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ENERGY PROSPECTS TO THE END OF THE CENTURY

(Commission working paper)

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P R E A M B L E

ENERGY PROSPECTS TO THE END OF THE CENTURY

(Working Document of the Commission)

The attached working document is to be circulated to the Council, the Parliament and the Economic and Social Committee.

The framework in which this document is being circulated is set out below.

1. The Energy Council, at its meeting on 22 May 1984, gave COREPER the following mandate:

- to conduct an in-depth examination of national energy policies to see the extent to which these policies were making a harmonised and balanced contribution to the common objectives;
- to carry out an examination of the conclusions to be drawn at Community level regarding the areas for concern and the priorities for action;
- consideration of new common guidelines for 1995.

2. During its meeting on 13 November 1984, the Energy Council continued its discussion on the Commission's Communication¹ reviewing Member States' energy policies and the progress realised towards the attainment of the energy objectives set for 1990. The Council said that it was awaiting the Commission's proposed new energy objectives for the next decade which should take account on the one hand of the results of the detailed examination of the Member States' energy policies² and on the other of the Commission study on the energy supply and demand options up to the year 2000.

3. The working document attached is a very brief resumé of the hypotheses and results of this study on the energy supply and demand perspectives to the year 2000. A fuller document synthesising the methods followed in concluding the study and setting out the results in a more detailed manner will be available in a few weeks'. It will reflect the outcome of a vast study whose results were the subject of discussion with different experts including those of Member States' administrations.

¹ COM(84)87 and COM(84)88 dated 29 February 1984

² SEC(84)1658 dated 30 October 1984

4. The working document attached is therefore destined to support the debate which is to take place within the Community Institutions during the first half of 1985, on the new energy objectives for the next decade. The recent Commission Communication concerning a draft Nuclear Indicative Programme³ will also contribute to this reflection.

³ COM(84)653 dated 22 November 1984

ENERGY PROSPECTS TO THE END OF THE CENTURY

(Commission Report)

INTRODUCTION

1. The past 10 years have been a period of instability and rapid change in energy markets. The original trigger was the five-fold increase in crude oil prices in 1973/4. Since then, there has been a period of stagnating prices until late 1978, a further price explosion in 1979/80 and then four years in which prices have declined in dollar terms. These fluctuations have reacted on all energy prices and on the energy market as a whole. In addition, governments and consumers have made successful efforts to save energy and reduce reliance on oil.

2. The result has been a dramatic change in the structure of the Community's energy economy. In 1973, over 60% of our energy needs were met by imported oil. Ten years later, our total energy consumption was lower, despite a decade of economic growth; oil accounted for only 48% of our energy needs; and imported oil for less than one third.

3. There will always be a risk of the unexpected, but we could well now be moving into a period of comparative energy stability. The level of production capacity in the main oil exporting countries, despite the continuing Iran/Iraq war, remains well above the demand for oil in world trade. This surplus, together with the reserve stocks held in OECD, should provide a cushion to deal with all but the most severe contingencies. At the demand level the trends towards greater energy efficiency and diversification to other fuels seem well established and likely to continue. Coal and nuclear principally as inputs for electricity generation, as well as gas, are continuing to substitute for oil in all European consumer sectors apart from transport.

4. That is not to say that worries about supply security and price instability can or should be set aside. Contingency measures to deal

with unexpected events will remain essential. But there does now seem to be a more stable climate for long-term planning than there has been in the past few years. Indeed, the very purpose of a long-term study is to evaluate the chances of maintaining reasonable market stability and to determine, if the case arises, how to achieve it. Continuation of effective policies are the best guarantee of reducing the risk that - once again - before the end of the century there will be supply difficulties and disruptive price movements on the international oil market.

5. It is against this background that the Commission Services have carried out a new study of energy trends to the year 2000. This analysis has been designed to illustrate the way in which the Community's energy situation may develop on present expectations, and to identify the extent to which trends could change if some of the key economic or energy parameters took a different path. Member States' experts have been consulted on the results of this work in its final stages. These results, along with the recent Council reflections on the examination of Member States' energy policies¹, should provide a useful analytical background for the discussion in 1985 of long-term energy objectives and energy policies. The Commission's recent Communication concerning a draft Nuclear Indicative Programme² for the Community will also contribute to this reflection.

6. The remainder of this Report outlines the most interesting and relevant features of the Commission Services study. It does not attempt to cover the full range of the results which have been obtained, or to explain in any detail the analytical modelling techniques which have been used. Both these points will be covered in a more detailed document which is currently being prepared and which is expected to be completed for presentation in the next few weeks.

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¹ SEC (84) 1658 dated 30 October 1984

² COM (84) 653 dated 22 November 1984

GENERAL APPROACH

7. The approach used in the study was to construct and analyse a Reference Scenario and then to test the effects on those results of changes in key economic or energy parameters by means of a series of Variant Scenarios. Among all the variants imaginable, only those which were judged to be sufficiently feasible and whose impact on the energy markets were shown to be significant were retained. In each case, the analysis was carried out at the level of the national economies. It is important to make it clear at the outset that the Reference Scenario is in no sense intended to be a central forecast. It is rather an internally-coherent set of what at present seem to be the most likely trends in economic and energy conditions. It would be remarkable if all those trends turned out to be accurate. The purpose of the Variant Scenarios therefore is to identify a range of future energy possibilities. Even this range cannot by definition be exhaustive. But it should serve to define the limits of the probable, as opposed to the conceivably possible, and to identify which energy or economic variants are likely to be of most significance.

THE MAIN RESULTS

A. Reference Scenario

8. In summary, the Reference Scenario assumes growth in Community GDP of 2.7% a year between now and the end of the century, a slow change in the structure of GDP in favour of the services sector and away from the energy-intensive basic industries. The average cost of crude oil supply is assumed to decline in nominal terms for several more years, then stabilise in real terms before growing constantly to reach \$35/barrel in real terms (1983) in the year 2000. The general level of energy prices will therefore in this situation remain relatively high. A more detailed description of the underlying assumptions will be supplied in the document mentioned above.

9. On this basis, the Reference Scenario results indicate a relatively slow increase in primary energy consumption in the Community between now and the end of the century, reaching a level of about 1130 million tons of oil equivalent (mtoe) in the year 2000 which would be only 25% higher than in 1983 (909 mtoe). Within this, demand growth is likely to be higher in the rest of the 1980s than in the 1990s because the Community will be moving out of economic recession in the next few years at a time when oil and other energy prices will be tending to erode. In 1984, for instance, Community energy demand will probably increase by as much as 4%. But this is very unlikely to be typical of the longer-term trend.

10. One of the most important factors in determining future energy demand is, of course, how efficiently a given volume of energy is used. Between 1973 and 1983, energy efficiency in the Community, largely due to the massive price increases, improved by about 20%. The Reference Scenario indicates a similar improvement being possible between 1983 and 2000. This trend is in part due to the assumptions concerning structural change in the economy but also in part due to new investment in new and more energy-efficient processes and investment in more modern equipment which improves the energy yield. Energy saving from now until the end of the century will reduce the necessary increase in energy demand by almost a half.

11. Combining the trends of recent years, the Reference Scenario suggests that electricity should cover a significant share of the increase in final energy demand. Electricity's share of final energy demand should increase from 15% in 1983 to 18% in 2000. Electricity consumption will increase by an average of 2.2%/year until the end of the century -- twice the rate expected for overall energy growth in the 1990s. This expected penetration of electricity in consumer markets will follow from important developments in specific uses of electricity and from increased competitiveness of electricity for thermal uses which in turn is due to the investment in nuclear and coal-fired power plant.

12. During the last ten years, nuclear energy production in the Community has quadrupled. Today it covers more than 22% of total electricity production. In the Reference Scenario, the nuclear share of electricity production is expected to double by the end of the century. Nuclear power, therefore, will account for more than half of the expected increase in energy demand to the year 2000.

13. Natural gas, solid fuels and, to a lesser degree, the new and renewable energies will cover the other half of the increase in overall energy demand. These increases allow each of these fuels to maintain approximately their current market shares.

As a result, oil consumption will remain flat at today's underlying level until the end of the century. This means that oil's share of total energy consumption decreases from 48% to about 40% by the year 2000. These main trends can be seen in the table below.

Table 1: Gross Community Energy Consumption (including bunkers)

	<u>1 9 7 3</u>		<u>1 9 8 3</u>		<u>1 9 9 0</u>		<u>2 0 0 0</u>	
	<u>MTOE</u>	<u>%</u>	<u>MTOE</u>	<u>%</u>	<u>MTOE</u>	<u>%</u>	<u>MTOE</u>	<u>%</u>
Solid fuels	222	23	212	23	240	23	250	22
Oil	601	62	438	48	440	43	440	39
Natural gas	116	12	165	18	191	19	205	18
Nuclear energy	18	2	76	9	136	13	205	18
Other	13	1	18	2	18	2	28	3
<u>TOTAL</u>	<u>970</u>	<u>100</u>	<u>909</u>	<u>100</u>	<u>1025</u>	<u>100</u>	<u>1128</u>	<u>100</u>

Although significant in terms of their relative growth, new and renewable energies will still be weak in volume terms up to 2000. In the context of the hypothesis taken, research, development and demonstration efforts in this sector should start to have real effects on the Community's energy supply around the turn of the century.

14. The substantial increase in nuclear production, coupled with a flattening of the Community's hydrocarbon production curve, plus a possible reduction in Community coal production, means that the Community will be able to cover approximately one-third of its energy requirements by the year 2000 under the Reference Scenario assumptions. Energy imports, after four consecutive years of decline, are expected to increase over the period.

In the Reference Scenario, net energy imports into the Community could rise from 378 mtoe in 1983 to 528 mtoe in the year 2000. However, even this 40% increase only results in reaching the 1980 net import level. Annual oil imports would increase in 2000 by about 40 mtoe which is less than 1 mbd over present levels, accounting for less than two-thirds of total energy imports. Nevertheless, the Community will continue to depend on imported oil for about one-third of its total energy requirements. Imports of coal and natural gas would increase substantially; both more than doubling to reach 100 mtoe each.

15. Fuller information on the Reference Scenario results are summarised in the table in the Annex to this Report.

B. Variations in Economic Growth and Structure

16. Higher economic growth in the Community, averaging 3.5% a year, rather than 2.7% for the period concerned, would increase total primary energy consumption in the year 2000 by only about 5% over the Reference Scenario case. Oil consumption would also increase by about 5%; solid fuels by rather less and both nuclear energy and natural gas by a slightly higher figure. But the market shares for each source would not change very significantly. On the other hand, lower average economic growth, for example 2% will tend to slow down investment and capital replacement. This would slow down the penetration of new technologies

or processes which favour a more rational use of energy. Therefore the resulting primary energy consumption under such a low growth scenario would not be significantly less than that calculated in the Reference Scenario in the year 2000.

17. The sensitivity of the projections to economic structure is significant. In the Reference Scenario it was assumed that the trend towards greater activity in the services sector at the expense of manufacturing industry would continue. If, however, this trend did not develop and the structure of GDP remained unchanged, energy consumption in the year 2000 would be some 5% higher than in the Reference Scenario. In other words, this factor would be as significant as the higher economic growth assumption discussed above. Solid fuels would fare slightly better under this Scenario because basic industries (iron and steel, non metallic ore, ...) which are heavy coal consumers, are reaching higher production levels.

18. These results are summarised below:

EUR-10: 2000

	<u>Reference Case</u>	<u>Economics Variants</u>	
		<u>High GDP</u>	<u>UnChanged GDP Structure</u>
GDP annual growth rate	+2.7%	+3.5%	+2.7
Gross energy consumption (mtoe)	<u>1128</u>	<u>1187</u>	<u>1190</u>
of which:			
coal	250	257	268
oil	440	464	456
natural gas	205	221	220
nuclear	205	217	218
Net oil imports (mtoe)	330	354	346
Dependence on energy imports	47%	48%	48.5%

C. Oil Price Variations

19. Two further Variant Scenarios analysed the effects of different oil price trends. If crude oil prices eroded to reach a level of only \$20 a barrel in real (1983) terms by the end of the century, then energy consumption in the Community would be about 7% higher in the year 2000 than in the Reference Scenario. As would be expected, oil would benefit from this situation, both by meeting the growth in consumption and by displacing more coal. In effect, this price scenario makes a number of coal mining sites uncompetitive which could or would otherwise be able to supply the world markets. Consumption of solid fuels would be about 40 mtoe lower than in the Reference Scenario. Nuclear energy and natural gas would be hardly affected. Oil consumption could reach a level of 565 mtoe and a market share of 47% in the year 2000, as compared with only 39% in the Reference Scenario. This additional oil requirement would have to be met by further imports.

20. Conversely, if oil prices increased by more than expected, to reach \$50 a barrel in real terms by the end of the century, total Community energy consumption in 2000 would be about 6% lower than in the Reference Scenario. As for the other Scenarios studied, this result follows from a series of cross effects between competing energy prices and also from the economic climate conditions on which the Scenario is based. Furthermore, under these conditions, oil could lose its role as 'price-leader' in the energy markets; with natural gas prices decoupling from competing oil prices. In this case, oil consumption would be reduced by over 35% to a level of about 280 mtoe. This would in turn reduce oil imports by nearly half. But natural gas should increase its market share. Nuclear energy and renewable energies should also increase, with coal consumption remaining unchanged. Under this scenario, each fuel (including nuclear) would have a roughly equal share of the market.

21. These results are summarised in the following table:

EUR-10: 2000

	<u>Reference Case</u>	<u>Crude Oil Price Variants</u>	
		<u>Lower Price</u>	<u>Higher Price</u>
Average crude oil imports price	\$35/bbl	\$20/bbl	\$50/bbl
Gross energy consumption (mtoe)	<u>1128</u>	<u>1210</u>	<u>1056</u>
of which:			
coal	250	210	250
oil	440	565	278
natural gas	205	204	265
nuclear	205	203	230
Net oil imports (mtoe)	330	465	178
Dependence on energy imports	47%	55%	41%

D. Variations in Electricity and Gas Prices

22. In the Reference Scenario the share of electricity in final energy demand would slowly increase from 15% in 1983 to 18% by the year 2000. This degree of penetration would of course depend crucially on the policies used to promote its use, on the growth of electricity for specific uses and on the general level of investment. This will also depend on the relative price of electricity to other competing fuels. Should the adoption of stricter emission controls in conventional power plants lead to electricity prices being some 10-15% higher than in the Reference Scenario throughout the period, this would reduce electricity consumption in the year 2000 by some 4%. At the level of primary energy consumption, the global effects of this would not be very great. On the other hand, substitution should operate between energy forms for electricity generation. This is described in paragraph 25.

23. The formation of natural gas pricing is another issue that is open to conjecture. For natural gas pricing the Reference Scenario assumes a continuation of the present system under which the price of gas is indexed to competing fuels. This results in gas roughly maintaining its present 18% share of the Community energy market. There would however be scope for expansion of this market share if the price of gas were reduced and decoupled from the price of oil. A 10% reduction in gas prices would increase gas market share in 2000 from 18% in the Reference Scenario to 20% by the year 2000, and a 30% reduction would result in a market share of 23%. In the latter case, some 1 million barrels of oil per day would be displaced, accompanied by a smaller reduction in the use of solid fuels.

24. These results are summarised below:

EUR-10: 2000

	<u>Reference Case</u>	<u>Consumer Prices Variants</u>	
		<u>Electricity</u>	<u>Gas</u>
Consumer price changes	-	+15%	-10%/-30%
Gross energy consumption (mtoe)	<u>1128</u>	(-0.5)	<u>1128/1128</u>
of which:			
coal	250		245/237
oil	440		420/395
natural gas	205		230/265
nuclear	205		205/203
Net oil imports (mtoe)	330		310/285
Dependence on energy imports	47%		47%/48%

E. Variations in the Role of Solid Fuels

25. The Reference Scenario suggests that on present expectations solid fuels, including coal, peat and lignite, will maintain roughly their present 23% market share. There is clearly scope for variation in either direction. Current Community proposals for enforcement of emission controls for large combustion installations will affect both the coal and oil markets. The way in which Member States would choose to meet these standards, if adopted, is subject to some degree of uncertainty, but it is probable that in the electricity sector there would be some marginal replacement of coal by nuclear energy for base-load generation, and some replacement of both coal and fuel oil by natural gas in the medium-load range. Gas would probably also increase its share of the industrial market at the expense of coal and oil. The net result could be a decrease in solid fuels consumption in the year 2000 from 250 mtoe in the Reference Scenario to just under 215 mtoe. Oil consumption would also go down, although only by 10/mtoe. Natural gas and nuclear energy would share the benefits about equally.

26. The use of solid fuels could on the other hand increase more quickly if there were any setbacks to the nuclear construction programme. Assuming that there were important delays or cancellation of a part of the future planned nuclear programme, there would be a sizeable additional need for coal to meet base-load electricity needs. In an extreme case, the consumption of solid fuels could rise to 300 mtoe by the year 2000, accompanied by a much smaller increase in natural gas consumption.

27. These results are summarised below:

EUR-10: 2000

	<u>Reference Case</u>	<u>Role of Solid Fuels Variants</u>	
		<u>Low Coal</u> Higher emission Standards	<u>High Coal</u> Nuclear programmes Setbacks
Asumption changed	-		
Gross energy consumption (mtoe)	<u>1128</u>	<u>1131</u>	<u>1125</u>
of which:			
coal	250	214	300
oil	440	430	440
natural gas	205	231	217
nuclear	205	228	140
Net oil imports (mtoe)	330	320	330
Dependence on energy imports	47%	48%	52%

F. Changes in Energy Efficiency

28. On the assumptions set for the Reference Scenario, an average improvement in energy efficiency of about 20% is foreseen between 1983 and 2000. While it is substantial, it still does not cover the entire existing potential for increased rational use of energy in the different final consumer sectors. If it is assumed that there is an increased downgrading of equipment which is replaced by others of higher performance standards for space heating in the residential and tertiary sector or for the production of heat in industry, the efficiency of utilisation of energy for these would be found to increase. Additional energy savings of the order of 25 mtoe or 2% would be made in 2000. A maximalist scenario for the penetration pattern of RUE technologies in such areas as increased insulation levels in buildings, heat recovery, town heating from combined heat and power production, heat pumps, the production of biogas or other renewable sources, ought also be considered. In the situation where one can, in parallel, also increase the techniques for electronic control and organisation measures, it appears possible that a further 100-150 mtoe could be saved by the year 2000 compared to the Reference Scenario.

29. This confirms the views of certain energy market experts who think that energy savings higher than the 20% used in the Reference Scenario could be obtained by 2000. Their assumption is that the energy savings possible are around 30-40% from now to the year 2000. In this case, there would be no increase in Community consumption (except temporary or marginal) from now until the end of the century. The crucial determinant will be whether the necessary level of investment is made and whether the rate of capital replacement is sufficient in each of the four energy markets industry, transport, the tertiary and domestic sectors.

WORLD CONTEXT

30. Although the focus of the Commission Services study has naturally been the Community itself, a broader analysis has been carried out of energy supply and demand at world level in the year 2000. The main objective of this part of the study has been to establish that the Community's energy import requirements could feasibly be supplied without generating a level of market competition which would escalate price levels. In order to carry out this analysis, the Commission services have had to use numerous information services which vary in quality and in detail from region to region. The results therefore could be less robust than those obtained from the analysis of the Community market.

31. The available information on other countries' future energy requirements suggests that total world energy demand, including the centrally-planned economies, could reach the level of about 11,000 mtoe by the end of the century. Nuclear energy would be likely to account for only about 7% of these needs and renewable sources, particularly hydroelectricity and firewood, for perhaps a further 11%. Solid fuels consumption would account for just over 30% and there

would be no difficulty in supplying that amount from reserves already identified or in production. Future natural gas production is subject to some uncertainties about when particular deposits will be developed and marketed, but the assessment suggests that gas could meet a further 20% of world energy needs by the end of the century.

32. The remaining needs would of course have to be met by oil, which would require total world production of some 3500 mtoe a year or close to 70 million barrels a day. This should be achievable. Taking account of production possibilities elsewhere, this total level would imply an output from the Middle East producers of about 20 million barrels a day, which is less than those countries produced in 1980 and perhaps only 80% of their current production capacity. At the same time, there would clearly be very little safety margin. There is no certainty that the investments necessary to maintain or increase production capacity will be made in coming years. Even a small percentage increase in oil consumption on a world scale, for instance because of higher economic growth or lower use of other fuels, could overtake the production capacity of the Middle East countries which are likely to remain the marginal oil suppliers. There is therefore some risk that an unstable oil market situation could recur before the end of the 1990s.

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Summarized Energy Balance - EUROPEAN COMMUNITY - ENERGY 2000

27.11.84

in million toe	1973 ^a	1979 ^a	1983 ^a	1990 ^b	2000 ^b
I. Gross Energy Consumption	968,04	1011,67	909,08	1025	1128
- Bunkers	37,36	26,86	21,98	25	28
- Inland consumption	930,68	984,81	887,10	1010	1100
II. Inland Energy Consumption	930,68	984,81	887,10	1000	1100
- Solid fuels	221,97	223,36	211,99	240	250
- Oil	563,93	536,63	416,29	415	412
- Gas	115,83	172,45	165,35	191	205
- Primary Electricity, etc.	28,95	52,37	93,47	154	233
III. Indigenous Production¹	351,29	457,93	518,10	550	600
- Hard coal	171,16	149,20	143,06	133	116
- Lignite & Peat	26,49	31,00	30,99	36	35
- Oil	13,17	89,32	132,51	112	110
- Natural gas	112,20	137,49	119,94	113	107
- Nuclear energy	17,73	37,19	76,06	136	205
- Hydro & geothermal ²	9,38	12,19	13,87	17	20
- Others & renewables ³	1,16	1,54	1,67	3	7
IV. Net Imports	619,91	558,68	377,90	475	528
- Solid fuels	19,00	33,77	39,08	71	99
- Oil	596,21	487,26	288,78	328	330
- Natural gas ²	4,01	36,21	48,17	78	98
- Electricity ⁴	0,69	1,44	1,87	-2	1
V. Stock changes⁴	+3,15	+4,83	-13,08	-	-
- Solid fuels	-5,32	-9,41	+1,14		
- Oil	+8,09	+12,98	-16,99		
- Gas	+0,38	+1,26	+2,77		
VI. Electricity Generation Input⁵	235,13	278,72	288,60	362	433
- Solid fuels ⁵	108,33	132,04	138,38	161	170
- Oil	75,04	66,76	36,86	21	17
- Natural gas	23,51	29,00	21,76	28	22
- Nuclear energy	17,71	37,19	76,06	136	205
- Hydro & geothermal ²	9,38	12,19	13,87	14	15
- Others & renewables	1,16	1,54	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%	+1,7%	+1,0%
GDP annual growth rates	+4,7%	+3,6%	+2,3%	+2,7%
Energy-GDP ratio	0,98	0,94	0,74	0,37
	1973	1979	1983	1990
Share of oil in gross energy consumption	62.1%	55.7%	48.2%	43%
Share of coal and nuclear in electricity production	53.6%	60.7%	74.3%	82%
Supply dependance on imports	64 %	55.2%	41.6%	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)