisions to expand the network continue to be taken.

Description of the sector

Gas is largely burned as a fuel for space heating and hot water production. It is also used in power stations to generate electricity, and for non-energy purposes as a feedstock to the chemical industry, in the manufacture of intermediate products such as ammonia.

The natural gas industry embraces a range of activities, of which the three principals are exploration and production, transmission, and distribution. Some companies carry out all three activities including exploration and production, but this activity is generally considered to be outside the gas sector since it is mainly carried out by major oil companies. The industry applies the term transmission to:

- the purchase of gas from producers or from other transmission companies;
- the transportation and storage of gas;
- the sale of gas to industrial consumers and power stations and to local distribution companies.

Table 1
Transmission and distribution of gas
Main indicators, 1982-90

(GCV) (1)	1982	1983	1984	1985	1986	1987	1988	1989	1990(2)
Gross EC consumption	7 458.6	7 791.5	8 217.0	8 592.3	8 689.6	9 221.9	8 956.8	N/A	N/A
Primary EC production	5 395.5	5 579.5	5 580.2	5 913.5	5 798.3	6 001.6	5 590.6	5 762.5	5 865.1
Imports from third countries	2 226.3	2 436.0	2 777.9	2 858.8	3 094.0	3 427.2	3 474.3	3 731.5	N/A

(1) GCV = gross calorific value; Thousand TJ
(2) Estimated
Source: Eurostat (Sirene)

The transmission side of the business, irrespective of the industry structure involves strategic planning in the long (ie 20 years + horizon) and shorter terms to ensure security of supply for consumers.

The distribution activity is concerned with the supply of gas by a local network, to domestic and non-domestic consumers linked to this network.

Supply and demand trends

In volume terms Community production fell steadily as a percentage of gross EC consumption from 72% in 1982 to the present 62%. Over the same period imports rose from 30% to about 40% of gross EC consumption.

Production Provisional figures for 1989 indicate an increase in primary production of about 4% over 1988, but it remains level as a share of gross national consumption.

In 1988 Community production was almost 5.6 million TJ, a decrease of about 7% from 1987. The largest producers, the Netherlands and the UK, reduced production by about 12% and 4% respectively, the Federal Republic of Germany by 7%, France by more than 20%. Denmark's and Italy's production levels, however, remained steady, and Ireland increased production by more than 20%.

As a percentage of gross EC consumption, production fell by about 2% from the previous year, to 62%. The Netherlands continued to be the principal Member State gas supplier, and in 1988 supplied 946,645 TJ to the other Member States.

Imports from third countries Imports from third countries are expected to total 3.73 million TJ in 1989, a volume increase of 7% over 1988, and about 40% of total gross EC consumption. Imports totalled 3.77 million TJ in 1988, an increase of about 1.5% over 1987 and about 38% of gross EC consumption.

The USSR increased its exports the most to Italy, Norway to Belgium, and Algeria to Spain (+41%) and Belgium, while reducing exports to France and Italy.

The volume of gas from USSR, the major third country supplier increased by 4% over 1987; the share of Soviet supplies rose slightly to 38.9% (37.8% in 1987).

It is estimated that the existing production and transmission infrastructure will permit the USSR, without much incremental cost, to increase its exports to western Europe by another 20 million toe. Given the size of the Russian gas reserves and provided the appropriate political and economic conditions prevail, substantially greater supplies into the Community could be envisaged.

The volumes of Norwegian and Algerian gas demand remained about level as did their share in EC imports, about 32% and

Table 2
Transmission and distribution of gas
EC Trade by origin, 1982-89

1000TJ (GCV) (1)	1982	1983	1984	1985	1986	1987	1988	1989
Primary production	5 395.5	5 579.6	5 580.2	5 913.5	5 794.8	6 001.7	5 590.6	5 762.5
Intra-EC trade	1 297.4	1 306.2	1 207.0	1 297.4	1 115.7	1 123.5	978.0	1 131.1
Imports from third countries	2 226.3	2 436.0	2 777.9	2 858.8	3 094.0	3 427.2	3 474.3	3 731.5
Norway	1 007.8	1 005.1	1 090.6	1 030.4	1 039.2	1 133.2	1 122.9	1 162.1
USSR	841.7	823.8	949.4	979.6	1 215.0	1 294.7	1 351.7	1 475.2
Algeria	333.7	530.0	684.6	797.9	797.9	961.5	960.8	1 039.5
Other	43.2	77.1	53.5	50.1	41.9	37.8	38.9	54.7
Third country imports as a % of gross EC consumption	29.8	31.3	33.8	33.3	35.6	37.2	38.8	40.3

(1) GCV: gross calorific value; TJ = 10KJ
Source: Eurostat (Sirene)

Table 3
Share of natural gas in gross EC consumption, 1982-88

(%)	1982	1983	1984	1985	1986	1987	1988
EC	16.6	17.4	17.8	17.9	17.9	18.6	17.9
Belgique/België	16.4	17.6	17.6	16.8	14.6	16.1	15.6
Danmark	0	0.1	0.6	3	5.5	6.9	7.8
BR Deutschland	15.4	15.9	15.8	15.5	15.5	17.1	16.5
Hellas	0	0.4	0.5	0.4	0.6	0.6	0.7
España	3.1	3.2	3	3.3	3.6	3.6	4.2
France	12	12.7	12.6	12.5	12.3	12.5	11.8
Ireland	20.5	22.3	22.7	22.2	15.1	14.4	17.2
Italia	17.3	17.9	20.5	20.6	21.5	22.8	23.5
Luxembourg	9.2	9.1	9.2	9.7	9.8	11.4	11.3
Nederland	48.3	50.6	51.2	52.8	51.2	51.5	47.3
United Kingdom	21	21.9	22.6	23.1	23.2	23.3	22

Source: Eurostat (Sirene), IEA

28% respectively.

Norwegian gas deliveries to the Community will take on a new dimension when the development of the huge Troll-Sleipner project and the corresponding infrastructure, including a pipeline (Zeepipe) to Zeebrugge in Belgium, are completed in the mid-1990s. Initial deliveries of about 7 million toe in 1994 are rapidly reaching 20 million toe at the end of the century and may even go up to 27 million toe per annum if corresponding contractual options are exercised by buyers. For the period 2005 onwards, annual volumes could rise to 36 million toe provided contract partners on the production side and on the importing gas transmission companies side make the required decisions in the mid 1990s.

Algerian gas is transported by pipeline via Tunisia into the Italian grid and as liquefied natural gas (LNG) via Arzew and Skikda, where the gas is liquefied to various LNG terminals on the coast in Belgium, France, Spain, the United Kingdom and, from 1992 onwards also to Greece.

Share in gross energy consumption

The share of natural gas in gross energy consumption in 1988 was 17.9%, slightly down on the 1987 share of 18.6%. Excluding Greece and Portugal, the 1988 shares ranged from 4.2% in Spain to 47.3% in the Netherlands. In Denmark, Spain, Ireland and Greece, gas increased its share, and Italy was the only country with a "mature" industry to show a slight rise (see table 3).

Consumption trends In 1988 the gross EC consumption was 8.96 million TJ, a decrease of about 3% against 1987.

This compares with an increase of 6% in 1987 against 1986. This decline is mainly due to a fall in domestic consumption of gas by 225 214 TJ, about 5%, which contrasts strongly with the steady growth in this area in the preceding years, but after temperature correction, gas sales in this sector are estimated to have stabilised. Elsewhere too, the gas market remained relatively stable. Final non-energy consumption continues to decline, but at a much slower rate than in previous years and the industry's consumption rose slightly, by less than 50,000 TJ (+2%), but this is much less than the 12% increase of 1987 over 1986. The volume of gas transformed in power stations fell by 8 590 TJ, less than 1%.

Consumption decreased in most of the Member States (BLEU, Germany, France, the Netherlands and the UK, the last two by 9% and 5% respectively, but if figures are adjusted for variation from normal temperatures, then gas sales are estimated to have increased slightly in the UK, and to have fallen only marginally in the Netherlands. Moreover, the net effect of energy saving through installation of appliances with higher efficiencies is beginning to have an impact. Consumption increased in Denmark (+7%), Ireland (+20%), and Spain (+28%). Spain registered impressive increases in the industrial sector and the non-energy sector. Despite the overall slight decline of gas in power stations, its use increased in a number of countries (Belgium, Denmark, Germany, Ireland and Italy) but this was offset by decreases elsewhere, notably the Netherlands and the UK. Provisional figures indicate that the gross EC consumption in 1989 increased by about 3%, bringing the figure to the buoyant level of 1987. Consumption increased in all the Member States, ranging from +30% (Spain) to +2% (Netherlands) except the UK where it declined by 0.5%.

Gas prices Wide price variations between Member States for the same categories of consumers cannot be fully explained only by differences in costs, as they are heavily influenced by the different Mem-

Table 4
Trends in consumption and usage of natural gas, 1982-88

1000TJ (GCV) (1)	1982	1983	1984	1985	1986	1987	1988
Gross EC consumption	7 458.6	7 791.5	8 217.0	8 592.3	8 689.6	9 221.9	8 956.8
% of total energy consumption	16.6	17.4	17.8	17.9	17.9	18.7	17.9
Final non-energy consumption	540.3	569.0	646.2	626.6	529.7	527.2	531.2
Transformed in power stations	965.0	1 046.7	1 152.4	1 055.0	1 020.0	1 108.0	1 098.7
Final energy consumption	5 666.4	5 807.5	6 135.4	6 536.7	6 698.6	7 193.5	7 016.7
of which,							
Industrial	2 151.3	2 260.9	2 331.9	2 376.7	2 341.7	2 632.5	2 681.8
Domestic and commercial	3 502.9	3 634.5	3 791.5	4 148.8	4 355.5	4 549.7	4 324.5

(1) GCV: gross calorific value
Source: Eurostat (Sirene), IEA

ber States gas industry structures, pricing policies and taxation levels.

A more open and competitive gas internal market in Europe may help the price of alternative fuels become a ceiling for natural gas prices, and that gas to gas competition within the gas market should increasingly determine the gas prices at the different stages of gas production, transmission, distribution and final sales to end consumers.

Industry structure

The two-tiered structure In Belgium/Luxembourg, Denmark, Italy, the Netherlands and Spain, an essentially two-tiered vertical structure has developed:

- one merchant company is responsible for the transmission and related services. The company imports and perhaps exports gas, sells to large end-users such as major industrial consumers or power stations, or to undertakings responsible for distribution;
- other undertakings which are responsible for distribution activities, including regional carriers and local utilities, operating on a local basis, market and supply natural gas to domestic and non-domestic consumers through a local network.

The characteristics of the gas industry structure in West Germany link it into this group. There the distinction also exists between transmission and distribution responsibilities. In Germany, however, there is more than one merchant company importing gas and carrying it over long-distances as well as a number of regional transmission companies operating on basis of local concessions. There are about 500 municipal utilities.

Within this first group, some transmission companies are wholly state owned as in Italy and Spain, where SNAM and ENAGAS respectively are subsidiaries of Government energy holding enterprises, while others such as DISTRIGAZ of Belgium and GASUNIE of the Netherlands are in mixed state/private sector ownership. In Germany, private sector ownership, involving some major international oil companies and other industrial concerns predominates, but there is also an indirect public sector interest.

A number of the companies in the group, notably those with public sector involvement, have exclusive national concessions for purchase and/or transport and storage of gas. In Italy, this is limited geographically, and the state-owned organisation was granted exclusive rights in the north,

Table 5
Trends in natural gas consumption by country, 1982-88

1000TJ (GCV) (1)	1982	1983	1984	1985	1986	1987	1988
Total	8 152.6	7 792.0	8 217.0	8 592.1	8 689.3	9 211.4	8 956.6
Belgique/België, Luxembourg	328.3	343.3	354.8	355.0	317.7	356.1	352.1
Danmark	.0	0.6	4.6	26.3	47.8	60.8	64.8
BR Deutschland	1 781.8	1 843.0	1 896.1	1 918.2	1 908.5	2 115.7	2 069.6
Hellas	3.5	3.2	3.5	3.3	4.5	5.2	6.2
España	97.3	99.5	94.8	109.4	118.8	121.9	155.7
France	981.8	1 042.6	1 090.2	1 129.1	1 131.8	1 168.3	1 104.5
Ireland	771.2	82.6	87.8	90.5	63.2	62.8	75.7
Italia	1 022.8	1 048.6	1 234.0	1 265.2	1 343.3	1 491.5	1 561.5
Nederland	1 274.2	1 356.7	1 433.7	1 503.7	1 512.9	1 563.6	1 416.7
United Kingdom	1 891.7	1 971.9	2 017.5	2 191.4	2 240.8	2 265.5	2 149.8

(1) GCV: gross calorific value
Source: Eurostat (Sirene), IEA

where the gas fields were found, with respect to pipeline construction and gas transport.

These differing structures have different consequences for the gas transmission market structures, with some companies having monopolistic or near monopolistic positions as a result of these national concessions, but others not. In Italy for example, SNAM today has about 98% of the market throughout the country, while in Germany, RUHRGAS, the largest of the transmission companies, has about 75%. With regard to distribution in this tiered structure, the municipality is usually the cornerstone of the system, but may operate in conjunction with private sector interests. In Italy, for example, although gas distribution is formally the responsibility of the comuni (Italy's smallest unit of local Government) it may opt to give a long-term concession to a private operator to sell gas. 70% of comuni operate this system.

The vertical Structure In three Member States, the United Kingdom, France and Ireland there is a vertical structure, with the same company or companies responsible for activities from the purchase of gas to its distribution. The French and Irish companies are in the public sector, the British company in the private.

In the UK, however, a process is under way which over time is expected to change the market structure somewhat. BRITISH GAS, until now the sole gas supply company in the UK, is legally obliged to offer a common carriage service; that is other suppliers may pay to use the pipelines of British Gas to carry gas to their customers. It is, however, too early to assess how and to what extent this will lead to changes in the market.

The European grid

Investment The physical infrastructure of the gas industry consists of pipelines and of other equipment needed to regulate the passage of gas through the pipelines (notably compressors) as well as for storage and gas treatment. Table 6 shows the investment undertaken in recent years. The data concerns only transmission and distribution investment.

The outlay in 1988 was 4.77 billion ECU, an increase of 6% over 1987. Investment increased in both transmission (+9.67%) and distribution (+5.6%). Over the 6 year period, transmission investment declined by about 22%, but investment in distribution activities has increased by 56%, resulting in an overall increase of 24%.

This pattern reflects the maturity of the transmission grid in the majority of Member States, and the continuing expansion of the distribution lines to supply new end-users. However, the 1988 increase in transmission investment included France (+20%), the UK (+5%) and Germany (+9%), all countries with well developed and evidently still developing gas industries.

Planned expansions A sub-sea pipeline is planned which will link the Republic of Ireland to the UK. In Portugal, which as yet has no natural gas supply, planning continues for a proposed LNG Terminal to the south of Lisbon, from which it is planned to construct pipelines running north to Lisbon and other principal cities.

Spain and Algeria have agreed to carry out a feasibility study on a new link between Algeria and Europe through Morocco. It has been decided to upgrade the existing link between Algeria and Italy.

The gas infrastructure needs of eastern Europe may be expected over time to result in more integration with the west.

Natural gas and the environment

Natural gas has a potentially very important role to play in the world's endeavours to ensure a cleaner, healthier environment. Its chemical make-up makes it an environmentally-friendly fuel. Natural gas contains no sulphur and no particles and thus in comparison to other fossil fuels, it reduces the emission levels of SO_2 and particles in the air. It can be burnt at lower temperatures than other fuels, resulting in reduced emissions of nitrogen oxides. Natural gas can also make a major contribution to the precautionary measures to reduce the risk of adverse effects of global warming (the greenhouse effect). Natural gas combustion, in common with that of other fossil fuels, produces CO_2, but quantities produced per unit of energy used are less than for other fuels. Switching to fuels emitting less CO_2, together with energy conservation and increased fuel efficiency, will help reduce overall

Table 6
Transmission and distribution of natural gas Investment, 1982-88

(million ECU)	1982	1983	1984	1985	1986	1987	1988
Transmission	1 653.8	1 594.2	1 480.7	1 391.4	1 400.6	1 132.8	1 241.1
Distribution	2 169.9	2 265.7	2 640.5	3 007.0	3 217.0	3 338.2	3 525.5
Total	3 823.7	3 859.9	4 121.2	4 398.4	4 617.8	4 471.0	4 766.6

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Source: Industry sources

Table 7
Transmission and distribution of natural gas
Investment by country, 1988

(million ECU)	B	DK	D	E	F	IRL	I	NL	UK
Transmission	16.4	23.2	335.0	59.6	180.2	33.0	349.3	91.1	153.4
Distribution	89.0	185.2	1 088.0	159.4	427.5	23.8	829.4	245.8	477.3
Total	105.4	208.4	1 423.0	219.0	607.7	56.8	1 178.7	336.9	630.7

Source: Industry sources

CO_2 emissions.

In recent years there have been significant advances in energy efficiency technology for which natural gas can be used to an advantage, leading to energy savings compared with traditional practices and hence significant CO_2 reductions. The most notable are:

- ❖ combined cycle power generation;
- ❖ combined heat and power;
- ❖ replacement of central steam or hot water boilers by point of use technology;
- ❖ heat recovery in high temperature processes.

The industry is also taking all the necessary steps to prevent leakage of methane, although this is recognised to be very slight when set against other sources of methane emissions to the atmosphere, mainly agricultural activities and the natural world.

Outlook

The outlook for natural gas continues to be favourable. Demand is forecast to increase into the next century, as a result of continuing growth throughout the Community as a whole.

According to the Commission study "Energy 2010" broadly discussed at the conference on "Major themes in energy" on 3/4 May 1990, natural gas is expected to increase its share in the Community's energy balance. The results of this study are shown in Table 8.

Scenarios 1 to 3 show an increase from 1989 to 2010 in the total annual consumption of natural gas in the range of 100 million toe. (Scenario 4, in parallel with the relatively low total consumption of energy, shows an increase of about 50 million tonnes of natural gas consumption. However, the share of gas increases to a significantly higher level of 25%).

The level of indigenous production remains stable in all four scenarios. Additional demand will be covered by imports. The net imports into the Community will increase from 74 million toe in 1989 to between 160-180 million toe according to these scenarios.

In the short term, buoyant expansion is foreseen in the relatively young markets of Spain, Ireland and Denmark. In the more mature markets, sectoral developments will be significant. Increased use of gas for electricity generation will boost demand for natural gas as Member States decided to rescind the 1975 Community Directive limiting the use of gas in power stations. New markets will be developed in Greece and Portugal.

Various factors will influence the role of growth, including:

Table 8
Forecast position of natural gas in the Community's energy balance in the year 2010

	Total EC energy consumption (mio toe)	Of which natural gas consumption (1) (mio toe)	EC natural gas production (%)	EC natural gas production (mio toe)	EC net imports of natural gas as (%) of (1)	EC net imports of natural gas (mio toe)	as (%) of (1)
Scenario 1 (conventional wisdom)	1377	287	20	129	45	157	55
Scenario 2 (driving into tension)	1502	307	20	133	43	175	57
Scenario 3 (sustaining high economic growth)	1179	304	20	126	42	177	58
Scenario 4 (high prices)	975	248	25	119	48	129	52
In contrast 1989	1080	199	18	123	62	74	37

(1) GCV:gross Calorific value
Source: "Energy 2010", Commission of the European Communities

- environmental concerns, and their consequence for the pattern of fossil fuel use;
- developments in the other fuel markets especially the trend in oil prices, which once again have entered a volatile period, the policy on the role of nuclear generation of electricity and the decline of coal production in the Community;
- the competitive position of natural gas in the different end-markets;
- the implications for the gas industry of the Commission's drive towards an internal energy market;
- the longer-term effects on the supply-demand patterns of gas of the anticipated growth of demand in eastern Europe underpinned by the need for cleaner forms of energy.

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