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ENERGY 2000

A reference projection and its variants for the
European Community and the World to the year 2000

(Commission staff paper)

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I. INTRODUCTION

1. At its meeting on 13 November 1984, the Energy Council continued its discussion of a Commission report reviewing Member States' energy policies and progress made towards attainment of the energy objectives set for 1990.

The Commission confirmed its intention at this meeting of submitting proposals for new energy objectives for the next decade, which would take account on the one hand, of the results of the detailed examination of the Member States' energy policies¹ and, on the other, of the Commission study on the energy supply and demand options up to the year 2000.

A résumé of the main results of this study was submitted in a Commission working paper entitled "Energy prospects to the end of the century",² which was circulated to the Community institutions at the end of December 1984.

The present document presents the results of the same study in greater detail. It also sets out the method used and assumptions made in this study.³

2. Following a brief description of the methodology, this paper describes the hypotheses adopted to construct a reference projection and the results obtained for energy supply and demand in the European Community (EUR-10) up to the year 2000.

It then synthesizes the characteristics of the reference projection for each of the 10 Member States (studies will be completed later on Spain and Portugal).

The report also examines several variants of the reference projection in order to show the effects of possible changes in the economic and energy environment

The projections made for the Community are then placed in a world context to test their validity.

¹See doc. SEC(84)1658, dated 30 October 1984.

²See doc. SEC(84)1992, dated 18 December 1984. The present paper updates the results presented in SEC(84)1992.

³A detailed technical report on this study is being prepared by the Directorate-General for Energy and the Directorate-General for Science, Research and Development. This working paper will be available on request from the respective Directorates-General in the course of March 1985.

Finally, a number of general conclusions are drawn on the basis of the study results.

Global energy balances for the Community from 1973 to 2000 are supplied in the annex to the report.

II. METHOD

3. The exploratory study of the energy market up to the year 2000 was carried out by a joint working party from the Directorate-General for Science, Research and Development and from the Directorate-General for Energy, with the support of experts from other Directorates-General. It was carried out in six stages.
4. The first stage culminated in the choice, as a general framework for the study, of a socio-economic scenario for the Community as a whole which reflected a broad consensus in the group on the probable development of the European economy and society in the last part of the century. The group drew on previous work under the FAST⁴ multiannual research programme for the purposes of defining this scenario and describing its main parameters in qualitative terms.

The second stage concerned the definition of the characteristics of these socio-economic parameters for each of the Member States. These characteristics were then translated into quantitative terms. In carrying out this phase of the study, the group referred to a previous study⁵ made with the aid of an informal multidisciplinary working party. The results of these first two stages are contained in Part III below.

During the third stage, long-term projections of energy supply and demand in the Member States were made using mathematical models developed within the framework of the Community's programme of research on energy systems analysis. Three sets of models were used.

The first, known as MEDEE 3, is techno-economic in nature, and is designed to simulate energy demand at the final consumption level: industry, transport, residential and tertiary sector.

⁴"Forecasting and Assessment in the field of Science and Technology" (XII-A-1).

⁵This study was circulated in a limited number of copies and is entitled: "Scenarios to the year 2000 - an exploratory study of the market for energy in the European Community - 1983".

⁶The informal interdepartmental group included specialists in economics, industry, agriculture, transport, research, forecasting and energy. It held several meetings from May to October 1982.

⁷"Energy Systems Analysis and Strategic Studies (XII-E-5).

The second, known as EFOM-12-C, uses linear programming to optimize the primary energy supply needed to meet a given level of final demand.

The third model, EURECA, established the necessary coherence between the economic variables, the price of imported oil and the other variables in the energy market.

The fourth stage involved analysing the national results obtained and comparing them with the most recent national projections. The national administrations responsible for energy and several market operators were consulted. The national results were then aggregated to arrive at a reference projection for the Community.

During the fifth stage, variants of the Community reference projection were studied. The aim of these variants was to assess the magnitude of the uncertainties affecting the energy market and to ascertain the sensitivity of the results to possible variations in the main hypotheses.

The validity of the results obtained for the Community was analysed in the sixth stage, by placing these energy projections in the wider context of the world energy market. To this end, the supply and demand conditions for energy in the various parts of the world up to the year 2000 were studied.

III. A "REFERENCE PROJECTION" FOR THE EUROPEAN COMMUNITY: BASIC HYPOTHESES

5. The reference scenario studied is based on existing economic systems and their possible extension in the medium term. The economic framework assumes a gradual resumption of growth, but at a slower rate than in the sixties. It also assumes that the restructuring of industry will lead to a relative reduction in the share of basic industries.

With regard to energy, and taking account of the analysis made by the Commission and the Council of the energy policies of each Member State, the scenario assumes that the Community energy objectives set for 1990 will be achieved and, specifically, the completion of large programmes of construction of nuclear and solid-fuel fired electricity-generating stations. It also assumes greater diversification of supply sources, both in terms of type of energy and origin.

⁸ COM(84)87, COM(84)88 final, and COM(84)693 final.

(1) General economic framework

6. The annual growth rate of GDP in the Community dropped from 4.7% on average for the period 1960-1973 to 1.7% in the period 1974-1983.

The economic framework on which the "reference projection" is based assumes an average growth rate for the Community of 2.6% per annum for the period 1984-2000, resulting from a growth rate of 2.4% per annum between 1984 and 1990 and an increase of 2.8% per annum between 1991 and 2000.

This trend will be accompanied by relatively stable private consumption and a reduction in public consumption in favour of investment, there will be a gradual return to a positive trade balance, although the surplus will be very small. The ECU is expected to appreciate slightly against the US dollar from 1985.

7. The hypotheses adopted concerning the structural development of GDP envisage an increase in the relative significance of services, whose share is predicted to grow from 55% in 1980 to 59% in 2000. Consequently, there would be a decline in the shares of agriculture (-1%), the building trade (-1%) and industry (-2%).

It is conjectured that the industrial reorganization which began at the end of the 1970s will lead in the year 2000 to a reduction in the share of the energy-intensive intermediate goods industries and first processing industries, and a corresponding increase in the capital goods industries.

The share of the consumer goods industries would also be reduced.

Trend in the components and utilization of GDP

EUR-10	1970	1980	1983	1990	2000
<u>Component part of GDP (in %)</u>					
Agriculture	4,8	4,3	4,3	4,1	3,4
- Energy-intensive industries	10,2	9,2	9,0	8,6	7,7
- Other industries	26,0	25,3	25,3	25,2	24,9
- Building, public works	8,3	6,3	5,9	5,6	5,4
- Services	50,7	54,9	55,5	56,5	58,6
<u>Utilization of GDP (in %)</u>					
- Private consumption	60,0	63,2	64,0	63,8	63,8
- GFCF	23,7	20,8	19,5	20,8	21,3
- Public consumption	16,3	16,0	16,5	15,4	14,9

8. The population of the Community has increased by 0.4% per annum on average over the last fifteen years. It now stands at 272 million inhabitants.

The divergent demographic trends between the countries of the north and the south of the Community should lead, in 2000, to a total population of around 280 million inhabitants.

(ii) Energy context

9. For the initial period, until 1986-1987, the average crude oil supply cost to the Community, expressed in US dollars, should continue to fall in nominal terms. The gradual revival of world oil demand could then lead to a recovery in the international price of oil which would stabilize initially in real terms, and then increase by approximately 2.5% per annum from 1990 to reach \$35 per barrel in 2000. This assumption makes allowance both for the trend in world oil demand, in particular on the part of the developing countries, and the revenue requirements of the oil exporting countries.
10. As oil would continue to occupy a leading place in world energy supplies (approximately one-third), it would maintain its "guide price" function. The prices of natural gas would at least maintain their present advantage over oil products; the price differential might even increase under certain conditions. For the reference projection, however, it is assumed that the costs of production of imported coal rise more rapidly than prices in general, which would lead to a slight reduction in the differentials between coal prices and those of oil products on the Community markets. Electric power would benefit from a somewhat more favourable trend in consumer prices than that for other fuels, owing to the advantages in production costs resulting from the penetration of nuclear power and increased recourse to solid fuels.
11. In general, the presumed development of the relative prices of the various energy sources should preserve or reinforce the advantages that the competing energy sources already have over oil products. Under these conditions, the replacement of oil should continue in the long run at the same rate at least as that of equipment renewal.
12. The general climate should remain favourable to energy saving, mainly because of the favourable effect of new investment and because of the long term trend towards an increase in real prices, even if that increase will be much less pronounced than that experienced since the first oil crisis.

The changing structure of industry at the expense of energy-intensive industries should reduce demand for energy per unit produced. An economic climate more favourable to investment than in previous years should accelerate the introduction of new industrial processes and the renewal of household equipment,

⁹ Value in real 1983 terms; in current dollars, this price would correspond to the equivalent of \$80/bbl in 2000.

resulting in a substantial improvement in efficiency. The technical progress which can be expected to be made with regard to equipment components should also help to improve energy efficiency.

IV. A REFERENCE PROJECTION OF FINAL ENERGY DEMAND

(i) Background

13. Fast economic growth coupled with low energy prices caused final energy consumption to increase by an average of 5% per annum in the period 1960-1973. This steady growth in consumption in all sectors (industry, transport, homes, non-energy uses) was chiefly sustained by oil products (+9% per annum), which covered the whole increase in the volume of demand.

Between 1973 and 1983, on the other hand, energy consumption stabilized and then dropped in all the final demand sectors except transport. Oil was replaced to a considerable extent by natural gas and electricity.

(ii) Overall projections to the year 2000

14. Given the assumptions made regarding the rate of economic growth for the period 1984-2000, the structural changes in the economy, energy prices and rational use of energy, it seems reasonable to expect that energy demand in the final consumption sectors will increase slowly at around 0.9% per annum between now and the end of the century.

Final energy demand is likely to grow at a faster rate at the end of the 1980s (+1.3% per annum) than in the 1990s (+0.7% per annum). It is likely that the Community will emerge in the next few years from a period of economic recession and experience several years of falling prices for oil and energy in general. From 1990 onwards, the full effects of investment in rational use of energy should gradually make themselves felt.

This gradual slowing down in the growth of energy requirements should above all be apparent in the residential and tertiary sector, where energy requirements should gradually reach saturation point. The energy requirements of the transport sector, on the other hand, are expected to increase steadily, although at a progressively slower rate than in the past. The same would apply to the requirements of industry.

The final energy intensity of the Community economy¹⁰ should

¹⁰ The final energy intensity of the economy is calculated by dividing final energy consumption including non-energy uses, expressed in toe, by GDP,

therefore improve by one quarter over the projection period, falling from 0.490 toe/10³ ECU in 1983 to 0.455 in 1990 and finally to 0.370 in 2000.

Trend in final energy consumption, by sector
(in million toe)

EUR-10	1973	1980	1983	1990	2000
	(%)	(%)	(%)	(%)	(%)
Industry	247,9 (35)	227,0 (32)	186,4 (29)	216 (30)	234 (31)
Transport	128,2 (18)	153,6 (22)	155,6 (24)	169 (24)	182 (24)
Residential and tertiary	264,9 (37)	265,8 (38)	252,6 (38)	267 (37)	274 (36)
Non-energy uses	0,3 (10)	60,0 (8)	57,4 (9)	63 (9)	72 (9)
Total	711,3 (100)	706,4 (100)	652,0 (100)	714 (100)	762 (100)

15. In continuation of the trend which has emerged over the last few years, natural gas and electricity should cover most of the increase in demand, so that their share in final energy consumption would increase accordingly.

District heating and renewable sources of energy are also likely to undergo a significant development in relative terms.

Solid fuels should maintain their current share in final consumption, whereas that of oil products should decrease substantially, which would be equivalent to a volume of consumption around present levels, i.e. 35 mtoe less than in 1980.

Trend in final energy consumption, by sources
(in million toe)

EUR-10	1973	1980	1983	1990	2000
	(%)	(%)	(%)	(%)	(%)
Solid fuels	85,4 (12)	63,1 (9)	55,3 (8)	58 (8)	61 (8)
Oil products	439,3 (62)	395,1 (56)	351,2 (54)	363 (51)	359 (47)
Gas	107,4 (15)	151,5 (21)	147,2 (22)	169 (23)	186 (24)
Electricity	76,0 (10,5)	92,8 (13)	94,6 (15)	113 (16)	138 (18)
Heat and others ¹¹	3,2 (0,5)	3,9 (1)	3,7 (1)	11 (2)	18 (3)
Total	711,3 (100)	706,4 (100)	652,0 (100)	714 (100)	762 (100)

¹¹ expressed in ECU at 1975 prices and exchange rates.

¹¹ Including 2.5 mtoe of heat in 1983, 6 mtoe in 1990 and 10 mtoe in 2000.

(ii) Sectoral projections

16. Three principal factors should influence energy consumption in the industrial sectors in the Community between now and the year 2000:

- changes in the industrial structure, resulting in an increase in the share of light industries and capital goods industries at the expense of the energy-intensive industries, and thus in a reorientation of production towards products with a higher added value;
- the development of industrial equipment towards new processes which make more efficient use of energy;
- the modernization of existing production plant, which should improve its energy performance and, where appropriate, permit substitution between types of energy.

These three convergent factors would have the effect of gradually reducing unit energy consumption in industry from 0.44 toe/10³ ECU of value added in industry (in real terms) in 1983 to 0.41 in 1990 and 0.36 in the year 2000.

Although industrial activity should grow by an average of 2.3% per annum, energy consumption in this sector would increase annually by only 1.3% until the end of the century. Oil consumption would rise in volume terms until 1990 and then return to about the 1983 level in the year 2000, whereas consumption of steam coal, natural gas and, above all, electricity would increase slightly throughout the whole period.

Trend in energy consumption in industry
(in million toe)

EUR-10	1973	1980	1983	1990	2000
Solid fuels	45,6	38,4	35,7	40	46
Oil products	104,7	77,6	49,3	57	52
Gas	57,9	66,8	59,6	66	73
Electricity	38,6	42,8	40,6	49	58
Heat and others	1,1	1,4	1,2	4	5
Total	247,9	227,0	186,4	216	234

17. Activity in the transport sector is traditionally linked, as far as the carriage of goods is concerned, with the general pattern of economic activity. However, the link between economic growth and energy demand for this type of transport is likely to weaken progressively as a result, firstly, of the structural change in GDP in favour of services and, secondly, of technological progress.

Passenger transport is linked with the specific features of social organization (housing characteristics, distance from workplace, leisure, household income). With regard to modal structure, passenger transport could undergo two interesting changes: a slight

increase in the share of public transport and, parallel to this, an increase in the number of private vehicles. However the average annual distance travelled by car would be less.

Technological advances in vehicle design and technical improvements to engines should, moreover, lead to increased efficiency of the transport sector as a whole, leading to a decrease in energy consumption per monetary unit of GDP from 0.12 toe/10³ ECU (real terms) in 1983 to 0.11 in 1990 and 0.09 in 2000.

On the basis of the assumed rate of economic growth, the combination of the various factors listed above should result in a moderate growth in energy consumption in the transport sector of 0.9% per annum between 1983 and 2000; This increase would relate to consumption of motor fuels.

With regard to motor fuels there will probably be a substantial increase in the relative share of vehicle gasoil.

Trend in energy consumption in the transport sector
(in million toe)

EUR-10	1973	1980	1983	1990	2000
Oil products	125,1	150,7	152,8	166	178
Electricity	2,0	2,4	2,4	3	4
Others ¹²	1,1	0,5	0,4	0	0
Total	128,2	153,6	155,6	169	182

18. 70% of energy consumption in the residential and tertiary sectors is accounted for by space heating requirements.

The rate of renewal or renovation of buildings assumed in the reference projection and the assumed improvement in the efficiency and the characteristics of equipment would result in virtual stagnation of the total energy required for space heating until 1990, followed by a reduction in the subsequent ten years.

The other uses of energy in households, craft industry, trade and services include the production of domestic hot water, cooking and specific uses of electricity for motive power, household appliances and lighting

Energy consumption for each of these uses is likely to continue to increase until the end of the century. The increase in the case of specific uses of electricity is likely to be relatively large at around 3% per annum between 1983 and 2000, even when allowance is made for expected technological advances.

On the whole, energy consumption in the residential and tertiary sector should continue to grow by an average of 0.6% per annum until the year 2000.

¹² Solid fuels and natural gas.

Oil products and solid fuels will continue to be replaced by natural gas, electricity and district heating from heating stations or mixed power stations (coal- or gas-fired) or from recovered steam.

Trend in energy consumption in the residential and tertiary sector
(in million toe)

EUR-10	<u>1973</u>	<u>1980</u>	<u>1983</u>	<u>1990</u>	<u>2000</u>
Solid fuels	35,4	21,8	18,2	16	13
Oil products	148,8	117,4	101,3	90	71
Gas	43,2	76,5	79,0	92	100
Electricity	35,4	47,6	51,6	61	77
Heat and others	2,1	2,5	2,5	8	13
Total	264,9	265,8	252,6	267	274

19. Products for non-energy uses can be classed in two groups: oils, lubricants, bitumens and waxes on the one hand, and raw materials for the petrochemical industry on the other. There will be a slight increase in demand for the two groups of product until the end of the century, with no change in the overriding importance of oil products

Overall, consumption of all these products should grow by 1.3% per annum until 2000.

Trend in consumption of products for non-energy uses
(in million toe)

EUR-10	<u>1973</u>	<u>1980</u>	<u>1983</u>	<u>1990</u>	<u>2000</u>
Solid fuels	3,4	2,7	1,3	2	2
Oil products	60,7	49,4	47,8	51	58
Gas	6,2	7,9	8,3	10	12
Total	70,3	60,0	57,4	63	72

V. GROSS ENERGY CONSUMPTION TO THE YEAR 2000

20. Gross energy consumption in the Community increased by an average of 4.7% per annum between 1963 and 1973. It then followed an erratic development before arriving in 1980 at a level close to that in 1973.

Taking all consumption figures together, gross energy consumption¹³ in the Community should increase on average by only 1.7% per annum

¹³ Including bunkers.

until 1990, and then by 1% per annum during the following decade, which is equivalent to an increase of 1.3% per annum between now and the year 2000.

The moderate long term increase in energy demand in the Community not only reflects the relatively low economic growth rate assumed, and changes in economic structure, but above all the results of sustained and effective policies for rational use of energy.

21. Between 1973 and 1983, efficiency of primary energy use in the Community improved by about 20%. A further improvement of the same magnitude should be achieved between 1983 and 2000.

Thus, on the basis of the assumptions made, the energy ratio of the Community economy¹⁴ should decline slightly, from 0.67 toe/10³ ECU in 1983 to 0.64 in 1990, followed by a further sharp drop to 0.54 in 2000.

This trend would be the consequence of the envisaged structural changes and of future investment in new, less energy-intensive processes and modernization of equipment leading to improved energy performance.

22. In view of the supply and consumption conditions of electricity production (see paragraphs 28-30 below), the trend in the relative shares of the various sources of energy in gross consumption in the Community would be as follows:

- stability of the relative share of solid fuels;
- substantial reduction in the share of oil to less than 40% in 2000;
- considerable increase in the role of nuclear power which should cover 19% of energy requirements at the end of the century;
- slight increase until 1990, followed by a reduction in the relative share of natural gas. (This is in contrast to the evolution in gas' share of final energy consumption which is expected to grow steadily. The difference results from the expected fall in gas consumption in power stations).

¹⁴ The energy ratio of the economy is calculated by dividing internal primary energy consumption (without bunkers) by GDP in real terms (1975 prices and exchange rates)

Trend in gross energy consumption in the Community
(including bunkers) (in million toe)

EUR-10	1973 (%)	1980 (%)	1983 (%)	1990 (%)	2000(%)
Solid fuels	222,0 (23)	222,7 (23)	212,2 (23)	242 (23)	264 (23)
Oil	601,3 (62)	520,0 (54)	438,3 (48)	441 (43)	439 (39)
Natural gas	115,8 (12)	169,3 (17)	165,2 (18)	190 (18)	196 (17)
Nuclear energy	17,7 (2)	42,7 (4)	76,1 (9)	145 (14)	215 (19)
Hydro, geothermal, other	11,0 (1)	15,4 (2)	15,5 (2)	12 (2)	21 (2)
Total	967,8 (100)	970,1 (100)	907,3(100)	1034 (100)	1136(100)

VI. A SCENARIO OF ENERGY SUPPLY CORRESPONDING TO THE "REFERENCE DEMAND"

(a) Background

23. Between 1963 and 1973, internal energy production in the Community stabilized at approximately 350 million toe, with the increase in the production of natural gas balancing the reduction in coal production. The increase in energy demand was thus covered entirely by higher imports, which rose from 260 million toe in 1963 to 620 million toe in 1973. Oil accounted for 95% of these imports.

These trends were completely reversed after 1973, with the result that internal production in 1983 stood at 516 million toe and net imports at 378 million toe, of which oil now only constituted three-quarters.

Community dependence on external sources of supply thus rose from 43% to 64% during the period 1963-1973 and then dropped to 42% ten years later.

(b) Energy production in the Community

24. Nuclear energy is likely to be the only energy source whose production level will increase significantly in the Community by 2000. According to the reference projection, production of solid fuels should remain static at around the 1983 level. Production of oil and natural gas should decline gradually on the basis of fields being exploited and those likely to come into production.

Internal production of energy in the Community
(in million toe)

EUR-10	1973 (%)	1980 (%)	1983 (%)	1990 (%)	2000 (%)
Coal	171,2 (48)	153,3 (33)	143,0 (28)	139,0 (25)	137 (22)
Lignite and peat	26,5 (8)	31,8 (7)	31,0 (6)	36,0 (6)	35 (6)
Oil	13,1 (4)	91,1 (20)	132,5 (26)	111,0 (20)	108 (17)
Natural gas	112,2 (32)	129,2 (28)	119,8 (23)	115,0 (21)	108 (17)
Nuclear energy	17,7 (5)	42,7 (9)	76,1 (15)	145,0 (26)	215 (35)
Hydroelectric and geothermal energy	9,1 (3)	12,3 (3)	12,0 (2)	13,0 (2)	14 (2)
Others and renewable energy sources	1,2 (0)	1,7 (0)	1,7 (0)	3,0 (0)	7 (1)
Total	353,2 (100)	462,1 (100)	516,1 (100)	563,0 (100)	625 (100)

The above figures for energy production in the Community in 1990 are generally very close to the projections communicated by the Member States¹⁵ during the last "Review of national energy programmes".

The "reference projection" figures for 2000 were obtained by extrapolating a set of assumptions now considered plausible. Nevertheless these assumptions contain three major uncertainties:

- the possible addition of new, competitive coal production capacities, without which production levels would decline considerably in the 90s;
- the level of new investments in the nuclear sector, without which the expected increase in nuclear's contribution 1990-2000 would not take place;
- the possibility of discovering one or more major oil fields or natural gas fields in the Community.

(c) Energy imports from third countries

25. Energy imports into the Community should return to 1979 levels by 2000, i.e. approximately 530 million toe. After having reached their lowest level (378 million toe) in 1983, imports of coal, oil and gas would thus increase steadily until 2000.

¹⁵ See COM(84)88 of 29 February 1984.

Net energy imports into the Community
(in million toe)

EUR-10	1973 (%)	1980 (%)	1983 (%)	1990 (%)	2000 (%)
Solid fuels	19,0 (3)	47,3 (9)	39,1 (11)	67 (14)	92 (18)
Oil	596,2 (96)	437,9 (83)	288,8 (76)	330 (70)	331 (65)
Natural gas	4,0 (1)	40,6 (8)	48,2 (13)	74 (16)	88 (17)
Electricity	0,7 (0)	1,4 (0)	1,8 (0)	-	-
Total	619,9(100)	527,2 (100)	377,9 (100)	471 (100)	511 (100)

Attempts will probably be made on two fronts to diversify imports until the end of the century. On the one hand, there would be a shift in the respective shares of oil and the other imported fuels which would develop from a ratio of 83%:17% in 1980 to 65%:35% in 2000 and, on the other, there would be greater diversification in the geographical source of supplies.

26. The Community's dependence on imported oil for its energy supply should lessen considerably during the next 15 years. It was successfully reduced from 62% in 1973 to 32% in 1983. This figure should be reduced to less than 30% in 2000, if the basic assumptions made for the reference projection are borne out in reality.

On the other hand, dependence on imported gas should continue to rise until 2000. From zero in 1973, it reached 5% in 1983 and is likely to grow to 8% in 2000 because of the rise in consumption combined with a drop in internal production.

For the same reasons, dependence on imported coal should also increase, rising from 2% in 1973 to 4% in 1983 and 8% in the year 2000.

Consequently total dependence on imported energy should increase from less than 42% in 1983 to around 46% in 2000.

(d) Electricity production

27. The reference projection for final energy consumption puts final energy demand in 2000 at 763 million toe, 138 million toe of which would be electricity demand. Final electricity consumption would thus increase by 2.2% per annum between 1983 and 2000. Electricity would therefore cover about one third of the increase in final energy demand. Its share would grow from 15% in 1983 to 18% in 2000, whereas in 1973 this share was barely more than 10%.

The increased penetration of electricity on the consumption markets reflects an important development in the specific uses of electricity, and in certain countries also the increased competitiveness of electricity for heating purposes. In the

reference case, however, this penetration would be slowed down to a certain extent by a general improvement in the efficiency of electrical apparatus.

It is nevertheless necessary to emphasize the major uncertainties involved in the development of electricity demand. The growth rate ascertained in the study would imply a reversal of the trend in the ratio between economic growth and electricity demand. In the past, this has always tended to be greater than one, whereas it will not exceed 0.85 between now and the end of the century.

28. The generating plant needed to satisfy the estimated electricity demand will probably change considerably by the end of the century, with nuclear power stations producing about 43% of the electricity and 39% being generated by power stations fired with solid fuels. An investment programme providing for 100 Gw from nuclear power and 40 Gw from power stations burning solid fuels between 1983-2000 corresponds to this production plan.

Trend in total net electricity production, by energy sources
(in TWh)

EUR-10	1973	1980	1983	1990	2000
	(%)	(%)	(%)	(%)	(%)
Coal	301,1 (30)	412,8 (34)	423,3 (34)	513 (34)	599 (32)
Lignite and peat	78,1 (8)	98,1 (8)	106,3 (9)	118 (8)	134 (7)
Oil products	312,2 (32)	264,8 (22)	158,5 (13)	83 (5)	71 (4)
Natural gas	100,5 (10)	107,6 (9)	95,7 (8)	101 (7)	56 (3)
Derived gas	23,8 (2)	21,1 (2)	16,1 (1)	18 (1)	16 (1)
Nuclear energy	53,5 (5)	149,4 (12)	275,0 (22)	534 (35)	792 (43)
Hydroelectric and geothermal energy	112,9 (12)	148,8 (12)	147,4 (12)	150 (10)	165 (9)
Others	4,6 (1)	6,4 (1)	7,0 (1)	8 (1)	14 (1)
Total	986,7 (100)	1209,0(100)	1229,3(100)	1523(100)	1847(100)

29. If optimum use is to be made of electricity generating capacity in the Community, nuclear and coal-fired power stations should, from 1990, normally cover the base and middle load, with oil- and gas-fired plant being used to cover the remainder of the load and peak demand.

The following table shows the corresponding trend in energy consumption in the electricity generating stations in the Community.

Trend in energy consumption for electricity production
(in million toe)

EUR-10	1973	1980	1983	1990	2000
Solid fuels	101,3	130,1	133,9	160	178
Oil products	75,0	60,9	36,9	20	18
Gas (natural and derived)	30,6	31,3	26,2	27	15
Nuclear energy ¹⁶	17,7	42,7	76,1	145	215
Hydroelectric and geothermal energy ¹⁷	9,1	12,3	12,0	13	14
Other products	1,2	1,7	1,7	2	4
Total	234,9	279,0	285,8	367	444

VII. MAIN ASSUMPTIONS MADE IN THE REFERENCE PROJECTION, COUNTRY BY COUNTRY

30. The reference projection outlined above refers to the Community as a whole, but was calculated by adding together individual projections made separately for each Community country.

These national projections were all based on a comparable set of hypotheses derived from the general social and economic framework chosen for the Community as a whole. Consequently, certain aspects of these hypotheses may diverge from those adopted in, for instance, the individual national administrations' latest energy forecasts.

This section briefly sums up the results obtained for the reference projection, country by country.

(a) Belgium

31. Assuming that the Belgian economy grows by an average of 2% a year between 1983 and 2000, total energy demand in Belgium can be expected to increase by 1.3% a year, from 42.7 million toe in 1983 to 53 million toe in 2000.

The primary energy ratio of the Belgian economy has already fallen by roughly 30% since 1973, largely as a result of the restructuring of Belgian industry, and can be expected to fall by a further 12% or so by the end of the century, from 16.5 kgoe/10³ Bfr¹⁸ in 1983 to 14.5 kgoe/10³ Bfr in 2000.

¹⁶Fission heat is considered to be of primary origin using the SOEC method.

¹⁷Electricity derived from hydroelectric or geothermal energy is counted as primary energy using the SOEC method.

¹⁸kgoe/10³ Bfr = kilogram of oil equivalent per thousand Belgian francs at constant 1975 prices.

Final electricity consumption is expected to rise by 2.1% a year between 1983 and 2000, by which time electricity should cover 15% of final energy demand, compared with 13% in 1983.

Gross primary energy consumption in Belgium (including bunkers)
(in million toe)

	1973	1980	1983	1990	2000
Solid fuels	11,3	11,1	9,3	9,4	10,1
Oil	30,3	25,2	20,1	20,9	21,5
Natural gas	7,2	9,0	7,1	8,4	8,5
Nuclear energy	0	3,1	6,1	9,7	12,8
Hydroelectric power and others	-	0,2	0,1	0,1	0,1
Total	48,8	48,2	42,7	48,5	53,1

32. No increase is expected in solid fuel consumption before 1990.

This is largely because of the decline in consumption in the steel industry, as a result of more efficient processes being used, and in power stations as a result of increasing use being made of nuclear energy. On the other hand, the gradual conversion to coal by a number of large industrial energy consumers should offset this loss of market share.

After 1990 a substantial increase in sales to the electricity industry coupled with the forecast expansion of combined heat and power production should ensure that solid fuels' market share stabilizes, without, however, ever returning to 1980 levels.

Natural gas consumption is also expected to grow steadily again to return to close to 1980 levels by 2000. Sales to the domestic and equivalent sectors should rise as orders from power stations fall.

Led by the expected economic recovery, oil consumption should increase slightly by 2000, though it will not approach 1980 or 1973 levels and indeed its share of gross domestic energy consumption should even decline from 47.1% in 1983 to 40.4% in 2000.

Together, the increase in motor fuel sales and the levelling-off of sales to the domestic and equivalent sectors will increase light and medium distillates' share of domestic oil consumption and reduce heavy products' share.

Nuclear energy is expected to double its share by 2000.

33. The Belgian nuclear energy programme will reduce Belgium's dependence on imported energy supplies from 85% in 1980 to 67% by 2000.

Primary energy supplies in Belgium (in million toe)

	1973	1980	1983	1990	2000
Domestic production	5,9	7,8	10,8	14,0	16,9
of which: nuclear energy	0	3,1	6,1	9,7	12,8
Net imports	42,9	41,4	31,5	34,5	36,2
of which: oil	30,5	25,6	20,0	20,9	21,5
natural gas	7,1	9,0	7,2	8,4	8,5
Stock change	-	-1,0	+0,4	„	„
Total	48,8	48,2	42,7	48,5	53,1

Belgium's coal output is expected to hold steady at around 4 million toe a year up to the end of the century.

Oil imports are expected to rise by roughly 8% and natural gas imports by 18% between 1983 and 2000.

These extra imports should cover roughly 35% of the forecast extra demand for energy, with nuclear energy coping with the remainder.

(b) Denmark

34. Between 1983 and 2000 gross energy consumption in Denmark is expected to grow by an average of 1.7% a year and GDP by 2.4% a year.

This would bring the primary energy ratio of the Danish economy down from 71 kgoe/10³ Dkr¹⁹ in 1983 to 64 kgoe/10³ Dkr in 2000. After the 25% reduction between 1973 and 1982, Denmark's energy intensity coefficient is unlikely to fall by much more than 10% between now and the end of the century. At first sight this may appear modest, but it reflects the fact that over the next few years Denmark will probably put the accent on flexibility and diversification, favouring remote heating, and, to a lesser extent, electricity.

As a result, heat consumption in Denmark can be expected to rise by 3.0% a year by the end of the century, compared with 2.0% a year for final energy consumption. This would bring electricity's share of final energy demand up from 15.5% in 1983 to 17.7% in 2000.

¹⁹ kgoe/10³ Dkr = kilogram of oil equivalent per thousand Danish kroner at constant 1975 prices.

Gross primary energy consumption in Denmark (including bunkers)
(in million toe)

	<u>1973</u>	<u>1980</u>	<u>1983</u>	<u>1990</u>	<u>2000</u>
Solid fuels	2,3	5,9	5,4	8,4	10,2
Oil	17,9	13,7	10,8	10,4	9,8
Natural gas	-	-	-	1,7	1,9
Nuclear energy	-	-	-	-	-
Hydroelectric	-0,0	0,1	0,4	0,2	0,4
power and others					
<u>Total</u>	<u>20,2</u>	<u>19,7</u>	<u>16,6</u>	<u>20,7</u>	<u>22,3</u>

35. In the medium term, total consumption of oil products is likely to fall as the moves to replace oil products continue in all but premium applications such as transport. In this case the pattern of consumption would shift towards lighter products with light fractions increasing their share at the expense of medium fractions, and in particular of heating oil

Heating oil is now facing competition from natural gas which made its first contribution to Denmark's energy supply in 1984. Natural gas can be expected to increase its share as output from the Tyra field in the Danish section of the North Sea is stepped up.

In addition the gradual spread of remote heating networks, which are normally coal-fired, should also speed up the moves to replace gas oil in the domestic and equivalent sectors.

The anticipated increase in demand for electricity, most of it generated from solid fuels, should considerably increase coal's share of Denmark's energy supply. Almost 85% of the extra demand for energy between 1983 and 2000 is likely to be covered by solid fuels, with natural gas accounting for the rest.

36. The exploitation of Denmark's indigenous oil and gas resources over the next few years should reduce Denmark's dependence on imported energy supplies significantly, from 87% in 1983 to 69% in 2000. Output should rise to 6.5 million toe by 1990 and hold steady at that level thereafter. Plans are being made to conclude medium-term contracts to export roughly 0.7 million toe of natural gas a year to Germany and Sweden.

Primary energy supplies in Denmark (in million toe)

	<u>1973</u>	<u>1980</u>	<u>1983</u>	<u>1990</u>	<u>2000</u>
Domestic production	0,1	0,3	2,2	6,5	6,9
of which: oil	0,1	0,3	2,2	4,0	4,0
natural gas	-	-	-	2,4	2,6
Net imports	20,3	19,4	14,2	14,2	15,4
of which: coal	2,0	6,1	5,4	8,4	10,2
oil	18,3	13,2	8,5	6,4	5,8
Stock change	0,2	0,0	+0,2	,,	,,
<u>Total</u>	<u>20,2</u>	<u>19,7</u>	<u>16,6</u>	<u>20,7</u>	<u>22,3</u>

Finally, there is always the possibility that new oil or gas fields could be struck in the Danish section of the North Sea and thus reduce Denmark's dependence on imported energy supplies even further.

(c) Germany

37. Although the economy is expected to grow by an average of 2.7% a year between 1983 and 2000, total energy demand is unlikely to increase by more than 0.8% a year, on average, over the same period.

This would give a 27% reduction in the primary energy ratio of the German economy, down from 200 kgoe/10³ DM²⁰ in 1983 to 146 kgoe/10³ DM in 2000, after a reduction of almost 20% between 1973 and 1982. This is due to a combination of far-reaching restructuring of the economy on the one hand and substantial energy savings on the other.

Final electricity consumption is expected to rise by an average of 1.8% a year between 1983 and 2000, thus raising electricity's share of final energy consumption from 17% in 1983 to 19.5% in 2000.

Gross primary energy consumption in Germany (including bunkers)
(in million toe)

	<u>1973</u>	<u>1980</u>	<u>1983</u>	<u>1990</u>	<u>2000</u>
Solid fuels	83,2	82,7	81,5	83,8	88,4
Oil	149,8	131,7	110,5	111,9	104,3
Natural gas	27,0	44,6	39,6	43,3	42,1
Nuclear energy	3,0	11,1	16,5	34,1	50,3
Hydroelectric	2,8	2,9	3,3	3,5	4,5
<u>power and others</u>					
Total	265,8	273,0	251,4	276,6	289,6

38. Consumption of oil products is expected to remain relatively stable throughout the period, with a slight increase in sales of light products, and in particular of petrochemical cuts and kerosene, and a downturn in sales of medium products where the increase in diesel fuel deliveries will not be enough to offset the big fall in heating oil sales due, of course, to the generally more efficient use of heating oil and to the switch to natural gas, district heating and electricity in the domestic and equivalent sectors.

Consequently, demand for natural gas can be expected to return to close to the 1980 level and to remain there between 1990 and 2000. This presupposes increased sales to the domestic and equivalent sectors, consolidation of its share of the industrial market and a slight downturn in natural gas sales to power stations in the long run.

²⁰kgoe/10³ DM = kilogram of oil equivalent per thousand German marks at 1975 prices.

Since the German government has long been encouraging moves to burn coal in power stations or for combined heat and power production, whether in industry or for district heating schemes, consumption of solid fuels seems likely to increase even more by 2000.

The reference projection also assumes a substantial expansion of nuclear capacity, enabling nuclear energy to make an even greater contribution to Germany's overall energy balance and allowing electricity to capture new markets, particularly for heat end-uses.

39. This expansion of the nuclear programme combined with exploitation of Germany's indigenous solid fuel, oil and gas resources should make Germany slightly less dependent on imported supplies of energy, with the rate falling from 52% in 1983 to 48.4% in 2000.

Primary energy supplies in Germany (in million toe)

	<u>1973</u>	<u>1980</u>	<u>1983</u>	<u>1990</u>	<u>2000</u>
Domestic production	119,2	121,4	120,6	137,8	149,4
of which: hard coal	69,1	62,2	58,4	56,3	52,7
brown coal	22,9	26,5	25,3	26,0	25,0
natural gas	15,0	14,3	13,6	13,8	13,8
nuclear energy	3,0	11,1	16,5	34,1	50,3
Net imports	147,4	157,0	128,4	138,8	140,2
of which: oil	144,6	131,2	102,7	106,9	100,3
natural gas	12,0	30,6	26,3	29,5	28,3
hard coal	-4,4	-2,2	-0,5	1,5	10,4
Stock change	0,8	-5,4	2,4	,,	,,
Total	265,8	273,0	251,4	276,6	289,6

Imports of natural gas and oil products should remain relatively close to 1983 levels over the whole period, though imports of hard coal should increase considerably.

One final interesting point is that the expected increase in nuclear output should cover much of the extra demand for energy anticipated in Germany between 1983 and 2000.

(d) Greece

40. An average annual growth rate of 2.6% was assumed for the Greek economy throughout the period from 1983 to 2000, with gross energy consumption growing by 2.8%. The industrial development planned over the next fifteen years is the main reason why demand for energy is expected to grow faster than the economy as a whole. Together with Ireland, Greece is one of the two Community countries where manufacturing industry is expected to increase its share of GDP.

In the process the primary energy ratio of the Greek economy is likely to increase from 25 kgoe/10³ Dr²¹ in 1983 to 26.5 kgoe/10³ Dr in 2000.

²¹kgoe/10³ Dr = kilogram of oil equivalent per thousand Greek drachmas at 1975 prices.

Greece's energy intensity coefficient had already risen by roughly 5% between 1973 and 1983.

Final electricity consumption should rise by 3.6% a year up to the end of the century, from 16% of final energy consumption in 1983 to 18% in 2000.

Gross primary energy consumption in Greece (including bunkers)
(in million toe)

	<u>1973</u>	<u>1980</u>	<u>1983</u>	<u>1990</u>	<u>2000</u>
Solid fuels	2,2	3,4	4,8	8,0	10,0
of which: lignite	1,8	3,1	3,8	7,3	9,0
Oil	10,1	2,4	11,5	13,0	15,3
Natural gas	-	-	0,1	0,1	0,6
Hydroelectric power and other	0,2	0,3	0,3	0,5	0,9
Total	12,5	16,1	16,7	21,6	26,8

41. The most striking change in Greece's energy balance in the medium term is likely to be a major increase in consumption of solid fuels. This will be due partly to the vast programme to exploit Greece's indigenous lignite resources and to convert Greece's power stations to lignite and partly to the massive inroads made by solid fuels in the industrial sector.

In the long term natural gas is expected to cover a very small proportion of energy requirements in the industrial and residential sectors.

Output from hydroelectric and geothermal power stations is also expected to rise sharply by the end of the century without, however, becoming one of the major sources of supply for the Greek energy market.

One difference between Greece and the other Community countries is that a substantial increase in consumption of oil products is expected there to cover Greece's growing energy requirements.

42. As Greece progressively turns to its indigenous energy resources (lignite, hydroelectricity and new technologies) to generate its electricity it should be able to keep its energy dependence rate down to around 65% between 1983 and 2000 despite the sharp increase in its overall energy requirements.

Primary energy supplies in Greece (in million toe)

	<u>1973</u>	<u>1980</u>	<u>1983</u>	<u>1990</u>	<u>2000</u>
Domestic production	2,0	3,4	5,4	8,2	9,9
of which : lignite	1,8	3,1	3,8	7,3	9,0
oil	-	-	1,2	0,3	-
Net imports	11,6	13,4	10,9	13,4	16,9
of which: oil	11,1	13,0	9,9	12,7	15,3
Stock exchange	-1,1	-0,7	0,4	,,	,,
Total	12,5	16,1	16,7	21,6	26,8

Greece will probably at least double its lignite output by the end of the century. At the same time its steam coal imports should hold steady at around 1 million toe.

Greece will also probably be producing small amounts of natural gas by the 1990s. Towards the end of the century, it will probably import natural gas to top up its own output, presumably from Algeria, the Soviet Union or even Italy.

Finally, for the next fifteen years imported oil should remain the largest single source of supply for the Greek energy market even though oil products' share of gross domestic energy consumption is expected to continue to decline, from 69% in 1983 to slightly over 57% in 2000.

(e) France

43. For the period 1983 to 2000, it has been assumed that total demand for energy in France will grow by an average of 1.6% a year and GDP by 2.6% a year

This should make the French economy roughly 20% less energy-intensive by the end of the century, with its primary energy ratio dropping from 120 kgoe/10³ FF²² in 1983 to 100 kgoe/10³ FF in 2000, following the earlier 20% reduction between 1973 and 1982.

Final electricity demand is expected to increase by 3.2% a year up to 2000, lifting electricity's share of final energy consumption from 15% in 1983 to 23% in 2000. These advances by electricity on the French energy market are thus likely to be the key changes on the French market

²² kgoe/10³ FF = kilogram of oil equivalent per thousand French francs at 1975 prices.

Gross primary energy consumption in France (including bunkers)
(in million toe)

	<u>1973</u>	<u>1980</u>	<u>1983</u>	<u>1990</u>	<u>2000</u>
Solid fuels	28,7	31,1	25,2	23,6	27,9
Oil	129,2	113,0	89,6	84,2	80,1
Natural gas	13,6	21,6	22,4	26,5	26,9
Nuclear energy	4,5	16,3	37,4	74,3	93,4
Hydroelectric power and other	4,0	6,4	5,1	4,0	6,9
Total	180,0	188,4	179,7	212,6	235,2

44. Beyond a doubt the major change in consumption patterns in France over the next few years will be the growing share taken by nuclear energy at the expense of oil products in particular, with France's nuclear power capacity escalating from 28 MWe in 1983 to roughly 50 MWe in 1990 and to close to 70 MWe in 2000.

This breakneck expansion of nuclear capacity should curb coal consumption by power stations until 1995 or so. Nonetheless, the spread of district heating and the gradual conversion of various industries to coal should help to offset this slackening of the total demand for coal.

The market for natural gas is likely to grow slightly throughout the 1980s, mainly in the residential and tertiary sector though also to a lesser extent, in industry, to absorb the supplies available under the import contracts already signed. After 1990 the natural gas market should stabilize.

These prospects for solid and gaseous fuels should progressively reduce consumption of oil products which should, as a result, focus increasingly on premium markets such as transport and non-energy applications.

This shift would give light products a larger share of total oil consumption.

45. Even without any increase in domestic fossil fuel output, France's nuclear power programme alone should be enough to reduce France's dependence on imported energy supplies from 65% in 1983 to 50% in 2000.

Primary energy supplies in France (in million toe)

	<u>1973</u>	<u>1980</u>	<u>1983</u>	<u>1990</u>	<u>2000</u>
Domestic production	34,3	43,9	63,4	97,7	118,2
of which: coal	16,4	11,7	10,8	8,2	8,0
nuclear	4,5	16,3	37,4	74,3	93,4
Net imports	145,9	149,1	110,5	114,9	117,0
of which: coal	9,9	20,0	11,8	14,6	19,1
oil	128,7	112,6	81,0	79,7	75,6
natural gas ²³	7,6	16,2	18,8	23,6	23,9
electricity ²³	-0,3	0,3	- 1,2	- 3,0	- 1,6
Stock exchange	-0,2	-4,6	5,8	,,	,,
Total	180 0	188,4	179,7	212,6	235,2

The extra nuclear output should be enough to cover the entire increase in energy requirements between 1983 and 2000.

Coal production in France is likely to fall as a result of the rationalization of French mines, although a substantial increase in net steam coal imports is expected.

Natural gas imports should rise by about a quarter by 1990 under the contracts already concluded, but should hold steady thereafter at around 24 million toe. Oil imports should remain unchanged until 1990, after which another small reduction is possible.

France started to export electricity generated at its nuclear plants in the early 1980s and can be expected to continue to do so until the end of the century, with exports peaking in around 1990.

(f) Ireland

46. It was assumed that the Irish economy would grow by an average of 3.5% a year between 1983 and 2000, with total energy demand growing by 2.5% a year over the same period. This would make the Irish economy 15% less energy-intensive by the end of the century, with the primary energy ratio falling from 2 kgoe/£Irl²⁴ in 1983 to 1.7 kgoe/£Irl in 2000, in addition to the 12.5% reduction between 1973 and 1982.

Final electricity consumption is expected to rise by 2.4% a year up until 2000. This would make Ireland the only country in the Community with electricity consumption growing slightly slower than energy consumption and holding its share steady (at more or less 12%). This is primarily because of natural gas making deep inroads into the industrial, residential and tertiary markets.

²³A minus sign (-) indicates net exports.

²⁴kgoe/\$Irl = kilogram of oil equivalent per Irish pound at 1975 prices.

Gross primary energy consumption in Ireland (including bunkers)
(in million toe)

	<u>1973</u>	<u>1980</u>	<u>1983</u>	<u>1990</u>	<u>2000</u>
Solid fuels	1,4	2,0	2,0	3,3	4,3
of which: brown coal	0,7	1,1	1,0	1,1	1,3
oil	5,5	5,7	4,2	5,3	5,9
Natural gas	-	0,7	1,8	1,4	1,7
Hydroelectric power and others	0,1	0,1	0,1	0,2	0,3
Total	7,0	8,5	8,1	10,2	12,2

47. This increase in energy consumption in Ireland should be accompanied by greater diversification of supply to reduce oil products' share of gross energy consumption to 48% in 2000, as against 52% in 1983.

None the less absolute consumption of oil products is expected to increase, led by the vigorous growth in economic activity, particularly in manufacturing industry (up 5% a year). This should push up consumption of heavy fuel oil in industry, of motor fuels in the transport sector and of heating oil.

In contrast to other Community Member States, in Ireland the consumption pattern for oil products will shift towards heavier products after 1990 with the surge in demand in the industrial sector.

For the moment natural gas from the Kinsale offshore field has been ousting oil products at power stations or else been used primarily as a feedstock to produce ammonium and fertilizers. In the medium term it is likely to be redeployed in the more traditional industrial, residential and tertiary markets.

As a result, once the Moneypoint power station comes on stream (in 1985) one can expect more coal to be burnt in power stations as a substitute first for oil products and then, in due course, for natural gas. At the same time the moves to promote conversion to coal in industry should increase coal's share of final energy consumption in the industrial sector in the medium term.

Finally, peat production should continue at present-day levels, with one third of the output going to the domestic sector and the other two thirds to power stations.

48. However, not even this combination of continued peat cutting and exploitation of Ireland's natural gas fields will be enough to reduce Ireland's dependence on imported energy supplies. On the contrary, increasing demand will probably push the coefficient up from 63% in 1983 to 72% in 2000. But exploratory drilling is continuing in the Irish section of the offshore fields. There is therefore still every chance that new oil or gas fields could be struck and further reduce Ireland's dependence on imported energy supplies in the long run.

Primary energy supplies in Ireland

	(in million toe)				
	<u>1973</u>	<u>1980</u>	<u>1983</u>	<u>1990</u>	<u>2000</u>
Domestic production	0,7	2,0	2,9	2,8	3,4
of which peat	0,65	1,1	1,0	1,1	1,3
natural gas	-	0,7	1,8	1,4	1,7
Net imports	6,0	6,5	5,0	7,4	8,8
of which: coal	0,5	0,8	1,0	2,1	2,9
oil	5,5	5,7	4,0	5,3	5,9
Stock change	0,3	0,0	0,1	-	-
Total	7,0	8,5	8,0	10,2	12,2

Almost the entire anticipated extra demand for energy will probably have to be met by increasing imports with the increase being shared equally between solid fuels and oil products.

(g) Italy

49. Gross energy consumption in Italy can be expected to increase by 1.8% a year on average between 1983 and 2000, assuming that GDP increases by 2.8% a year over the same period.

This would make the Italian economy roughly 17% less energy-intensive by the end of the century, with the primary energy ratio falling from 835 kgoe/10⁶ Lit²⁵ in 1983 to 698 kgoe/10⁶ Lit in 2000, following a 15% fall between 1973 and 1982.

Final electricity consumption is likely to increase by roughly 2.6% a year between now and 2000, with electricity's share of final energy consumption surging to 17% by the end of the century compared with 14% in 1983.

Gross primary energy consumption in Italy (including bunkers)

	(in million toe)				
	<u>1973</u>	<u>1980</u>	<u>1983</u>	<u>1990</u>	<u>2000</u>
Solid fuels	8,1	11,0	12,8	21,5	31,0
Oil	102,2	97,0	86,3	83,7	81,6
Natural gas	14,2	22,7	22,4	32,7	35,1
Nuclear energy	0,9	0,7	1,6	5,4	19,4
Hydroelectric power and others	3,8	4,8	5,3	6,2	6,2
Total	129,2	136,2	128,4	149,5	173,3

50. Sharp increases in demand for coal and for natural gas are the main changes in the energy consumption pattern in Italy up to 1990. After that, solid fuels and nuclear energy will cover virtually the whole increase in demand. Little change is likely for any of the other fuels.

²⁵ kgoe/10⁶ Lit = kilogram of oil equivalent per million Italian lire at 1975 prices.

Consumption of oil products in Italy is likely to fall by about 10% over the whole period, with light and medium products gradually increasing their share at the expense of heavy products, which will suffer from the severe slump in consumption at power stations.

Power stations can be expected to make a massive shift away from oil products and towards solid fuels, which will also continue their advance on industrial markets.

Natural gas too should increase its share of the industrial market, where total energy demand is expected to rise by 1.7% a year throughout the period from 1983 to 2000. There should also be a steadily expanding market for gas in the residential and tertiary sector by the end of the century.

Finally, natural gas should also make inroads at power stations for a limited period, pending the expansion of the industrial and domestic markets.

51. As Italy's nuclear programme is put into action (in the medium term) and Italy continues to exploit its indigenous oil, gas, hydroelectricity and geothermal resources, Italy should gradually reduce its dependence on imported energy from 81% in 1983 to 76% in 2000.

Primary energy supplies in Italy (in million toe)

	<u>1973</u>	<u>1980</u>	<u>1983</u>	<u>1990</u>	<u>2000</u>
Domestic production	19,3	17,5	19,1	25,9	41,2
of which: natural gas	12,6	10,2	10,6	10,0	10,0
nuclear energy	0,9	0,7	3,7	5,4	19,4
hydroelectric power	3,8	4,8	5,3	6,2	6,2
and others					
Net imports	112,1	118,9	104,8	123,6	132,1
of which: coal	7,7	10,8	12,1	20,0	29,5
oil	102,7	95,8	79,6	79,7	77,1
natural gas	1,6	11,8	12,1	22,7	25,1
Stock change	- 2,2	-0,2	4,5		
Total	129,2	136,2	128,4	149,5	173,3

Electricity - whether generated from nuclear, hydroelectric or geothermal sources - will account for the entire increase in Italy's energy output from indigenous sources. Coal and natural gas imports will probably at least double between 1983 and 2000, with oil imports holding steady.

(h) Luxembourg

52. Assuming an average annual growth rate of 2.2% for the economy as a whole between 1983 and 2000, energy consumption in Luxembourg should rise by 1.6% a year over the period.

This would bring the primary energy ratio of the Luxembourg economy down from 30 kgoe/10³ Lfr²⁶ in 1983 to 27 kgoe/10³ Lfr, giving a 10% improvement in energy efficiency on top of the substantial (40%) reduction between 1973 and 1983 caused by the restructuring of the steel industry.

Electricity consumption too is expected to increase by an average of 2% a year until the turn of the century. Electricity's share of final energy consumption should rise from 11% in 1983 to 12% in 2000.

Gross primary energy consumption in Luxembourg (in million toe)

	<u>1973</u>	<u>1980</u>	<u>1983</u>	<u>1990</u>	<u>2000</u>
Solid fuels	2,45	1,84	1,27	1,55	1,65
Oil	1,65	1,10	1,00	1,05	1,15
Natural gas	0,22	0,42	0,26	0,40	0,45
Hydroelectric power & others	0,18	0,27	0,31	0,35	0,45
Total	4,50	3,63	2,84	3,35	3,70

53. Assuming that the steel industry gradually returns to 1980 production levels or thereabouts, there should be a slight increase in consumption of solid fuels.

) The underlying reasons for the slight increase in oil product consumption are the increased demand for motor fuel in the transport sector and the modest upturn in demand in most branches of industry, apart from steel.

The higher level in natural gas consumption - which should return to close to 1980 levels by the end of the century - is due partly to the replacement of oil products by alternative fuels in the residential and tertiary sector and partly to industrial growth.

New and renewable sources of energy such as hydroelectricity and biomass, could double their share by the end of the century, though the quantities produced will still be relatively small.

54. Another important feature is that the forecast increase in electricity demand should push up electricity imports.

Primary energy supplies in Luxembourg (in million toe)

	<u>1973</u>	<u>1980</u>	<u>1983</u>	<u>1990</u>	<u>2000</u>
Domestic production ²⁷	0,01	0,02	0,03	0,05	0,10
Net imports	4,50	3,61	2,79	3,30	3,60
Stock change	-0,01	-	+0,02
Total	4,50	3,63	2,84	3,35	3,70

²⁶ kgoe/10³ Lfr = kilogram of oil equivalent per thousand Luxembourg francs at 1975 prices.

²⁷ Hydroelectric power, biomass and recovered products.

In 2000 all Luxembourg's energy requirements apart from those covered by hydroelectric power (0.03 million toe a year) or by biomass will be covered by imports, most of them from other Community Member States.

(i) Netherlands

55. Assuming an average annual growth rate of 2.5% for the Netherlands economy from 1983 to 2000, gross domestic energy consumption can be expected to grow by an average of 1.3% a year over the same period.

In addition, consumption of bunker fuel for seagoing shipping - which already accounts for one quarter of all oil products sold in the Netherlands - could soar by 50% by the end of the century, thus returning to more or less the 1973 level.

Restructuring of the economy coupled with substantial energy savings should reduce the primary energy ratio of the Netherlands economy from 26 kgoe/10² Fl²⁸ in 1983 to 20.5 kgoe/10² Fl in 2000, a reduction of over 20% to follow the almost 25% drop between 1973 and 1982.

Final electricity consumption is expected to grow by an average of 1.4% a year between 1983 and 2000, markedly slower than in the other Member States. None the less, electricity will continue to cover around 11% of final energy demand throughout the period thanks to its relative competitiveness.

Gross primary energy consumption in the Netherlands (including bunkers)

	(in million toe)				
	1973	1980	1983	1990	2000
Solid fuels	3,2	4,1	5,1	10,4	10,5
Oil	41,0	38,4	29,9	34,3	37,9
Natural gas	28,5	30,4	29,2	28,0	28,0
Nuclear energy	0,3	1,1	0,9	0,9	4,4
Hydroelectric power and others	-0,1	0,3	0,6	0,8	0,8
Total	72,9	74,3	65,7	74,4	81,6
of which: bunkers	11,5	9,3	8,1	11,0	12,0

56. Much of the appreciable increase in coal consumption in the medium term will be due to the plans to convert some of the Netherlands power stations to coal. Steam-coal consumption in industry should also rise in the medium term.

Natural gas consumption in the Netherlands is expected to level off, since the domestic market is saturated and the forecast increase in sales to industry will only partly offset the lower offtake caused by power stations gradually switching over to coal.

²⁸ kgoe/10² Fl = kilogram of oil equivalent per 100 guilder at constant 1975 prices.

Demand for oil products should gradually pick up in the medium and long-term as demand for motor fuel and for bunker fuel for shipping increase along with sales to the petrochemicals industry. The net result would then be that sales of medium and light oil products should increase and sales of the heavier fractions decrease.

It has also been assumed that the Netherlands government will put its nuclear energy plans into action and, accordingly, have three more nuclear power plants on stream by 2000.

57. The net result of this surge in nuclear output by 2000 coupled with rapidly growing coal imports and gradually declining natural gas output is that the Netherlands' dependence on imported energy supplies is likely to rise from 10% in 1983 to 42% in 2000.

<u>Primary energy supplies in the Netherlands (in million toe)</u>					
	<u>1973</u>	<u>1980</u>	<u>1983</u>	<u>1990</u>	<u>2000</u>
Domestic production	56,8	69,6	59,4	54,8	47,3
of which: natural gas	53,8	66,7	55,3	49,7	39,1
nuclear energy	0,3	1,1	0,9	0,9	4,4
Net imports	16,3	5,4	4,6	19,6	34,3
of which: solid fuels ²⁹	1,7	4,1	4,5	10,4	10,5
natural gas ²⁹	-25,3	-36,2	-26,2	-21,7	-11,1
oil	40,2	37,6	25,9	30,6	34,9
Stock change	-0,2	-0,7	1,7	,,	,,
Total	72,9	74,3	65,7	74,4	81,6

The most prominent feature in the reference projection for the Netherlands is that natural gas production from the Dutch fields will gradually decline over the next 15 years. Since domestic demand can be expected to remain stable, exports will have to be scaled down in volume terms, despite the plans to import natural gas from Norway.

All the coal consumed in the Netherlands will have to be imported, just like the vast majority of the oil processed at Dutch refineries.

(j) United Kingdom

58. The reference projection for the United Kingdom assumes an average annual growth rate of 2.4% for the UK economy between 1983 and 2000, with gross energy consumption increasing by an average of 1.1% a year over the same period.

As a result the primary energy ratio of the UK economy should fall from 1.75 kgoe/£³⁰ in 1983 to 1.40 kgoe/£ in 2000 - in other words,

²⁹A minus sign (-) indicates net exports.

³⁰kgoe/£ = kilogram of oil equivalent per pound at 1973 prices.

a 20% improvement in energy efficiency, following the 17% or so improvement between 1973 and 1983.

Final electricity consumption is expected to increase by 1.8% a year by the end of the century, with electricity's share rising from 14.5% in 1983 to 16.5% in 2000.

Gross primary energy consumption in the United Kingdom (including bunkers) (in million toe)

	<u>1973</u>	<u>1980</u>	<u>1983</u>	<u>1990</u>	<u>2000</u>
Solid fuels	79,2	70,0	65,4	72,0	70,4
Oil	113,5	81,8	74,3	76,6	81,2
Natural gas	25,1	39,9	42,4	47,1	50,7
Nuclear energy	8,9	10,4	13,5	20,5	34,8
Hydroelectric power and others	0,3	0,3	0,4	0,4	0,7
Total	227,0	202,3	196,0	216,6	237,8

59. The marked increase in nuclear output is the most striking phenomenon shown in the reference projection for the UK energy market for the rest of this century.

This would have a direct effect on solid fuels with the market in power stations continuing to increase up to 1990, then levelling off and, in the end, even declining appreciably.

Natural gas consumption in the United Kingdom should also grow steadily, with a progressive increase in sales to the domestic and tertiary sectors and further consolidation of its share of the industrial market.

Consumption of oil products should also increase slightly partly because of the upturn in diesel sales to road users, in kerosene sales to aircraft and in naphtha sales to the petrochemical industry. The net result would be to produce a higher proportion of light products from each barrel, with the proportion of heavy products declining from 30% at present to 24% in 2000.

60. The scale and variety of the United Kingdom's indigenous energy resources, plus the plans to expand the UK's nuclear capacity, should enable the United Kingdom to remain virtually self-sufficient in energy for a long time while to come.

The United Kingdom's primary energy supply (in million toe)

	<u>1973</u>	<u>1980</u>	<u>1983</u>	<u>1990</u>	<u>2000</u>
Domestic production	113,0	196,1	232,9	215,9	231,5
of which: oil	0,7	79,7	117,0	90,0	88,0
natural gas	24,4	30,9	32,8	35,0	38,0
nuclear	8,9	10,4	13,5	20,5	34,8
Net imports ³¹	112,4	12,7	-34,8	0,7	6,3
of which: oil	112,6	2,0	-43,7	-13,4	-6,8
natural gas	0,7	9,0	9,6	12,1	12,7
Stock change	1,6	-6,5	-2,1	-	-
Total	227,0	202,3	196,0	216,6	237,8

Coal production is expected to maintain its present level until 2000, with new, competitive capacity replacing workings with high costs.

Oil and gas production, which should level out in the mid-1980s, would then tend to drop gradually. Clearly this tendency could be modified by the discovery of new fields in the North Sea. The United Kingdom would at all events remain a net exporter of oil at the end of the century. For natural gas, on the other hand, despite considerable domestic resources, imports should remain steady at the level contracted for 1990.

VIII. A STUDY OF SOME ALTERNATIVES TO THE "REFERENCE PROJECTION"

61. The "reference projection" described in the preceding pages should on no account be confused with a single forecast, but should be considered as a plausible and consistent scenario among other possibilities.

Obviously, the results obtained reflect the assumptions on which the projection is based and the cumulative uncertainties involved. Modifying any of the basic assumptions therefore alters the results accordingly.

It would thus be of great interest to assess the impact of a change in the main assumptions on the forecast long-term balance. This type of approach reveals the uncertainties involved in the assumptions chosen and their effects on the energy market and enables the identification of those factors which are the most important for the long-term demand and supply picture.

³¹ A minus sign (-) indicates net exports.

(a) Variations in economic framework(i) Economic growth

62. The "reference projection" assumes an average economic growth rate for the Community of 2.6% a year between now and 2000.

A lower rate of growth would have the effect of reducing the GFCF (gross fixed capital formation), thus delaying capital replacement. This would slow down the penetration of new technologies which favour a more rational use of energy and, in the medium to long term, improved energy efficiency. On the other hand, the drop in industrial production would result in a reduced total energy demand and a considerable drop in electricity consumption. The combined effects of these two opposing tendencies would depend on the rate of growth chosen and its duration. For example, an annual growth of 1.8% up to the year 2000 would reduce final energy consumption by approximately 50 mtoe compared with the reference projection. The drop in electricity consumption would chiefly affect solid fuel consumption.

A higher rate of economic growth, for example 3.5% a year, would enable the Community's energy efficiency to be improved by comparison with the reference projection but would also result in higher production of goods and services. This would lead, by 2000, to a gross energy consumption 60 mtoe higher than in the reference projection. Most of the new requirements would be covered by hydrocarbons: oil products (24 mtoe) and natural gas (16 mtoe); solid fuels (+ 7 mtoe) and nuclear energy (+ 12 mtoe) would also share in the increase in demand, though to a lesser extent.

(ii) Economic structure:

63. In the reference projection, a restructuring of the economy towards services, manufacturing industry and capital goods would have a favourable effect on the energy intensity of the Community economy.

If, however, it were assumed that energy-intensive industries were to maintain their present market shares up to the year 2000, then the Community's consumption of energy per unit of GDP would fall less than expected after 1990. This would lead, taking account of the technological improvements assumed in the reference projection, to an increase in energy consumption in the year 2000 of the order of 60 mtoe. Solid fuels would enjoy increased markets (+ 18 mtoe) because basic industries, such as steel and non metallic ore, which are heavy coal consumers, would show higher levels of production. Oil (+ 18 mtoe), natural gas (+ 13 mtoe) and nuclear energy (+ 13 mtoe) would cover the rest of the increase in demand.

EUR-10: 2000	Reference Projection	"Economic" alternatives	
		High GDP	unchanged GDP structure
Annual rate of increase of GDP	+ 2,6%	+ 3,5%	+ 2,6%
Gross energy consumption (mtoe)	1136	1195	1198
of which: solid fuels	264	271	282
oil	439	463	457
natural gas	196	212	209
nuclear	215	227	228
Net oil imports (mtoe)	330	354	348
Dependence on imported energy	46%	47%	47%

(b) Variations in average crude oil import price:

64. The central assumption for the average crude oil import cost used in the "reference projection" led to a \$35/bbl level in 2000 (at 1983 prices).³²

In certain circumstances, alternative price levels are possible. Two alternative price levels were chosen: \$20 and \$50/bbl, by 2000.

(i) Low oil price

65. Assuming that crude oil prices were to continue to fall, reaching \$20/bbl in 1990 and maintaining that level in real terms until 2000, the Community's GDP would - all other things being equal - increase somewhat, as private consumption and investment would grow more rapidly owing to lower pressure on the balance of payments. This would lead to an additional increase of about 80 mtoe in energy demand. This would chiefly favour oil, which would be substituted for coal, thus covering the additional energy demand.

As regards the world energy balance, this alternative would have two main results:

- a drop in solid fuel demand, which would only increase by 8% between 1983 and 2000 instead of the 25% allowed for in the reference projection. This change would be mainly due to electricity being less competitive than oil or gas for satisfying local needs. There would thus be a lower consumption of coal in power stations. Solid fuels, especially coal, would also experience stiffer direct competition on heating markets;

³²To arrive at final consumer prices, assumptions had to be made of course about transport and refinery costs, refinery set-backs, distribution costs and taxation. Given the uncertainties in all these areas it seemed reasonable to assume no major change in the present relationship between these costs and the basic price of crude.

- a fairly sharp recovery in demand for oil and, to a lesser extent, gas, which would cover both the increase in energy demand and the reverse substitution effect. at the expense of coal usage by final consumers.

Oil consumption could thus increase by more than a quarter, reaching 540 mtoe and covering 44% of energy demand in 2000, instead of 39% as in the reference projection. As in the price assumption adopted, the increase in consumption could only be covered by imports. This alternative would thus result in an increase in the Community's energy dependence of the order of 3%.

(ii) High oil price

66. If, on the other hand, oil prices were to grow more rapidly than anticipated and reach \$40/bbl in 1990 and \$50/bbl in 2000, the real GDP growth rate for the Community would be reduced owing to the inflationary effect of the high price of energy and the additional national resources devoted to oil imports.

In view of the cumulative effect of the reduction in GDP and the increase in the price of energy, the Community's gross energy consumption in 2000 would be approximately 70 mtoe lower than that estimated in the reference projection. With a crude oil price of \$50 per barrel, the competitiveness of nuclear energy, natural gas and coal should be enhanced vis-à-vis the competing oil products.

On the basis of the indexing systems adopted in the reference projection, natural gas would enjoy a very marked improvement in its threshold of competitiveness. This could even result in competition between producers and pressure for reduced market prices, which would increase its substitution for oil products for all non specific uses.

The fact that electricity would be more competitive for heating would lead to an increase in its share in covering final energy needs. This increase in production would be covered by both nuclear energy and solid fuels. The latter could also find themselves more competitive on industrial markets.

Under these circumstances oil consumption would be reduced by nearly a third, remaining limited to 300 mtoe. This would enable oil imports to be reduced by nearly 40%.

EUR-10 : 2000	Reference projection	<u>"Petrol price" alternatives</u>	
		low price	high price
Average import price of crude oil	\$35/bbl	\$20/bbl	\$50/bbl
Gross energy consumption (mtoe)	<u>1136</u>	<u>1218</u>	<u>1066</u>
of which: solid fuels	264	229	275
oil	439	539	306
natural gas	196	216	226
nuclear	215	212	230
Net oil imports (mtoe)	330	430	200
Dependence on imported energy	46%	49%	41%

(c) Alternatives regarding natural gas prices

67. The system for determining natural gas prices is another factor which is open to conjecture. The reference projection assumes that the present system, based on links between natural gas prices and those of competing oil products, will continue.

This assumption leads to natural gas maintaining a share of approximately 18% in the Community energy market.

It is however, possible that natural gas would increase its market share if its relative price were reduced and separated from oil prices.

In the context of the reference projection, it is possible to imagine that in case of a structural surplus in natural gas supply, its market penetration could be increased by decoupling the gas price from oil and aligning it with competing products in specific markets: coal, heavy fuel oil and gas oil for heating. Such a formula could cause gas prices to consumers to drop by about 8% and would increase the demand for natural gas by 20 mtoe in 2000. Oil products and coal would find their markets reduced by 15 and 5 mtoe respectively. In this case the proportion of Community energy needs covered by gas would reach 20% in 2000.

Under the assumption that the oil price were to reach \$50/bbl in 2000, all known potential sources of natural gas would become competitive. Increased competition between producers could lead to natural gas becoming freed from its linkage to the oil price and thus reducing its price by an estimated 30%.

In this case, an additional 25 mtoe of oil could be substituted compared with the "high oil price" alternative (see section 67). A certain drop in coal consumption would also be possible.

The natural gas market could thus represent 24% of energy supply in 2000. This is, however, an extreme case which could only come about in conjunction with considerable diversification of natural gas supplies.

EUR-10 : 2000	Reference projection	Consumer price alternatives	
		Natural gas	
Relative variation in prices	-	-8%	-30% ⁹⁹
Gross energy consumption (mtoe)	<u>1136</u>	<u>1136</u>	<u>1066</u>
of which: solid fuels	264	259	270
oil	439	424	281
natural gas	196	216	256
nuclear	215	215	230
Net oil imports (mtoe)	330	310	180
Dependence on imported energy	46%	46%	42%

(d) Alternatives regarding the role of solid fuels

68. The increase in coal consumption in the Community between 1983 and 2000 is an essential element of the energy strategy implicit in the reference projection. Coal would not only replace oil and gas in power stations but would also enjoy a certain revival in industry. The reference scenario suggests that on the basis of generally-accepted assumptions, solid fuel, comprising coal, brown coal and peat, will maintain their present market share at around 24%. This figure could, of course, vary in either direction.

(i) Strict emission controls on large industrial plants

69. The Commission's present proposals on the tightening-up of atmospheric emission controls on large industrial plants could influence the coal and oil markets in the future.

There is a degree of uncertainty as to the way in which the Member States could apply the proposed standards if they were adopted.

Different means could be employed by industrial concerns and electricity undertakings to respond to this need:

- replacing the fuel used by another, less polluting one; natural gas could become attractive in this case;
- turning to fuels with low sulphur content, involving a cost increase of from 4 to 8%;
- installing desulphurization units, the investment cost of which can vary, depending on the size of installation, from \$90 to \$200/KWe

A combination of these various means would not lead to any appreciable change in gross energy consumption in 2000, but would result in extensive substitutions of one energy product for another, compared with the reference projection.

³³ Under the "high oil prices" scenario.

In the electricity sector, stricter emission controls on conventional power stations will probably lead to increased production costs varying according to country between 8 and 12%. In this case overall final electricity demand could drop by 3 to 4% by the year 2000, most probably being replaced by natural gas. As far as electricity production itself is concerned, there could be some substitutions of nuclear energy for coal at the base of the load curve, while marginal quantities of coal and fuel oil could be replaced by natural gas in the middle of the curve.

In the same context, gas would also increase its market share in industry at the expense of coal and oil. The final result of this would be a level of coal consumption in 2000 close to 225 mtoe instead of the 265 mtoe arrived at in the reference projection.

Oil consumption would also drop by some 10 mtoe, in favour of natural gas and nuclear energy, which would each increase their respective market shares to much the same extent.

(ii) Slowing down of nuclear programmes:

70. The use of solid fuels could, on the other hand, increase more rapidly if there were to be a slowing down of nuclear programmes. Assuming that major delays postponements or even cancellations of part of the future programmes were to take place, this could result in an additional demand for coal to cover a growing part of basic electricity production.

In this extreme case, consumption of solid fuels could approach 310 mtoe in 2000. Natural gas needs should also show a slight increase.

EUR-10 : 2000	Reference projection	Low coal alternatives	"Solid fuels" High coal
Modified assumptions	-	Tightening up of emission standards	Delays in nuclear programmes
Gross energy consumption (mtoe)	1136	1136	1133
of which: solid fuels	264	223	309
oil	439	430	444
natural gas	196	226	208
nuclear	215	235	150
Net oil imports (mtoe)	330	321	335
Dependence on imported energy	46%	46%	50%

(e) Analysis of energy efficiency

71. On the basis of the assumptions adopted in the reference projection, average (primary) energy efficiency in the Community should improve by about 20% by the turn of the century **assuming the maintenance of present energy saving policies.**

Although this improvement would be substantial it would not exhaust the scope for more rational energy use in the different sectors of final energy demand. If more vigorous energy saving policies were to be introduced generally in the Community it would be possible to envisage savings of 100 mtoe or more compared with the reference projection. This would result from higher levels of insulation in buildings, heat recovery, district heating and combined heat and power, greater use of heat pumps and improvements in electronic control techniques and organisational techniques.

72. The largest share of the savings could be made on the basis of technologies already available within the Community and which could be commercialised more widely. **The most important sector for savings would be the residential sector,** which would reduce directly the consumption of oil, gas and electricity. Solid fuels would be affected indirectly and to a less significant extent through the reduction in electricity consumption.
73. It should be underlined however that without the maintenance of present RUE policies - building regulations, support for development and commercialisation of technologies and so on - even the level of savings indicated in the Reference Scenario would not be realised. If this occurred, it would affect primary energy demand, energy import dependence and energy prices.

The determining factor here will be the level of investment proposed and the resulting speed of capital replacement in the industrial, transport services and domestic sectors.

IX. THE COMMUNITY'S PLACE IN THE WORLD

74. In 2000, the Community should be consuming 11% of the energy produced in the world and producing only 5.5%. In 1970, the corresponding figures were 16% and 6% respectively.

In spite of considerable improvements which have been made in its supply structure during the last ten years, a trend which is expected to continue during the 1990s, the Community is likely to remain dependent on the outside world - in other words the international energy market - for a little less than half its supplies.

Thus even a small percentage increase in world oil consumption, owing to a higher rate of economic growth or a lower consumption of other forms of energy, could exceed the oil production capacity of the Middle East countries, which remain the world's marginal source of oil owing to their large reserves and low production costs.

There is thus still a certain risk of the reappearance of an unstable oil market before the end of the 1990s.

Other uncertainties could also vitiate the reference projection, for example price levels. If the assumptions adopted did not prove correct, there would also be the danger that situations of temporary unbalance could arise before the turn of the century, especially on the oil and gas market. These would create the conditions for new world economic crises and would again lead to instability on the energy markets; this would have a major effect on the Community.

X. CONCLUSIONS

78. The study "Energy 2000" has made it possible to describe the consequences for the energy market of a socio-economic reference scenario and of changes which could occur in this scenario if crucial variables were to diverge from the trends adopted for the reference scenario. The only changes which have not been considered are those which could be caused by decisions of a purely political nature or by situations of acute crisis. The results of the whole study nevertheless cover a sufficiently large area of possibilities to enable the key factors in the Community energy market to be identified up to the year 2000.

These factors can thus be taken into account during the consideration now taking place in the institutions of the Community, of **new energy objectives for the end of the 1990s**. The major findings which have emerged are listed below.

79. The degree to which the Community countries achieve **rational use of energy** is by far the most important factor determining energy needs. The impact on the energy market of the present uncertainties in this area is far greater than variations arising from a higher or lower rate of long term economic growth.
80. **Environmental protection** will be one of the main preoccupations in the remainder of the century. The Commission services attach great importance to the adoption by the Council of a Community directive to limit atmospheric emissions from large combustion installations. The introduction of the proposed norms ought not to affect the overall level of energy consumption but could give rise to

switching between fuels (see para 83 below). Moreover, the financial impact of these measures would not be without effect on energy prices.

81. Stable or slightly falling **energy prices** do not necessarily work against the long-term restructuring of the energy market. They could stimulate the GDP and, given suitable policies, encourage the growth of investment. This would, of course, yield energy savings, broadly compensating for the increase in consumption brought about in the short term by the direct effect of prices on demand.

In the same vein, it also appears that above a certain threshold of economic growth, the rate of growth has less effect of energy market trends than that of gross capital formation.

Energy prices varying sharply upwards or downwards would, on the other hand, lead to fresh disruption of the economy, which would, in the medium term, create reversals of trends and engender a lack of confidence which would be damaging to current attempts at restructuring the energy market.

82. One of the important factors in the restructuring of final energy demand is the penetration of energy as electricity. This could become the most rapidly growing part of the energy market between now and the turn of the century despite a relationship between economic growth and electricity demand below unity.

The additional costs which could result from the application of stricter emission standards for power stations should detract little from the final electricity demand. On the other hand, their effects on the structure of **energy consumption in combined heat and electricity generators** could be considerable and could delay the policy of returning to coal in this sector, unless the investments needed were to be aided with financial incentives.

The balance achieved in the Community's electric power stations between nuclear energy and solid fuel for electricity production could be modified. However, even in this case, the complementary relationship between coal and nuclear energy in power stations is confirmed.

83. In the residential and services sector, **natural gas** should, with electricity, constitute another factor leading to restructuring of the market as it replaces oil products. This increased penetration of natural gas in a sector subject to large seasonal fluctuations implies a simultaneous increase in gas supply to sectors such as industry, where the offtake for consumption is either more regular or can be varied more easily.
84. The restructuring of the energy market now taking place and the continuation of this process that can be foreseen in the medium term will continue to create the conditions for **oil product consumption** to stabilize. Consumption is likely to be increasingly

concentrated on specific uses. The respective market shares of light and medium oil products would thus tend to increase in the medium term at the expense of heavy oil products, which would justify the continuation of efforts to rationalize the refining sector.

85. Continuation of efforts to **diversify supplies** will lead to (mainly imported) oil being replaced by solid fuels or natural gas, an increasing proportion of which will also have to be imported in the future. Excessive dependence on one supplier could then again, in the medium term, raise similar problems to those created by dependence on particular oil suppliers at the beginning of the 1970s
86. Any development - even if marginal - of Community energy **production**, achieved under satisfactory economic conditions, should help to reduce this risk.

In this context the importance must be emphasized of the rapid continuation of nuclear programmes, the development of new and renewable energy sources, the maintenance of a reasonable level of solid fuel extraction and the continuation of oil and gas research exploration, which could lead to new capacity being exploited.

87. **The world energy market** should enable the volumes of energy needed for the Community countries' import needs to be made available. But the oil markets development will be strongly influenced by consumption trends in the other industrialized countries (particularly the United States) on the one hand and by those in the developing countries on the other. It is thus still of crucial importance that the Community's industrial partners continue their efforts to reduce their dependence on imported oil and that the Third World countries, especially those which are oil importers, should be in a position to take advantage of greater diversification of energy sources and more rational use of it.

COMMISSION OF THE EUROPEAN
COMMUNITY
DIRECTORATE-GENERAL ENERGY
ENERGY 2000

EUROPEAN
COMMUNITY

EUR-10

ENERGY SUPPLY/DEMAND BALANCE

EUROSTAT 1973

(Mto Tce)	SOLID FUEL	PETROL PRODCT	GAS	NUCLR ENERGY	HEAT	HYDRO+ OTHERS	RENEW ENERG	TOTAL
PRIM PRODUCT	197,7	13,1	112,2	17,7	-	9,1	1,2	351,0
TOT IMPORTS	42,6	732,6	29,3	-	-	2,9	-	807,4
TOT EXPORTS	23,6	136,3	25,3	-	-	2,2	-	187,4
STOCK CHANGE	5,3	-8,1	-0,4	-	-	-	-	-3,2
GROSS CONSUM BUNKERS	222,0	601,3	115,8	17,7	-	9,8	1,2	967,8
INLAND CONSM	222,0	563,9	115,8	17,7	-	9,8	1,2	930,4
ELEC POWER S	101,3	75,0	30,6*	17,7	-3,2	-80,4	1,2	142,2
OTHER TRANSF ENERG INDUST	32,7	13,5	-33,7	-	-	-	-	12,5
FINAL CONSUMP	2,5	33,8	12,7	-	-	14,2	-	63,2
- NON ENERGY	85,4	439,3	107,4	-	3,2	76,0	-	711,3
- INDUSTRY	3,4	60,7	6,2	-	-	-	-	70,3
- TRANSPORT	45,6	104,7	57,9	-	0,9	38,6	-	247,7
- HOUSEHOLD	1,0	125,0	0,1	-	-	2,0	-	128,1
STAT DIFFER	35,4	148,9	43,2	-	2,3	35,4	-	265,2
STAT DIFFER	0,1	2,3	-1,2	-	-	-	-	1,2

* of which gas derived from coal: 7,1 mtoe

ENERGY SUPPLY/DEMAND BALANCE

EUROSTAT 1980

(Mto Tce)	SOLID FUEL	PETROL PRODCT	GAS	NUCLR ENERGY	HEAT	HYDRO+ OTHERS	RENEW ENERG	TOTAL
PRIM PRODUCT	185,1	91,1	129,2	42,7	-	12,3	1,7	462,1
TOT IMPORTS	67,2	596,6	81,7	-	-	5,1	-	750,6
TOT EXPORTS	19,9	158,7	41,1	-	-	3,7	-	223,4
STOCK CHANGE	-9,7	-9,0	-0,5	-	-	-	-	-19,2
GROSS CONSUM BUNKERS	222,7	520,0	169,3	42,7	-	13,7	1,7	970,1
INLAND CONSM	222,7	493,8	169,3	42,7	2,1	13,7	1,7	943,9
ELEC POWER S	130,1	60,9	31,3*	42,7	-3,9	-96,9	1,7	165,9
OTHER TRANSF ENERG INDUST	26,4	6,4	-25,0	-	-	-	-	7,8
FINAL CONSUMP	1,2	31,2	9,6	-	-	17,8	-	59,8
- NON ENERGY	65,0	395,3	153,4	-	3,9	92,8	-	710,4
- INDUSTRY	2,7	49,4	7,9	-	-	-	-	60,0
- TRANSPORT	38,4	77,6	66,8	-	1,4	42,8	-	227,0
- HOUSEHOLD	0,2	150,7	0,3	-	-	2,4	-	153,6
STAT DIFFER	21,8	117,4	76,5	-	2,5	47,6	-	265,8
STAT DIFFER	+1,9	+0,2	+1,9	-	-	-	-	+4,0

of which gas derived from coal: 6,5 mtoe

Summarized Energy Balance - EUR-10 / ENERGIE 2000

in million toe	1973 ^a	1980 ^a	1983 ^a	1990 ^b	2000 ^c
I. Gross Energy Consumption	968,04	970,05	907,21	1034	1107
- Bunkers	37,36	26,21	21,98	28	29
- Inland consumption	930,68	943,84	885,23	1006	1107
II. Inland Energy Consumption	930,68	943,84	885,23	1006	1107
- Solid fuels	221,97	222,68	211,99	242	264
- Oil	563,93	493,82	416,29	413	490
- Gas	115,83	169,26	165,35	190	152
- Primary electricity, etc.	28,95	58,08	91,60	161	236
III. Indigenous Production	351,29	462,10	516,29	563	625
- Hard coal	171,16	153,31	143,06	139	137
- Lignite & peat	26,49	31,81	30,99	36	35
- Oil	13,17	90,52	132,51	111	108
- Natural gas	112,20	129,16	119,94	115	108
- Nuclear energy	17,73	42,67	76,06	145	215
- Hydro & geothermal ²	9,38	12,39	12,00	13	14
- Others & renewables	1,16	1,66	1,67	4	7
IV. Net imports	619,91	527,15	377,90	471	511
- Solid fuels	19,00	47,28	39,08	67	92
- Oil	596,21	437,95	288,78	330	330
- Natural gas	4,01	40,56	48,17	75	88
- Electricity ²	0,69	1,36	1,87	-1	-
V. Stock changes	+3,15	-19,21	-13,08	-	-
- Solid fuels	-5,32	-9,72	+1,14		
- Oil	+8,09	-9,03	-16,99		
- Gas	+0,38	-0,46	+2,77		
VI. Electricity Generation Input	235,13	279,06	286,73	367	444
- Solid fuels ⁵	108,33	130,12	138,38	160	178
- Oil	75,04	60,91	36,86	20	18
- Natural gas	23,51	31,31	21,76	27	15
- Nuclear energy	17,71	42,67	76,06	145	215
- Hydro & geothermal ²	9,38	12,39	12,00	13	14
- Others & renewables	1,16	1,66	1,67	2	4

Main indicators (related to the 1990 objectives)

	1973-1963	1979-1975	1990-1983	2000-1990	
Inland energy annual growth rates	+4,6%	+3,4%	+1,8%	+1,0%	
GDP annual growth rates	+4,7%	+3,6%	+2,4%	+2,8%	
Energy - GDP ratio	0,98	0,94	0,75	0,37	
	1973	1980	1983	1990	2000
Share of oil in gross energy consumption	62,1%	52,3%	48,%	41%	37%
Share of coal and nuclear in electricity production	53,6%	61,9%	74,3%	83%	88%
Supply dependence on imports	64 %	54,3%	41,8%	46%	46%

Sources:

- a. Statistical Office of the European Communities
- b. ENERGY 2000 Study - DG XVII - November 1984

Notes:

1. Production of primary sources, including recovered products.
2. The conversion of electricity, including hydro and geothermal, is based on its actual energy content: 3600 Kjoules/kwh or 860 kcal/kwh
3. The (-) sign means net exports
4. The (-) sign means a stock decrease
5. Including coke oven gas and blast furnace gas (derived from coal)