Study on the Long-Term Energy Outlook for the European Community

Luxembourg 1964

THE HIGH AUTHORITY
OF THE
EUROPEAN COAL AND STEEL COMMUNITY

THE COMMISSION
OF THE
EUROPEAN ECONOMIC COMMUNITY

THE COMMISSION
OF THE
EUROPEAN ATOMIC ENERGY COMMUNITY

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LUXEMBOURG 1964

FOREWORD

This Study on the Long-Term Energy Outlook for the European Community is the outcome of long and exacting labour on the part of various departments of the High Authority in conjunction with those of the E.E.C. and Euratom. Various coal and oil experts were also consulted.

In its present state it constitutes a working document of the Community services. Its aims are three-fold :

1) *The Outlook first of all explains the basic hypotheses outlined in the Memorandum on Energy Policy submitted to the Special Council of Ministers of the E.C.S.C. on June 27, 1962. The Outlook is thus not a document of economic policy but an objective attempt to assemble all the information necessary for surveying the field and estimating the effects of possible policies. It is important to remember that the major conclusion arising from this Outlook is that existing hazards and margins of error in no way detract from the validity of the lines of economic policy proposed in the Memorandum. This in fact reinforces the independence and security for political decisions.*

2) *The Outlook then goes on to provide answers to the main questions raised by the Council of Ministers as regards the competitiveness of Community coalmining, subsidy mechanisms, oil supply conditions, nuclear energy prospects, balance of payment problems and cyclical fluctuations.*

   Once the Council of Ministers has signified its agreement to the general lines of the Memorandum, these answers will enable methods of applying the chosen policy to be specified and their consequences assessed.

3) *Finally, the Outlook does not prejudice the General Objectives for coal as envisaged by Article 46 of the Treaty of Paris but constitutes a necessary preliminary thereto.*

Prefaces

by P.-O. LAPIE
Member of the High Authority,
Chairman of the Inter-Executive Working Party
on Energy

To the Second Edition

The "Study on the Long-Term Energy Outlook of the Community" aroused much interest on its original appearance in January 1963. It was dissected and discussed in detail in the Press and in specialized publications, and debated in all sorts of circles.

The object in bringing out this second edition is twofold, to meet the continuing steady demand for the work, and, this time, also to make generally available the technical Annexes [1]) explaining more fully aspects which are dealt with in condensed form in the body of the overall *Study*.

Readers may be somewhat surprised to find that we have neither sought to clarify certain disputed points nor updated the figures and findings in the light of the latest developments. We have not done so for two reasons.

Minor alterations would have added little to the value of the work, and might have wrongly suggested greater reliability or the need to view the balance and general conclusions of the *Study* differently. It was therefore preferred to make none.

On the other hand, we should of course have felt obliged to recast the entire *Study* had it been considered, on the strength either of new developments meantime or of criticisms voiced, that the basic approach required alteration. I must emphasize that there appears to be at present no reason to do anything of the kind : on the contrary. A first check on the trends outlined in the *Study* was effected in connection with the annual scrutiny of the Community's energy position. [2]) This check, which will be repeated at regular intervals, showed that the long winter of 1962 and the unusually severe one of 1963 temporarily intensified, but in no way deflected, the main trends described — growing energy requirements, growing proportional consumption of oil, growing dependence on imports, hard times for much of the Community's coal industry.

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1) These Annexes are not included in the English version. Readers wishing to consult them are referred to the editions published in the four official Community languages (French, German, Italian and Dutch).

2) See *Conjoncture énergétique dans la Communauté: Situation à la fin de 1963, Perspectives 1964,* January 1964.

Actually, there has been one new development, the reassessment of the natural-gas reserves of Groningen discovered in 1960. When the *Study* was compiled these were officially put at 400,000 million cubic metres : since then, however, the estimate has been raised to 1,100,000 cubic metres. The question is naturally what the impact is likely to be on the Community's energy supply pattern in the years immediately ahead. An E.E.C. Commission report now in preparation on natural gas is seeking to ascertain this. As things now stand, it does not look as if the new find would invalidate the overall outlook indicated up to 1970 : for a variety of technical and economic reasons, the Groningen gas can only — as is usual in such cases — come into the market by easy stages, so that natural-gas availabilities may be expected to remain within the range suggested in the *Study* for 1965 and 1970. The effects of the new circumstances can thus be adequately allowed for simply by basing calculations on the upper-limit figures indicated.

Policy-wise, then, there is at present no change in the basic problem represented for the Community *as a whole* by the growth in imports of energy, and more especially in imports of oil.

Doubtless because of its sheer size, the discovery in the Netherlands has caused a general rush to prospect for oil everywhere along the North Sea coast. However, it is impossible to tell yet whether the results will be of local importance only or whether they will be big enough and numerous enough really to produce a material change in the international oil market. We can only accept the uncertainty, which is part and parcel of the outlook described — and which, incidentally, further confirms, the *Study's* findings as to the parlous position of Community coal.

As regards the adverse comment encountered in the course of the many consultations which followed the issue of the provisional version, this was of two quite distinct kinds.

In the first place, it was complained that some of the estimates were highly debatable and embodied a great many factors of uncertainty. On this point I would simply repeat what I said in my preface to the earlier edition, that we were not out to forecast to within half a dollar or within a million tons here or there : we were seeking to bring into one coherent picture the main technical, economic, social and political factors governing the energy market. Since the aim was to examine what was likely to occur in different eventualities, it was only intended to indicate approximations and to work out roughly the benefits and costs of various courses of economic policy. From this angle we consider the *Study's* findings entirely cogent. It draws a clear dividing-line between the economic and the political side; it indicates the links between the two, and in so doing draws attention to the value of fundamental economic studies as a guide for purposes of political decision.

To expect more of it is to mistake the ends, the means, the whole essence of forward assessment. To reject it on such grounds is to rule out all analysis aimed at establishing the margin of choice and the alternatives actually open.

The other main criticism was that we did not set our sights on a sufficiently distant target. Consequently, it was argued, we had failed to note that the supply of oil could be expected to reach its limits from round about 1975—80. In view of the probable turnround at that juncture, the proper course now was to husband the resources available, and on no account to squander them by such actions as (in particular) ceasing to mine European coal.

This objection would have been fair enough if the *Study* had adopted a hard and fast line as to the future and called for the immediate and irrevocable closure of all pits rated, merely on the strength of their individual present costs, as uneconomic. But it did not. On the contrary, both the *Study* and the *Memorandum* expressly emphasize the unacceptable economic and social risk of leaving the coal industry defenceless.

Yet they show, too, that it would be rash and costly to secure the Community's long-term energy supply *purely* by keeping Community coal production going *at any price*. A balance does have to be struck between realistic appraisal of the dangers involved and honest estimation of the cost of the proposed palliatives. Any but the most minor act of economic choice involves risks — but they have to be calculated risks, properly thought out in full knowledge of the facts. It was for this purpose that the *Study* was compiled in the first place, and for this purpose we are republishing it to all intents and purposes as it stands.

As Chairman of the Inter-Executive Working Party on Energy, I feel certain that it will remain the standard work of reference for the framing of a European energy policy. Now that the dialogue between the Governments and the Communities is yielding the first practical decisions, it is more vital than ever that informed and thinking people should have reference data also to enable them to grasp the implications of those decisions and form their opinion as to the line of thought and action adopted.

Luxembourg, June 30, 1964.

To the First Edition

Here for the first time on a European scale is an analysis of the fundamental trends in energy, co-ordinated in terms of quantity, cost and price. This represents the outcome of two years' work on the part of our various departments.

On behalf of the three executives of the E.C.S.C., the Common Market and Euratom, I am glad to be able to present this joint Study, which is as important as it is original.

From the inception of our work we were convinced that an energy policy would have to be based on a precise analysis of fundamental long-term trends in the European energy market. Surveys were therefore embarked upon for this purpose.

By April 5, at the meetings of Ministers in Rome, work was sufficiently advanced for the Inter-Executive Working Party to commit itself to drafting energy policy proposals within two months. It was only material difficulties and the shortness of time available which prevented the present Study from being submitted on June 25 along with the Memorandum on Energy Policy.

This Outlook ist not therefore designed as a sort of *a posteriori* justification of the Memorandum but as an instrument of analysis intended to introduce it. Nor is it a political document, but a study intended as a forerunner to political action. The aim has been to inform rather than persuade.

The Study aims at providing guidance for political action, not by forecasting the future nor by offering recommended goals, but more modestly by suggesting prospects for its consideration.

These are not forecasts. The Study does not claim to estimate coal production or imports in 1970 or 1975, since we are fully aware that an attempt to do so would result in an underestimate not only of the uncertainties which bedevil calculations of this kind but, more important still, of the real weight of the political decisions whose aim it is to enlighten.

Nor do we propose aims to be achieved. In no way does the Study claim to recommend that coal production should be fixed at such and such a level. In analysing the position in the Community in the event of the total absence of aid or protection for Community energy, this Study is emphasizing a danger rather than suggesting a goal.

If there are no forecasts and no aims, what then does the Outlook consist of ?

In Parts One, Two and Three we have a close analysis of the factors involved in the energy market. Part One provides a convenient means of uniformly organizing and assembling the sum total of our knowledge of the general economic trends which govern the energy market. Supply and demand factors are then re-grouped and evaluated in Parts Two and Three. We thus have an analysis in terms of quantity, cost and price of the various factors controlling energy market mechanisms.

Part Four aims at achieving a synthesis between supply and demand. It starts by demarcating the genuine area of competition between different forms of energy and thus defines the limits within which political options can properly be exercised. To each of the latter corresponds a different balance between various forms of energy and in particular between Community energy and imported energy. These levels are reflected in the overall Community situations for 1970 and 1975.

The last part of the Study aims at providing a means of assessing as accurately as possible the advantages and disadvantages of any given measure of economic policy. The idea is not to urge the abstract advantages of a particular free or protected market policy but to evaluate the effects of a given level of protection or assistance, and it is in this spirit that Part Five should be approached.

In preparing this document we have aimed at an objective analysis and have therefore stressed the uncertainties inherent in the results we offer. For the same reason we have at no time offered these results as an argument in favour of a particular political measure. It may be asked whether we have not gone too far in this direction and whether the neutral character of the analysis does not constitute an obstacle to its efficiency and a limitation to its scope.

I do not think so, because a number of considerations which emerge from this work remain valid despite the acknowledged margin of uncertainty which surrounds any proper energy policy.

The first of these considerations involves the very existence of the Common Market. A work of this kind shows that the success of the Common Market implies the creation of a common energy market. It is difficult to see how, by 1970, energy alone can constitute a factor of distortion in the economic area of the Common Market in which raw material prices, wages and fiscal and social charges have been harmonized. If, as this document shows, different energy policies are really capable of producing differences in energy prices amounting to as much as 40%, energy must not be allowed to block the path towards integration.

The second point is that Europe must have a supply and import policy. The Study shows that imports can play an increasing and decisive rôle under all the circumstances envisaged. The problem of reliable supplies must thus count amongst the major preoccupations of a European Energy Policy.

Thirdly, aid to Community coal-mining is imposed on the Community by social and regional considerations. It would seem socially and politically dangerous to allow coal production to drop to barely half the present figure. This situation can only be avoided by establishing systems of aid and protection, and procedures for these have been carefully described and evaluated in the body of this document.

The last consideration concerns the rôle of nuclear energy. Viewed from the points of view both of cheap energy and security of supply, the peaceful use of the atom can play a decisive rôle in Europe, although the impact of nuclear energy will not make itself deeply felt until after 1975. Nevertheless the development of nuclear energy in the Community must be prepared for and organised now. Moreover Europe will undergo a critical period, to which we must start adapting ourselves now, until nuclear energy is fully capable of taking over from European coal.

I hope this Outlook will allay the anxieties and answer the questions which constantly assail governments, parliamentarians, producers, workers and all concerned with energy policy, sometimes to the point of desperation. At all events it will constitute an essential work of reference in formulating European energy policy.

Luxembourg, December 1962.

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The annexes are not reproduced in this English edition.

N.B. In some tables rounded figures were used. This explains slight differences in totals.

INTRODUCTION

This document offers the reader "outlooks" and in no way constitutes a programme. These "outlooks" are nevertheless intended to form the basis of an energy policy and as such entail our taking a long-term view which explores several possibilities.

(a) *The long-term view*

Even though the main task is to work out decisions to be taken fairly soon, we must still look to a fairly distant future if we wish to avoid our immediate policy being subject to wasteful changes in direction. Only by thinking in terms of a sufficiently distant future date can we detect alterations and far-reaching changes too slender to be readily perceptible in the short-term view. An additional factor in the energy sector is that projects are often very slow to come to fruition. Ten years or more may elapse before a new mine starts operating or the results of oil prospection in a new area become available, and a decade will be needed before nuclear energy can help appreciably in meeting the increased demand for energy. The delays are no less great amongst consumers, since it took at least fifteen years to complete the electrification and diesel conversion of the railways.

We must accordingly look as far ahead as 1975, which is, moreover, the date selected in the report of the Energy Commission of the fourth French plan and in the German energy survey. This clearly does not preclude the consideration of intermediate stages. 1970 is an obvious choice as marking the end of the transition period for the Common Market. Basically the entire report will be built around the year 1970, but as far as possible the corresponding figures will be given for 1965 and 1975. The figures for distant years must therefore be regarded as approximations rather than rigidly inflexible data.

Looking so far ahead the uncertainties are obviously great. What will the state of technology be in fifteen years ? Will not new energy production, conversion and utilisation processes have appeared ? What will the structure of the economy itself be ?

Although these are major sources of uncertainty, two points can be made. Firstly, the future is not so entirely unknown as might be supposed. A period of some years usually elapses between a discovery and its industrial application; because of the inertia inherent in existing equipment and mental attitudes this is followed by a lapse of time between the initial industrial application and the generalization of the process. Most of the techniques which will be in current use in ten or fifteen years' time have already been discovered in today's laboratories; the problem is rather that of detecting and selecting the laboratory results which have an industrial future, and the High Authority has accordingly entrusted this type of research to a specialized body.

These considerations lead us on to our second and more fundamental point. The imponderables which weigh heavily on any attempt to discern the pattern of the future must not frighten us away from taking decisions which, at least in part, are bound to have long-term effects and thus condition this future pattern, although it would be a serious mistake to adopt them lightly without endeavouring to foresee their effects and reach a conclusion as to whether they are the best decisions in the light of our present knowledge. It is nevertheless important to remain aware of the uncertainties and adopt a strategy which allows for them by weighing up the risks involved. This Study therefore pays great attention to bringing out the factors underlying the uncertainties which affect any results and, at least approximately, to assessing their effects. Finally, in our major task of deciding whether these unknown quantities can substantially affect the general conclusions on which policy decisions are based, we shall find that their influence in no way detracts from the validity of the conclusions.

(b) *Alternative possibilities*

In order to facilitate the choice of an energy policy, these "outlooks" require to be worked out for several alternative and well differentiated possibilities as regards the respective places to be allotted to Community and imported energies. We have thus calculated not only the Community production level which will be competitive with imported energy in the light of the most likely price hypothesis for the latter but also the variations this level would undergo as the result of different price hypotheses and different forms of assistance for Community energy, particularly coal.

Parts One to Three are devoted respectively to a survey of the economic development horizons which constitute the overall framework for our Study, to an assessment of global and sectoral energy requirements and to a definition of supply trends in different forms of energy (coal, petroleum, etc.). In Part Four we shall outline the probable breakdown of consumption amongst various energy products on the basis of comparative costs to the consumer under alternative policy hypotheses. Finally, Part Five will review the major problems involved in balancing the energy positions thus arrived at.

Part One

The Overall Economic Context

Chapter 1

General economic outlook

Forecasts of economic growth form the general framework within which future energy trends have to be estimated. Both demand and, in some respects, supply are governed by the level of economic activity, so that we have had to formulate hypotheses regarding the general economic trend in the years to come.

This procedure has three consequences :

1. Energy forecasts are conditional, i.e. they are only valid for the overall economic hypotheses selected.
2. Energy forecasts may be regarded as consistent with overall economic growth.
3. Any differences between the energy forecasts in this report and the results of other studies must be examined in the light of the general growth hypotheses selected as a point of departure.

Section 1 — The economic outlook in the Community

A — *General remarks*

As regards economic growth in the Community countries, the E.E.C. Commission has recently brought out a study entitled *Rapport sur les perspectives de développement économique dans la C.E.E. de 1960 à 1970* compiled by experts belonging to the Working Party on Problems of Structure and Long-Term Development.

These growth forecasts form the basis of the estimates presented in this study. Everything in this chapter which deals with national product and population trends for the period 1960—1970 is a summary of this report, to which the reader is referred for further information.

It has also been necessary to work out estimates for the period 1970—1975. These were extrapolated by High Authority departments on a basis similar to that adopted in the above-mentioned report in order to ensure coherence between the figures involved. In addition certain sectoral data, especially for general industrial activity and iron and steel industry activity, were needed to enable demand to be forecast in some sectors, and here the estimates were also made by High Authority departments.

Before passing on to the main economic growth trends which may be expected in the next fifteen years, it is worth-while pausing to examine briefly certain aspects of the forecasts adopted in the report referred to above.

First of all it should be noted that two alternatives were postulated, alternative B being considered by the experts as the major growth hypothesis and alternative A as indicating the results of a slower rate of expansion. The overall hypotheses adopted for the energy forecasts are those of alternative B, which is considered to be the most likely possibility.

Secondly, the forecasts are based on constant prices, with 1960 prices used as a reference index. They have been converted into dollar units of account at 1960 exchange rates.

Past economic development trends do not justify postulating an unchanged rate of growth for the future or ascribing a change in this tempo to 1960. Nevertheless it is important to see whether these changes in tempo take place slowly over the years or whether they result from the sudden intervention of a determining factor. We have therefore brought out the rate of growth trend by selecting 1965 as an intermediate point.

It should be noted that the figures given in this report represent average rates of growth and that the position in 1965, 1970 and 1975 could be markedly influenced by cyclical or accidental fluctuations. Our forecasts ignore these factors and assume that business conditions are at an average level.

Tables 1 and 2 summarise the main economic development data taken as a basis for the energy forecasts :

Gross national product

(i) as average annual rates (Table 1 A);

(ii) as indices (Table 1 B).

Industrial production

(i) as average annual rates of growth (Table 2 A);

(ii) as indices (Table 2 B).

The forecasts form part of a corpus of estimates which, in the experts' report, involve the following assessments for the Community as a whole and for each country :

(i) population trend;

(ii) growth in national product;

(iii) the trend in the components of the national product.

The main results are summarized in the following paragraphs and are accompanied by a brief outline of the development trends.

Table 1 — Trend in Gross National Product

A — Average annual rates of growth

Country	1950-1960	1960-1965	1965-1970	1970-1975	1960-1970
Germany (Fed. Rep.)	7.4	4.4	4.0	4.2	4.2
Belgium	2.7	3.8	3.9	3.9	3.9
France	4.3	5.2	4.7	4.6	5.0
Italy	5.9	5.95	5.75	5.3	5.8
Netherlands	4.9	4.3	4.9	4.7	4.6
Community	5.5	4.9	4.6	4.6	4.7

B — Indices by comparison with 1960

Country	1965	1970	1975
Germany (Fed. Rep.)	124	151	186
Belgium	121	145	177
France	129	162	203
Italy	133	176	227
Netherlands	123	157	197
Community	127	159	199

Source: Report by E.E.C. experts.

Table 2 — Trend in Industrial Production

A — Average annual rates of growth

Country	1950-1960	1960-1965	1965-1970	1970-1975	1960-1970
Germany (Fed. Rep.)	9.1	5.5	5.0	5.0	5.3
Belgium	3.0	4.8	4.8	4.8	4.8
France	6.4	6.5	5.9	5.5	6.2
Italy	8.1	8.8	7.8	6.5	8.3
Luxembourg	—	4.0	4.0	4.0	4.0
Netherlands	5.8	5.4	6.0	5.6	5.7
Community	7.5	6.3	5.9	5.5	6.1

B — Indices by comparison with 1960

Country	1965	1970	1975
Germany (Fed. Rep.)	131	167	213
Belgium	126	159	202
France	137	183	238
Italy	152	221	303
Luxembourg	122	148	180
Netherlands	130	174	229
Community	136	181	236

Source: Estimates by High Authority departments.

B — *Population trends*

Population trends constitute an important factor in economic growth. The estimates of total population trend (Table 3 A) have been used to calculate the future growth in the working population on the basis of the anticipated total population structure and constant rates of activity, with corrections for children remaining at school, women in employment, age of retirement and migration. The results are summarized in Table 3 B.

These estimates form the basis of the forecast of population employed, which takes into account certain unemployment hypotheses for 1960 and 1970 (Table 3 C).

This table reveals a sharp decline in the labour force trend by comparison with the reference period. The considerable increase both in working population and population employed in Germany and Italy will not continue.

In the former country the trend in recent years has been towards massive immigration and a heavy call on labour reserves. These have now dropped to a very low level and the population structure is developing unfavourably.

Table 3 — Population Trend 1950-1975 (average annual rate of growth)

A — Total population

Country	1950-1960	1960-1965	1965-1970	1970-1975
Germany (Fed. Rep.)	1.1	0.8	0.75	0.8
Belgium	0.6	0.6	0.5	0.5
France	0.9	0.7	0.95	0.9
Italy	0.6	0.6	0.6	0.6
Netherlands	1.3	1.1	1.1	1.0
Community	0.9	0.75	0.75	0.75

B — Working population

Country	1950-1960	1960-1965	1965-1970	1970-1975
Germany (Fed. Rep.)	1.5	0.4	0.3	0.3
Belgium	0.1	0.3	0.7	0.7
France	0.4	0.7	0.8	0.7
Italy	1.4	0.65	0.65	0.65
Netherlands	1.2	1.5	1.2	1.0
Community	1.1	0.65	0.6	0.6

C — Population employed[1])

Country	1950-1960	1960-1965	1965-1970	1970-1975
Germany (Fed. Rep.)	2.2	0.4	0.3	0.3
Belgium	0.3	0.3	0.7	0.7
France	0.4	0.7	0.8	0.7
Italy	1.7	0.9	0.9	0.9
Netherlands	1.3	1.4	1.2	1.0
Community	1.4	0.7	0.65	0.6

Sources: 1950-1960: O.E.C.D., Policies for Economic Growth, November 1962.
1960-1970: Report by E.E.C. experts.
1970-1975: Estimates by High Authority departments.

[1]) The difference between working population and population employed consists of unemployed.

Likewise in Italy the population structure and the continuous call on labour reserves are leading to a reduction in the rate of growth in the population employed, although to a lesser extent.

In France and Belgium, on the other hand, the population trends suggest a more rapid growth in the population employed, whilst in the Netherlands the heavy increase over the past decade will only slacken to a slight extent.

For the Community as a whole the rate of growth in the labour force during the next fifteen years will remain below half the reference period figure.

C — *The trend in the gross national product*

The labour quantity factor will only play a small part in the increase in gross national product. By comparison with the reference period its relative contribution will drop from nearly 25% to as little as 15%. After a period of sharp rise in the population employed, the only important factor in the future will thus be the trend in productivity (gross national product per person employed per annum).

Table 4 A shows the rate of growth in the gross national product per person employed. It should be noted that the figures for some countries allow for a substantial reduction in working hours during the next fifteen years, entailing a more rapid rise in hourly than in annual wages.

For *Germany* a reduction of nearly 10% in working hours for the period 1960—1970 has been assumed; this would only affect the national product by 8.5%, since the reduction in working hours may stimulate productivity. Allowing for this reduction, the productivity forecasts represent a slightly slower rate of advance than during the years 1950—1960, which was subject to recovery and reconstruction factors, particularly during the first five years.

In *Belgium*, on the other hand, the anticipated growth for the period 1960—1965 is where recovery influences occur, which means that from 1965 onwards Belgium will have overcome the consequences of the 1950—1960 slump period and the resulting brake on expansion. For 1970 and 1975 the forecasts assume that the rate of recovery in the gross national product (3.9%) for the period 1960—1965 will have become a long-term structural feature.

As regards France, the forecasts until 1965 agree with the estimate worked out under the fourth plan. These figures also show an increase in the rate of growth in the gross national product per person employed. One of the major objectives of the French Government's fourth plan is to increase the rate of investment under the stimulus of public investment. For the long-term view we have adopted the existing French forecasts for 1975, which are

Table 4 — Per head of population Gross National Product (annual rate of growth)

A — Gross national product per person employed

Country	1950-1960	1960-1965	1965-1970	1970-1975
Germany (Fed. Rep.)	5.2	4.0	3.7	3.9
Belgium	2.4	3.5	3.2	3.2
France	3.9	4.5	3.85	3.9
Italy	4.2	5.0	4.8	4.4
Netherlands	3.9	2.8	3.7	3.7
Community	4.1	4.2	3.9	4.0

B — Gross national product per inhabitant

Country	1950-1960	1960-1965	1965-1970	1970-1975
Germany (Fed. Rep.)	6.3	3.6	3.25	3.4
Belgium	2.1	3.2	3.35	3.3
France	3.4	4.5	3.7	3.7
Italy	5.2	5.3	5.1	4.7
Netherlands	3.8	3.2	3.8	3.7
Community	4.6	4.1	3.8	3.8

Sources: 1950-1960: Calculated from the data given in the *Bulletin statistique* published by the Statistical Office of the European Communities, by fitting $p = a\ (I + \pi)^t$.
1960-1970: Report by E.E.C. experts.
1970-1975: Estimates by High Authority departments.

more representative of long-term economic growth trends and correspond to the rate achieved during the reference period.

For *Italy* the Working Party report shows an average annual rate of growth of 4.9% in overall productivity (1960—1970). In the next fifteen years the expansion in productivity would thus be greater than previously on account of the trend of investment to move towards increased mechanisation and thus towards an increasing employment of capital assets.

Economic expansion will, moreover, benefit as and when the Italian Government succeeds in solving its problems of regional imbalance and occupational training. The forecast levels are thus high by comparison with the other countries in the Community. In the long term, on the other hand, we can envisage a slackening in economic expansion, which to a certain extent is already reflected in the estimates for 1975.

Table 5 — Data in Terms of Value per Inhabitant at 1960 Prices (units of account)

A — Gross national product

Country	1960	1965	1970	1975
Germany (Fed. Rep.)	1,268	1,515	1,776	2,100
Belgium	1,331	1,557	1,835	2,160
France	1,276	1,587	1,904	2,280
Italy	650	842	1,080	1,360
Netherlands	975	1,140	1,374	1,650
Community	1,074	1,315	1,585	1,910

B — Private consumption

Country	1960	1965	1970	1975
Germany (Fed. Rep.)	720	907	1,079	1,280
Belgium	914	1,052	1,251	1,470
France	829	1,039	1,283	1,540
Italy	339	526	695	890
Netherlands	550	661	809	980
Community	655	828	1,022	1,170

Sources: 1960, 1965 and 1970: Report by E.E.C. experts.
1975: Estimates by High Authority departments.

Table 6 — National Percentages of Community Total (%)

A — Gross national product

Country	1960	1965	1970	1975
Germany (Fed. Rep.)	37.3	36.5	35.5	34.9
Belgium	6.7	6.4	6.2	6.0
France	32.1	32.5	32.6	32.7
Italy	17.2	18.6	19.6	20.3
Netherlands	6.2	6.0	6.1	6.1
Community	100	100	100	100

B — Industrial production

Country	1960	1965	1970	1975
Germany (Fed. Rep.)	39.6	38.1	36.7	36.1
Belgium	6.6	6.1	5.8	5.6
France	33.6	33.9	34.0	33.9
Italy	15.0	16.9	18.5	19.4
Netherlands	5.1	4.9	4.9	4.9
Community	100	100	100	100

In the *Netherlands* we must allow for a reduction of nearly 5% in total working hours for the period 1960—1965. The rate of increase in the gross national product per person employed during this period will thus be relatively low. For the period 1965—1975 the rate adopted is substantially that of the reference period.

By combining the population employed and productivity estimates we obtain forecasts for the expansion in *gross national product* per country and for the Community as a whole (Table 1). The main fact to emerge from this table is that economic expansion in the Community will remain rapid, although on a lesser scale than the range of growth rates in the different countries tends to contract, with extremes at 5.8% (Italy) and 3.9% (Belgium) per annum and an average of approximately 4.7% per annum.

D — *Implications of the anticipated growth in national product*

The E.E.C. report also includes the following data which we have utilized in working out the energy forecasts :

(i) gross national product per inhabitant (in units of account) (Table 5 A);

(ii) the relative share of each country in the gross national product of the Community (Table 6 A);

(iii) private consumption per inhabitant (Table 5 B).

As regards product per inhabitant, the gap from one country to another will narrow, although it will still be running at a fairly high level at the end of the forecast period. Despite the fact that the rate of growth in Italy is much higher, the 1975 level will only slightly exceed that of Belgium in 1960.

Allowing for the total population trend, the estimated relative shares in the gross national product of the Community reflect the same tendencies : a fairly substantial decrease on the part of Belgium and Germany, contrasted with a sharp rise in Italy and little change in France and the Netherlands.

In all countries private consumption per inhabitant is expected to rise more rapidly than G.N.P. per inhabitant. The share of private consumption in G.N.P. will thus rise slightly and the figure for the Community as a whole will be 63%.

E — *The outlook in various sectors*

In order to work out forecasts for the energy sector, especially detailed estimates of demand, it has been necessary to supplement the forecasts in the Working Party's report with data on the prospects in industry as a whole and the iron and steel industry in particular.

As regards the latter, a large consumer of energy products, we have adopted forecasts of steel and pig iron production (Table 7). The steel production figures for 1965 are the result of detailed work carried out under the General Objectives for Steel programme in connection with estimating internal and external requirements and production potential. [1]) The more approximate estimates for 1970 and 1975 allow for a slight reduction in the past elasticity observed between apparent steel consumption and industrial production and for the stabilisation of net exports from the Community to the rest of the world.

As regards industrial production as a whole, an important factor in determining energy consumption in the industry sector, High Authority departments have worked out provisional hypotheses. This point is at present under detailed study by the Working Party referred to above.

The method used to estimate industrial production has had to be an approximate one for the time being.

The data regarding the future trend of the labour force in industry in the Community countries are fragmentary. The Working Party's report gave extrapolations up till 1970 for certain countries only. Under these conditions it has proved difficult to follow the procedure of estimating productivity and labour trends which was employed for gross national product.

We have thus relied on the relationship between industrial production and gross national product trends, although extrapolation on this basis raises certain problems. For instance, where elasticities are very high during the reference period, pure extrapolation implies a sharp increase in the relative share of industry in the gross national product over the long term, whereas it is highly likely that the growth rate of this share depends on the share already achieved. In Italy, for example, the share of industry in the gross national product in 1950 was still very low and as a result elasticity in the period 1950—1960 was as high as 1.5. Extrapolation of the same elasticity figure up to 1975 would imply the highest share of industry in G.N.P. for all the countries in the Community in that year. It is thus certain that the trend will be asymptotic, i.e. elasticity will decrease.

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[1]) See memorandum on the definition of the Community's General Objectives for Steel, *Journal officiel des Communautés européennes*, April 5, 1962.

Taking this fifteen year view, a slight reduction in elasticity by comparison with the period 1950—1960 will probably suffice. [1]) As Table 8 shows, the elasticity adopted for the Community countries from 1960 to 1975 is fairly uniform (about 1.2), except for Italy, where it remains moderately high (1.4), although at a lower level than in the refrence period.

Table 7 — Iron and Steel Activity — Steel production ('000,000m.t.)

Country	1950	1955	1960	1965	1970	1975
Germany (Fed. Rep.)	14.0	24.5	34.1	38.6	47.5	57.5
Belgium	3.8	5.9	7.2	8.5	10.1	11.0
France	8.7	12.6	17.3	21.7	26.9	31.5
Italy	2.4	5.4	8.2	13.0	16.8	20.0
Luxembourg	2.5	3.2	4.1	4.5	4.9	5.2
Netherlands	0.5	1.0	1.9	2.7	3.8	4.8
Community	31.9	52.6	72.8	89.0	110.0	130.0

Source: Estimates by High Authority departments.

Table 8 — Industrial Production — Rate of Growth and Elasticity in relation to Gross National Product

Country	1950-1960		1960-1965		1965-1970		1970-1975	
Germany (Fed. R.)	9.1%	(1.23)	5.5%	(1.25)	5.0%	(1.23)	5.0%	(1.19)
Belgium	3.0	(1.11)	4.8	(1.25)	4.8	(1.26)	4.8	(1.23)
France	6.4	(1.49)	6.5	(1.24)	5.9	(1.25)	5.5	(1.20)
Italy	8.1	(1.40)	8.8	(1.50)	7.8	(1.37)	6.5	(1.23)
Luxembourg		(—)	4.0	(—)	4.0	(—)	4.0	(—)
Netherlands	5.8	(1.18)	5.4	(1.25)	6.0	(1.24)	5.6	(1.20)
Community	7.5	(1.36)	6.3	(1.29)	5.9	(1.28)	5.5	(1.20)

(The figures in brackets represent elasticity of industrial production with respect to G.N.P.)
Source: Estimates by High Authority departments.

Table 6 B summarizes each country's share in the industrial production of the Community in 1960, 1965, 1970 and 1975.

[1]) It should also be noted that the index of industrial production corresponds to the current index of the O.E.C.D., which generally shows a higher rate of growth than the index of value added at constant prices in industry. This is why the calculated elasticities to a certain extent overestimate the increased share of industry in G.N.P.

Section 2 — The world economic and political situation

It is obvious that the outlook for economic growth in the Community will depend on the economic and political development of the rest of the world.

In this context the forecasts rest on the primary assumption that there will be no world war, but we cannot exclude the possibility of local conflicts and tension which may influence the conditions under which energy is supplied to the Community.

From the economic point of view, foreign trade, which often expands more rapidly than G.N.P., always tends to strengthen links between national economies. Economic expansion in the Community will thus to a certain extent depend on development in a number of other countries. We have not attempted an accurate estimate of world economic growth, but the rates of growth adopted for the Community are based on the assumption that development in the Community will not be restricted by foreign trade, which is a fairly realistic view.

Data on economic growth in other industrialized western countries are to be found in the work of the Economic Policy Committee of the O.E.C.D. These studies, carried out by Working Party No. 2, assume a growth figure of 50% from 1960 to 1970 and the implications at economic policy level are at present under discussion.

The estimated growth for the major industrialized countries appears to be in line with the outlook we have just sketched for the Community.

Moreover it is almost certain that during the next fifteen years the key problem in world economy will be the growth of developing nations, which to a large extent will be influenced by expansion in the industrialized countries. It seems that growth in the Community will determine the development of the emergent countries rather than the contrary.

To sum up, the economic outlook foreshadowed for the Community in this report presupposes a fair degree of world political stability and fairly rapid economic growth in the other industrialized countries.

Part Two

Future Energy Requirements

Chapter 2

General remarks on forecasting methods

The object of this chapter is to describe the principal methods used in the demand forecasts which are the object of the following chapter.

A — *Conditional outlooks*

The energy demand estimates given in this report are *conditional outlooks* worked out for the specific general economic outlook described in Part One. Consequently if this general outlook does not materialise the energy data will need to be revised, and in Chapter 3, Section 3, we shall deal with the uncertainty which can affect energy figures for this reason.

In this connection it should be remembered that energy requirements are forecast on the assumption of average cyclical, climatic and rainfall conditions.

B — *Synthesis of economic results and direct information*

The general method of forecasting consists in a synthesis of lessons drawn from past experience of the relationship between energy consumption and economic development and of direct information, mainly of a technical origin, on certain specific consumption trends.

There is an obvious temptation to estimate consumption in each detailed category of consumers systematically and thus arrive at a total for each country or for the Community as a whole.

This method suffers not only from a general impediment but also, at the present time, from additional difficulties; we have therefore had to restrict ourselves to a few major sectors.

A substantial share of the market (more than 30%) is accounted for by a very large number of consumers such as householders and vehicle users whose requirements cannot be established separately. Statistical analyses, involving either retrospective data or new surveys, must therefore be made of consumer groups which are as homogeneous as possible.

At the present time we are also hampered by a dearth of information :

(i) only in limited cases — e.g. the coke input at iron and steel plants. and fuel consumption by thermal power stations — are adequate technical and economic surveys available to enable the trend in energy consumption per unit of production to be forecast. On other points the High Authority has commissioned surveys from research centres, but the results will not be available for several months;

(ii) as noted above, the outlook for economic expansion can only be assessed on a fairly global scale. No forecasts are at present available on levels of activity in individual branches of industry (chemicals, cement, textiles etc.), nor do we know the future pattern of income distribution, which will affect the energy consumption of different classes of households. Here again studies are being undertaken by departments of the European Communities, but we cannot count on having detailed results for many months yet.

It has thus been necessary to limit ourselves to a method which aims at learning as much as possible from the past and at supplementing or correcting this knowledge with any information directly available.

The variables adopted to represent economic development are gross national product and the index of industrial production. These have served as a general economic background in sectors where information on consumption per unit of production is available, whilst in other sectors retrospective data have been examined in order to establish the relationship between energy consumption and national product or industrial production. The forecasts are based on this relationship, corrected where necessary to allow for supplementary information. [1])

[1]) See Annex 1 to full Community-language edition, General remarks on energy requirement forecasting methods.

C — *Synthesis of overall analysis and sector-by-sector analysis*

Two analyses have proceeded side by side, one relating to the energy consumption of the economy as a whole and the other to the major consumer sectors taken individually. Successive adjustments have then been made to enable the results to be compared and a single forecast for overall consumption arrived at by giving preference to the sectoral approach. [1]

D — *Assessment of primary energy-distinction between fuel and electricity*

The juxtaposition of different sources of energy capable of rendering similar services and the conversion of certain forms of energy into others raise delicate problems which, although well known, are difficult to solve.

One method of approach is based on the final consumer, with his requirements broken down into different forms of energy, and the activities of the various converters of energy, and finally primary energy requirements, deduced from this. Such a method entails an immediate comparison of the cost to the consumer of the various forms of energy; this is a fundamental factor in establishing the requirement breakdown of each final consumer.

We preferred to proceed in two stages and concentrate first of all on an overall study aimed at establishing approximate consumption in the various sectors involved, followed by a calculation of regional requirements, which is necessary for a comparative cost study at consumer level. The breakdown of requirement coverage between the various primary sources has thus been reserved for Part Four.

At this point it becomes necessary to use a common unit for the various forms of energy. We have worked in equivalent of primary energy, which means that the figures can be added together subject to certain small-scale statistical adjustments [2]) and that explanations of all conversion stages are unnecessary. At final consumer level, however, we have analysed fuel and electricity requirements separately. [3])

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1) See Annex 1, section III, to full Community-language edition.

2) See Annex 1 to full Community-language edition.

3) See Annex 1 to full Community-language edition, regarding the somewhat inaccurate nature of this distinction.

In all the following analyses have been carried out :

	Fuel	Motor fuel	Electricity
1. Final consumption by sector (iron and steel industry, other industries, transport, domestic sector)	X_1	X_2	Y_1
2. Consumption by primary producers, converters and distributors of energy[1])	X_3		Y_2
3. Total electricity requirements. Comparison between L and overall forecast results.			$L = Y_1 + Y_2$
4. Power stations (production L)			
a) Primary enrgy requirements corresponding to hydro, geothermal and nuclear generation and requirements covered by foreign trade	X_4		
b) Fuel requirements of conventional thermal power stations	X_5		
5. Total internal requirements of primary energy. Comparison between E and overall forecast results	$E = X_1 + X_2 + X_3 + X_4 + X_5$		

These analyses are limited to a study of internal requirements and exclude exports and bunkers.

E — *Country-by-country assessment*

At this stage we were faced with a choice between two courses of action : to proceed directly at Community level or to carry out country-by-country analyses. The latter alternative was considered advisable for three main reasons :

(i) in later stages of the work it is necessary to forecast requirements on a regional basis in order to estimate costs at consumer level and any information which enables this regional approach to be adopted is therefore desirable;

(ii) the economic structures of the various countries in the Community are very different and will remain so for a long time. [2]) There is thus every likelihood that the forecast will be improved if each country is examined separately, in addition to which comparisons between different countries provide extremely interesting information;

(iii) experts can only be consulted to advantage if country-by-country figures are available.

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[1]) A strict forecast of this demand cannot be made until the breakdown of demand into products is known, but a fairly accurate approximation can be given.

[2]) A particularly clear example is afforded by the iron and steel industry (see Annex 3 to full Community-language edition).

F — *Assessment in physical units and not in terms of value*

In accordance with current practice, requirements have been estimated in physical units (metric tons hard-coal equivalent), which facilitates the interpretation of primary requirements. It is also likely that at industrial (and transport) consumer level it is physical consumption which is closely linked to levels of activity (owing to technical limitations) [1]), whereas at domestic consumer level it seems probable that energy expenditure is the factor to be investigated.

G — *Non-definitive nature of figures*

The figures which follow are not intended to be definitive, but are simply offered *as an indication of trends.* The fact that the unit adopted is millions of metric tons hard-coal equivalent and that all the results are given to this degree of accuracy is merely a convenient aid to co-ordinating the various tables according to how detailed the particular stage of the analysis is. No claim to such a degree of accuracy is implied. Chapter 3 gives a thorough account of the origin and extent of the uncertainties involved, which can only be reduced after further lengthy work. It is nevertheless true that the general trends which emerge during the course of this work correspond closely to what can in fact be forecast at the moment. The Study will eventually make it clear that on most essential points its fundamental conclusions are not affected by uncertainties as to requirements.

Chapter 3

Overall energy requirements

The figures given in this chapter are based on the methods of forecasting future requirement in terms of primary energy equivalent as briefly outlined in the foregoing chapter. We shall give the trend in overall requirements first of all, followed by that of the major sectors.

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1) We must nevertheless bear in mind the possibility that the energy price level in relation to general price levels affects the energy requirements of industry to a certain extent. This extremely ticklish and little understood problem will be dealt with in Chapter 4.

The order in which the forecasts have ben prepared is thus partially reversed for reasons of presentation. The forecasts in fact consisted of a series of independent estimates added together, rather than a sector-by-sector breakdown of an overall quantity determined in advance. Our account is nevertheless easier to comprehend if we take an overall view as our point of departure.

Section 1 — Total internal requirements

As against a consumption of about 460 million metric tons hard-coal equivalent in 1960, the Community's total energy requirements may be expected to rise to 700 million by 1970 and something like 850 in 1975 (see Table 9 A) — an increase of approximately 50% over ten years and 85% over fifteen. [1][2]

Table 9 — Overall Primary Energy Consumption

A — Absolute figures ('000,000m.t. H.C.E.)

Country	1950	1955	1960	1965	1970	1975
Germany (Fed. Rep.)	129.0	180.9	205.3	239	282	330
Belgium	28.4	33.5	33.9	37	42	48
France	82.5	102.4	121.9	151	187	231
Italy	26.2	43.0	65.6	99	137	176
Luxembourg	3.0	4.0	4.6	6.1	6.6	7.1
Netherlands	20.0	25.2	30.1	38	46	55
Community[1])	289	389	461	570	700	847

B — Annual rates of growth [2])

Country	1950-1955	1955-1960	1960-1965	1965-1970	1970-1975
Germany (Fed. Rep.)	7.0	2.7	3.0	3.4	3.2
Belgium	3.4	0.3	1.8	2.7	2.5
France	4.4	3.6	4.4	4.3	4.3
Italy	10.4	8.8	8.6	6.6	5.2
Luxembourg	3.9	2.8	5.7	1.6	1.5
Netherlands	4.7	3.6	4.9	3.8	3.8
Community	6.1	3.5	4.3	4.2	3.9

1) Rounded figures, which may therefore differ slightly from the sum of the individual items (Community).

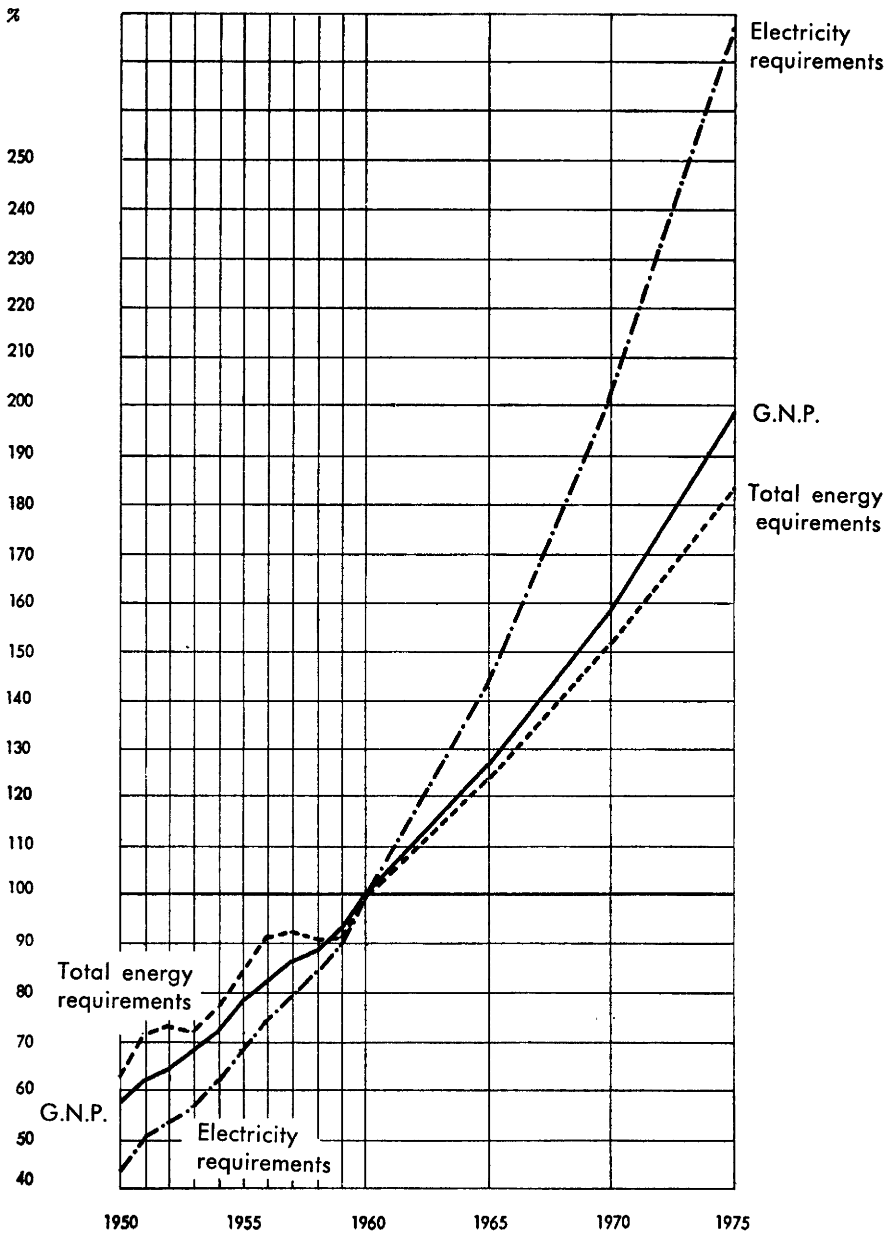
2) Calculated on the basis of non-rounded figures by comparing the two end years.

[1]) The country-by-country and sector-by-sector figures are detailed in Annex 2 to full Community-language edition.

[2]) These figures exclude bunkers and exports, which in 1960 represented 4% and 5% respectively of internal requirements.

Graph I

Comparative Trend in G.N.P., Total Energy Requirements and Electricity Requirements in the Community, 1950–1975



The Community average *annual rate of growth* in total energy consumption, which was 4.8% during the period 1950—1960, would thus be only 4.3% from 1960 to 1970. This would reflect the deceleration in general economic expansion, partly offset by a gradual increase in elasticity between consumption and gross national product (1950—60, 0.86; 1960—70, 0.91).

The differences between the national rates of increase were due in the past to differing tempos of economic expansion, to differences in structural change (more intensive industrialization in Italy than elsewhere, for example) and to appreciably dissimilar rates of improvement in productivity. With regard to the future, it has been assumed that technological progress will be roughly the same from one country to another, so that differences in the rate of growth of energy requirements will mainly be due to the first two considerations.

Community consumption of energy per inhabitant is expected to grow by 40% over the ten years, allowing for the population increase, namely from 2.7 metric tons H.C.E. in 1960 to 3.8 in 1970 (with the consumption levels in the various member countries drawing closer together — see Table 10). Nevertheless the real value of this 1970 forecast is only revealed when it is compared with figures for other areas. It is well below the British average for today (4.8 metric tons in 1960) and less than half that of the United States, whilst the 1970 Community *per capita* national product works out at about 60% of the present United States figure.

Table 10 — Energy Consumption per Inhabitant (kg H.C.E.)

Country	1950	1955	1960	1965	1970	1975
Germany (Fed. Rep.)	2,699	3,604	3,845	4,300	4,900	5,500
Belgium	3,302	3,764	3,685	3,940	4,400	4,800
France	1,978	2,365	2,679	3,200	3,800	4,500
Italy	562	894	1,328	1,940	2,600	3,200
Luxembourg	10,000	13,333	15,333	18,770	19,700	20,700
Netherlands	1,980	2,333	2,617	3,150	3,600	4,100
Community	1,863	2,410	2,726	3,250	3,800	4,500
Great Britain			4,800			
United States			8,200			

This tendency for Community consumption per inhabitant to level out will have the further effect of appreciably altering the *breakdown by countries* of Community energy requirements (see Table 11). To cite the outstanding examples, Italy's share of total energy will rise from 14% to 20% and Germany's will fall from 44% to 40% between 1960 and 1970.

Table 11 — Breakdown of Overall Community Energy Consumption by Countries (%)

Country	1950	1955	1960	1965	1970	1975
Germany (Fed. Rep.)	44.7	46.5	44.5	41.8	40.3	38.9
Belgium	9.8	8.6	7.4	6.5	6.1	5.7
France	28.5	26.3	26.4	26.5	26.6	27.2
Italy	9.1	11.1	14.2	17.4	19.5	20.8
Luxembourg	1.0	1.0	1.0	1.1	0.9	0.8
Netherlands	6.9	6.5	6.5	6.7	6.6	6.6
Community	100	100	100	100	100	100

Section 2 — Requirements of main consumer sectors

This section deals with the energy requirements of individual sectors, the final consumers selected being the iron and steel industry, other industries, transport and the domestic sector. Thermal power stations will be treated separately, so that in order to avoid accounting for consumption twice over the requirements of the above four sectors will exclude electricity, which will be analysed on its own. Last of all we shall examine energy producers' and converters' own consumption.

A — *Iron and steel industry*

The energy requirements of the iron and steel industry are directly related to the production of pig iron and steel. [1])

As stated in Chapter 1 (Table 7), the figure for 1965 is put at 89 million metric tons, in line with the requirements indicated in the General Objectives for Steel, with further production levels of 110 million and 130 million tons for 1970 and 1975 respectively.

It is further assumed that the pig iron input coefficient at steel works will drop a little further for the Community as a whole (although the movement will vary in Italy and, until 1965, in the Netherlands).

Coke consumption will rise far less rapidly than pig iron production. A sharp drop is expected in the blast furnace coke input coefficient (24% in ten years) due to load preparation, the growing use of high-grade ores and the injection of fuel in liquid or gaseous form. This tendency will only be

[1]) See Annex 3 to full Community-language edition : The energy requirements of the iron and steel industry.

partially offset by an increase in coke consumption at sintering plants. The forecasts adopted for the Community are shown in Table 12. [1] [2]

Table 12 — Trend in Iron and Steel Industry Energy Consumption

	1950	1955	1960	1965	1970	1975
1. Steel production ('000,000m.t.)	31.8	52.6	72.8	89	110	130
2. Steelworks pig iron input coefficient (kg)	822	780	740	735	720	690
3. Pig iron production, including foundry iron ('000,000 m.t.)	26.1	41.0	54.0	66	79	90
4. Blast furnace coke input coefficient (kg)	947	970	883	750	670	640
5. Blast furnace coke consumption ('000,000m.t. coke)	24.7	39.9	47.8	49.2	53.4	57.7
6. Blast furnace coke consumption ('000,000m.t. H.C.E.)	23.6	38.2	45.8	47.0	51.1	55.2
7. Solid fuel consumption for sintering ('000,000m.t. H.C.E.)	19.9	1.6	3.2	6.7	10.0	12.0
8. Other non-electrical energy requirements ('000,000m.t. H.C.E.)		25.1	29.0	34.3	39.9	43.3
9. Gross energy consumption of sector (6+7+8) ('000,000m.t. H.C.E.)	43.5	64.9	78.0	88.0	101.0	110.5
10. Blast furnace gas production ('000,000m.t. H.C.E.)	14.0	22.0	26.0	24.3	24.0	24.9
11. Net energy consumption of sector (9-10)	29.5	42.9	52.0	63.7	77.0	85.6

[1] Country-by-country details are shown in Annex 3 to full Community-language edition.

[2] These figures are based on the assumption that advances will occur in blast furnace technology only and that there will be no revolutionary changes or alterations in ore reduction processes. Should the natural gas-direct reduction method become possible for industrial use, coke consumption could differ from the figures given. This is not likely to happen by 1965, but it could be a possibility for 1970, although its scope would be limited. By 1975, however, it could make a substantial difference. Thus supposing for example that the method is developed by 1965 and is used in half the new plants commissioned between 1965 and 1975, pig iron production at blast furnaces by 1975 would be 65 + ½ (90-65) = 78 million metric tons instead of 90; this would reduce coke requirements by 10 to 15%.

To sum up, with an increase in industrial production of 81% between 1960 and 1970, the following growth rates are indicated :

Steel production	51%
Pig iron production	47%
Blast furnace coke consumption . . .	12%

B — *Other industries*

Requirements in this sector are governed by its general level of activity, by structural changes affecting the major energy-consuming industries and by any improvements achieved in fuel efficiency. [1])

The following results emerge from the studies it has been possible to carry out with existing information on the trend over the last ten years :

(i) structural modifications in industry, i.e. the relative size of the various branches composing industry as a whole, have had little effect on energy consumption. Branches whose activity has expanded more rapidly than the average for industry as a whole turn out to include not only the low-energy-consumption mechanical and electrical engineering industries but also the chemicals industry, which is a large consumer, whilst those branches with a slower rate of expansion include textiles, the food industry and to a certain extent building materials;

(ii) the reduction in consumption per unit of production varies considerably from one country to another, and with the exception of Italy appears to have been most marked where the rate of growth in industrial production was highest. This may be because rapid growth opens up the possibility of utilising the latest technical advances quickly and on a large scale. The trend may also have been facilitated by the replacement of coal by fuel oil and gas.

In calculating for the future, it has been assumed that the expected deceleration in expansion would produce a corresponding deceleration in fuel efficiency improvement, which is expected to progress at only 2.4% per annum for the Community as a whole, as against 3.1% between 1950 and 1960. In the absence of detailed information on the general economic outlook, it has so far been impossible to allow for any modifications in the relative share of each branch of industry.

To sum up, we have assumed that the fuel requirements of the other industries sector will rise from 88 million metric tons hard-coal equivalent in 1960 to 125 million in 1970 and 143 million in 1975. This gives an increase of 42% from 1960 to 1970, i.e. an annual growth rate of 3.6%. Since the

[1]) See Annex 4 to full Community-language edition: The fuel requirements of other industries.

growth rate for industrial production in the Community has been estimated at 6.1%, we thus obtain an apparent elasticity of 0.6 (approximately the same figure as between 1950 and 1960). [1])

Table 13 — Fuel Consumption in Industry ('000,000m.t. H.C.E.)

Country	1950	1955	1960	1965	1970	1975
Germany (Fed. Rep.)	22.3	33.3	36.4	41.0	45.7	50.9
Belgium	5.3	5.3	4.7	5.2	5.8	6.5
France	15.9	18.5	23.4	27.7	32.0	36.4
Italy	5.8	9.8	17.1	24.9	33.0	39.2
Luxembourg	0.06	0.10	0.11	0.12	0.14	0.16
Netherlands	3.6	4.5	5.8	6.9	8.4	10.0
Community[1])	53	72	88	106	125	143

1) Rounded figures.

C — *Transport* [2])

The majority of the energy used in this sector is already accounted for by road transport (more than 70% in 1960), and this trend will increase.

In recent years the number of *private cars* in the Community has undergone a very rapid increase and that of commercial vehicles a rather slower but sustained one.

Motor vehicles in the Community (in 1,000's of vehicles)

	1955	1960	1965
Private cars	6,181	12,984	23,500
Commercial vehicles	2,314	3,112	3,500

From now until 1965 we can expect to see a certain slackening in the rate of growth in the number of motor vehicles on the road in most countries. This trend will be accentuated after 1965, and the forecast curves thus become logistic in shape. They obviously have a considerable effect on the trend in motor fuel demand, but as regards the individual countries in the Community we must bear in mind that the number of vehicles on the road still varies considerably from one country to another and that saturation point

1) For details on this point see Annex 1 to full Community-language edition.

2) See Annex 5 to full Community-language edition. For the purposes of this Study, the transport sector is taken as including the energy consumption of agricultural machinery and of civil-engeneering equipment. Annex 5 is updated to July 30, 1963, whence a number of variations from the figures given in this section : the differences are significant, however, only in respect of the estimate for 1975, which has been lowered, mainly in consideration of a reduction in the figure for diesel oil consumption in Germany (Fed. Rep.).

will probably not occur simultaneously and with the same intensity in all countries.

In recent years there has been a marked reduction in *unit consumption* of gasoline in most Community countries, whereas that of diesel oil has maintained a much steadier level.

This reduction is generally expected to continue, although in some countries the process will be checked by the increase in average engine capacities.

As regards *railways*, the chief point to note is the continuance of the process of diesel conversion and electrification of a large number of lines. The forms of energy used are consequently changing and specific consumptions (per metric ton-kilometre or train-kilometre) are falling steeply.

This leads to the conclusion that non-electrical energy requirements in the transport sector may be expected to rise from 59 million metric tons hard-coal equivalent in 1960 to 102 million in 1970 and 128 million in 1975.

Table 14 — Non-electrical Energy Consumption in the Transport Sector ('000,000m.t. H.C.E.)

Country	1950	1955	1960	1965[1]	1970[1]	1975[1]
Germany (Fed. Rep.)	14.8	20.2	23.9	31	38	46
Belgium	3.1	3.6	3.7	5	5	6
France	13.3	15.4	17.2	22	26	33
Italy	3.8	6.5	9.8	16	24	32
Luxembourg	0.16	0.16	0.17	0.3	0.3	0.4
Netherlands	2.4	2.9	4.1	6	8	10
Community[2]	38	49	59	80	102	128

1) Rounded figures to the nearest million metric tons H. C. E.
2) Rounded figures, which may therefore differ slightly from the sum of the individual items.

D — *The domestic sector* [1]

This is a non-uniform sector embracing households, offices, trade, crafts and agricultural consumption, except that of tractors, which is included under transport. The sector is variously demarcated from one country to another. A drawback which often arises in interpreting retrospective data is that the long-term trend is hidden by fluctuations due to temperature and stock variations.

The consumption level per inhabitant in Community countries and the ten-year trend are largely influenced by income and climatic conditions.

1) See Annex 6 to full Community-language edition : The non-electrical energy requirements of the domestic sector.

Table 15 — Non-electrical Energy Consumption in the Domestic Sector

A — Absolute figures ('000,000m.t. H.C.E.)

Country	1950	1955	1960	1965[1]	1970[1]	1975[1]
Germany (Fed. Rep.)	23.5	39.2	43.5	51	56	60
Belgium	8.9	9.9	9.4	10	11	11
France	18.5	23.2	26.0	32	38	45
Italy	3.4	5.8	9.1	13	18	23
Luxembourg	0.24	0.30	0.36	0.4	0.5	0.5
Netherlands	6.7	7.7	8.3	9	10	11
Community[2]	61	86	97	116	133	151

B — Per inhabitant (kg H.C.E.)

Country	1950	1955	1960	1965	1970	1975
Germany (Fed. Rep.)	491	781	815	910	970	1,000
Belgium	1,030	1,116	1,027	1,103	1,094	1,095
France	443	536	571	674	764	864
Italy	73	121	184	257	343	428
Luxembourg	811	987	1,147	1,292	1,463	1,507
Netherlands	662	716	723	760	800	840
Community	394	533	570	658	729	794

1) Rounded figures to the nearest million metric tons H.C.E.

2) Rounded figures, which may therefore differ slightly from the sum of the individual items.

Future demand has been estimated by linking consumption in this sector to an income indicator (gross national product) and a trend factor. Although households constitute only a fraction of this sector, an attempt has also been made to forecast demand on the basis of anticipated developments in housing.

The estimates show a rise in Community consumption from 97 million metric tons H.C.E. in 1960 to 133 in 1970 and 151 in 1975, with a fairly high margin of uncertainty. During the period 1960—1970 consumption will therefore rise by about 38% at an annual rate of about 3.3%. From 1950 to 1960 the overall increase was 58%, representing a growth rate of about 4.7% per annum. The deceleration reveals a gradual saturation in demand, with a slower rate of increase not only in the number of dwellings but also in consumption per dwelling.

E — *Electricity requirements*

The demand for electricity in each country has been estimated overall and by sectors in the same way as total energy requirements. [1]

1) See Annex 7 to full Community-language edition : Electricity requirements.

It should, however, be noted that past figures show electricity consumption to be less closely linked than total energy consumption to the general economic indicators, and that it would largely appear to follow a trend of its own. This is a help in forecasts in that uncertainties as to the rate of general economic growth affect the calculations less, but at the same time a hindrance inasmuch as it cannot be known whether the independent trend in electricity consumption will continue to be equally marked during the next fifteen years.

The figures finally adopted are shown in Table 16. Community consumption is expected to increase from 285 TWh in 1960 to 574 in 1970 and 790 in 1975. The average annual rate of increase from 1960 to 1970 is put at approximately 7.2%, representing a doubling in ten years.

The rate of growth in electricity requirements is thus appreciably higher than in total energy requirements, as it has been for a good many years past. This means a steady increase in the proportion of primary energy ultimately used in the form of electric current.

Table 16 — Trend in Electricity Consumption

A — Absolute figures ('000,000,000 kWh, gross)

Country	1950	1955	1960	1965	1970	1975
Germany (Fed. Rep.)	46.9	80.0	120.6	170	234	316
Belgium	9.0	11.9	15.2	20	27	36
France	34.8	51.5	74.8	108	155	218
Italy	24.8	38.1	56.1	83	119	166
Luxembourg	0.7	1.1	1.6	3.5	4.4	4.9
Netherlands	7.4	11.4	16.5	24	34	49
Community[1])	124	194	285	409	574	789

B — Annual rates of growth[2]) (%)

Country	1950-1955	1955-1960	1960-1965	1965-1970	1970-1975
Germany (Fed. Rep.)	11.3	9.5	7.1	6.6	6.2
Belgium	5.7	5.0	5.8	6.0	5.7
France	8.2	7.7	7.6	7.5	7.0
Italy	9.0	8.0	8.2	7.5	6.8
Luxembourg	9.5	7.8	17.5	4.4	2.3
Netherlands	9.0	7.6	7.5	7.6	7.2
Community	9.4	9.4	7.5	7.0	6.5

1) Rounded figures, which may therefore differ slightly from the sum of the individual items.
2) Calculations based on non-rounded figures by comparing the two end years.

Consumption per inhabitant (Table 17) is expected to rise by nearly 87% from 1960 to 1970, with the differences between country and country becoming progressively smaller. Even so, the forecast of 3,100 kWh per inhabitant for 1970 is well below the present figure for the United States (4,650 kWh in 1960).

Table 17 — Apparent Electricity Consumption per Inhabitant (kWh)

Country	1950	1955	1960	1965	1970	1975
Germany (Fed. Rep.)	980	1,195	2,259	3,070	4,100	5,300
Belgium	1,042	1,341	1,660	2,140	2,800	3,600
France	834	1,190	1,642	2,290	3,100	4,200
Italy	532	793	1,137	1,640	2,300	3,100
Luxembourg	2,365	3,618	5,095	10,830	13,000	14,200
Netherlands	734	1,060	1,436	1,950	2,700	3,600
Community	796	1,202	1,683	2,330	3,100	4,200

N. B. These figures are obtained by dividing the gross overall consumption in each country by the population. Owing to production, transmission and distribution losses, they thus exceed actual consumption.

F — *Fuel requirements for thermal power stations*

Part of the demand for electricity will be covered by hydro, geothermal and nuclear power stations and by net imports. The output of these types of power stations, with net imports included, was 106 TWh in 1960 and is estimated at 156 TWh in 1970 and 230 in 1975 (see chapters 11 and 12), representing an increase of 47% over ten years.

The remaining requirements will be supplied by conventional thermal power stations [1]), whose unit consumption should continue to fall owing to improved efficiency. Table 18 shows the anticipated trend of average unit consumption at public power stations in each of the six countries. The reduction should be about 15% (approximately 1.6% per annum) between 1960 and 1970.

Assuming the same *tempo* of reduction for thermal power stations as a whole, we can thus expect a demand of 151 million metric tons hard-coal equivalent in 1970 and 190 million in 1975, by comparison with 81 million in 1960.

Table 18 — Forecast Trend in Average Unit Consumption in Public Power Stations (in kcal/kWh, gross)

Country	1960	1965	1970	1975
Germany (Fed. Rep.)	2,850	2,560	2,410	2,300
Belgium	2,830	2,560	2,410	2,300
France	2,600	2,420	2,280	2,200
Italy	2,760	2,470	2,350	2,250
Netherlands	2,830	2,560	2,410	2,300

[1]) See Annex 8 to full Community-language edition : Fuel requirements in conventional thermal power stations.

G — *Own consumption by energy producers and converters and losses*

This item includes all *non-electrical energy* consumed before reaching the final consumption stage or being converted into secondary energy. It therefor excludes electricity consumption and accounts for 13.2% of total energy requirements in 1950 and 9.3% in 1960.

At this stage of the analysis it is impossible to predict the future level of consumption with any accuracy, because it depends on the output of the various energy producers, which cannot be estimated until the total demand has been broken down not only into different forms of energy but also into internal production and imports.

We have nevertheless tried to produce an approximate figure by extrapolating the 1950—1960 trend and correcting it to allow for the margins within which energy production levels may lie within the next ten to fifteen years. [1])

The difference in the trend between one Community country and another mainly seems to depend on the volume of refineries' own consumption and losses throughout the sector. In Italy and the Netherlands, where this item predominates, the overall consumption of the sector will increase heavily owing to growing refinery capacity; at the same time there are no signs of a substantial reduction in unit consumption.

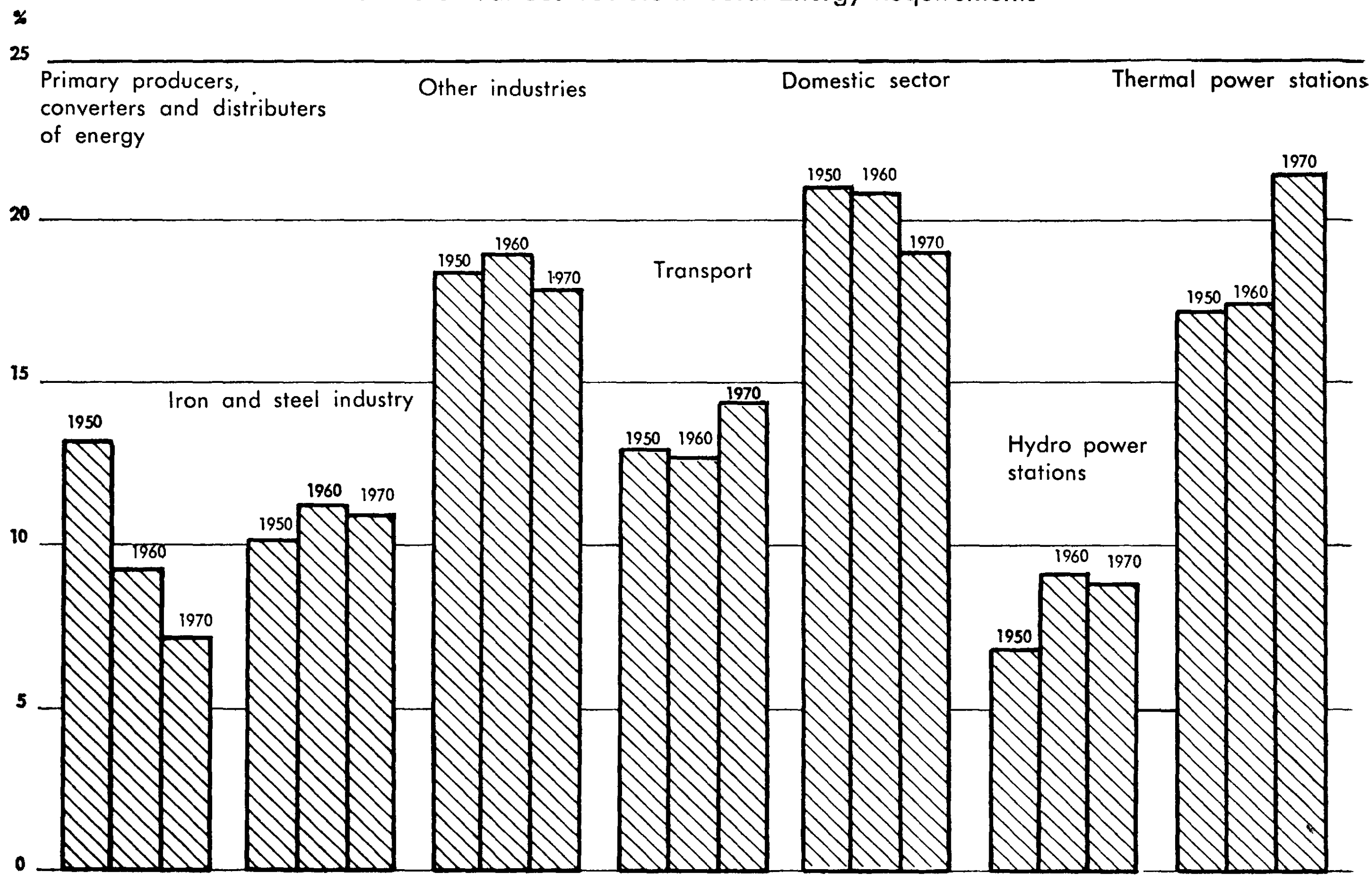
In Germany, and to a lesser extent Belgium, the increase in refineries' own consumption will partly be offset by stationary consumption at coking plants and a lower rate of collieries' own consumption, at least for the first five years. It must be borne in mind that the latter factor is due not only to shrinking coal production but also to a marked drop in consumption per unit of production, which in the past has mainly been due to the replacement of steam by electricity. It is likely that the fall in consumption per unit of production will continue for a number of years, although at a slower rate.

If we allow France an intermediate trend between that of Germany and Italy, we obtain a fairly slow rise in Community consumption throughout the sector, from 43 million metric tons hard-coal equivalent in 1960 to 51 million in 1970 and 58 million in 1975, representing an increase of 17% over ten years. Refineries' own consumption may vary between 21 and 24 million metric tons hard-coal equivalent in 1970 and between 28 and 32 million in 1975, according to the output hypothesis adopted. Collieries' own consumption may be expected to lie between 3 and 8 million metric tons, with the latter figure more likely in 1970.

[1]) See Annex 2 Appendix 1 to full Community-language edition.

Graph II

Share of Various Sectors in Total Energy Requirements



H — *Summary*

Table 19, which summarises the requirements of the various sectors, provides an overall picture of the structural alterations which may be expected in primary energy demand. [1])

The major change arises from the fact that electricity consumption will rise much faster than that of other forms of energy and that hydro, geothermal and nuclear generation will only be able to meet a very small portion of the increase in demand. There will thus be a sharp rise in the primary energy requirements of conventional thermal power stations, whose share in primary energy requirements as a whole will rise from 17.5% in 1960 to 21.5% in 1970 and 22.4% in 1975.

Another important change will be that the demand for motor fuel will raise the transport share from 12.8% in 1960 to 14.5% in 1970 and 15.1% in 1975.

To offset the trend in thermal power station and transport requirements, the share of the non-electrical energy requirements of the other sectors is expected to drop; this tendency will probably be most marked in the domestic sector and "other industries", where the possibilities of saving energy seem greatest.

Table 19 — Breakdown of Total Community Primary Energy Requirements by Sectors

A — Absolute figures ('000,000m.t. H.C.E.)

Sector	1950	1955	1960	1965	1970	1975
Primary energy producers' own consumption and conversion and distribution losses (excl. electricity)	38.2	44.3	43.0	46.7	50.6	57.6
Iron and steel industry (excl. electricity)	29.5	42.9	52.0	63.7	77.0	85.6
Other industries (excl. electricity)	53.1	71.6	87.6	105.8	125.1	143.2
Transport (excl. electricity)	37.6	48.8	59.0	79.8	101.9	127.6
Domestic sector (excl. electricity)	61.1	86.1	96.5	115.5	133.0	150.5
Power stations (excl. electricity)						
a) hydro, geothermal and nuclear	19.7	28.8	42.6	48.3	62.1	92.1
b) conventional thermal	50.0	66.5	80.6	110.1	150.5	190.4
Total requirements (rounded figures)	289	389	461	570	700	847

[1]) For the position by countries, see Annex 2 to full Community-language edition.

Section 3 — Reasons and scope for uncertainty as to future requirements

The consumption figures given above are subject to a fairly large margin of inaccuracy due to two types of uncertainty :

(i) *inadequate information from the past :* inaccuracy in certain figures and gaps in statistical data (particularly in stock fluctuations) which impair the accuracy of statistical adjustments;

(ii) the much more important question of *the future trend of the main factors determining energy consumption :* rhythm of economic expansion, structural distortions in the economy, rate of progress in the conversion and utilisation of energy and the influence of price on unit consumption.

B — Percentages of total

Sector	1950	1955	1960	1965	1970	1975
Primary energy producers' own consumption and conversion and distribution losses (excl. electricity)	13.2	11.4	9.3	8.2	7.2	6.8
Iron and steel industry (excl. electricity)	10.2	11.0	11.3	11.2	11.0	10.1
Other industries (excl. electricity)	18.4	18.4	19.0	18.6	17.9	16.9
Transport (excl. electricity)	13.0	12.6	12.8	14.0	14.5	15.1
Domestic sector (excl. electricity)	21.1	22.1	20.9	20.2	19.0	17.8
Power stations (excl. electricity)						
a) hydro, geothermal and nuclear	6.8	7.4	9.2	8.5	8.9	10.9
b) conventional thermal	17.3	17.1	17.5	19.3	21.5	22.4
Total requirements	100	100	100	100	100	100

We shall now attempt to assess the effect of the main factors referred to above, but before doing so it should be noted that not all the margins of inaccuracy deduced from these factors are necessarily cumulative.

For instance, the margin of statistical error on either side of the central value of an extrapolation may simply result from gaps in the basic information (e.g. the absence of data on stock variations or the effect of temperature fluctuations). But it may also reflect the fact that structural modifications have built up at the end of the reference period, thus making the average trend less representative. In this case we must avoid allowing twice over (type 1 and type 2) for uncertainties due to structural changes.

More important still is the fact that the rates of technical progress and economic growth seem to be linked, in that the former increases proportionately to the latter. The high rate of growth is reflected in the yearly increasing number of new plant installations, which enables technical improvements introduced by manufactures to be put into practice. This is borne out by a comparison between the six Community countries during the last decade. With the exception of Italy, whose rapid industrialisation places her in a separate category, the reduction in consumption per unit of production during the period 1950—1960 has been greater in the countries in which economic growth has been fastest [1]).

The following observations should be seen in this light.

A — *Basic information on energy requirements*

The way in which the forecast hypotheses are obtained — by extrapolating relatively short chronological series and using basic data uncorrected for stock and climatic fluctuations — leads to fairly ample margins of statistical error. With the most representative adjustment formulae these work out at an average of about 3% on either side of the central value for the total Community energy requirements in 1965 and at about 4—5% for the 1975 estimates [2]).

[1])

Country	Annual percentage increase in industrial production	Annual percentage change in consumption per unit of production
Germany (Fed. Rep.)	+ 9.1	— 4.6
France	+ 6.4	— 2.6
Netherlands	+ 5.8	— 1.8
Belgium	+ 3.0	— 1.8
Italy	+ 8.1	+ 0.4

[2]) This allows for a probability.

As already noted, these margins of statistical error cannot automatically be added to the other uncertainties affecting the forecasts offered, which are the result of a selection from within the range of figures offered. For this purpose we have used all the information available and it is only where the choice is influenced by a trend line which is falsified by gaps in information and statistical methods that any additional uncertainty should be taken into account. At the *total consumption stage* — this is no longer the case with sector and product analyses — these distortions should not be too great.

B — *Rate of growth*

It is difficult to assess the uncertainty which affects economic rates of growth. It is largest in countries which, like Italy, still have a substantial growth potential and where there is more room for a policy which actually influences the growth rate.

The uncertainty as to 1965, which is relatively close, mainly arises from cyclical fluctuations around the average trend; the effect of these will be dealt with later on.

For 1975, on the other hand, the rate of growth cannot be estimated accurately and it may be thought that the figure adopted is on the high side by comparison with what was actually achieved in the period 1950—1960. As a preliminary hypothesis for 1975, we can adopt extreme levels which are 5% higher and 10% lower than the figure given in this document.

For a number of reasons the variation in industrial production may be somewhat higher than this figure.

Since the elasticity in energy consumption by comparison with the gross national product is at present below unity for the Community as a whole and will probably remain so in the years to come, the uncertainty as to the rate of growth is felt less than proportionately in energy consumption. With the elasticities of about 0.9 adopted in the present study, the effect of the abovementioned margins on energy requirements in 1975 would be about 70 million metric tons less and 35 million more.

C — *Rate of technical progress*

Another major factor making for uncertainty is the rate of technical progress, which has been high in the last ten years (reduction in energy consumption to obtain the same degree of efficiency).

It is likely to fall in the future, especially owing to the reduction in growth rates. This has been allowed for in the calculations for Table 9, but a certain amount of uncertainty remains which could alter the total consumption of energy by about 10% by 1975.

D — *Structures of the economies*

Assuming an equal working population and national product, energy consumption differs according to the structure of the economy and is particularly dependent on the volume of activity in the iron and steel industry, the share of industry in the economy and the relative importance of various industries. Some idea of this may be gained from the fact that the energy consumption per worker per annum in metric tons hard-coal equivalent is about 120 in the iron and steel industry, from 2 to 20 in industry (Community average about 7) and less than 1 in tertiary activities.

The uncertainty as to pig iron production in the development hypotheses we have adopted is low in 1965 but very much greater by 1975, owing to uncertainties as to steel outlets and technological developments in the iron and steel industry (pig iron/steel ratio). The figure may be estimated at between 10%and 15%. With the energy consumption of the iron and steel industry accounting for about 12% of the total, the uncertainty as to overall energy requirements drops to less than 2%.

As regards the "other industries" sector, the uncertainty as to the index of industrial production may be reckoned at a maximum of 10% for the Community at a given national product level in 1975. With industry using about 35% of final energy (including electricity), the uncertainty as to total requirements would be 3.5%.

Lastly, an examination of the past decade shows that structural change in the industrial sector (disparity of growth rates between industries with a high energy consumption per unit of value added and low-energy consumption industries) has not had much effect on energy consumption, although this may not apply in the future. Nevertheless it can be reckoned that the sensitivity of energy consumption to this factor is low (±5% for energy consumption in industry, making ±2% for total energy consumption).

To sum up, since it is unlikely that all the factors referred to above will act in the same direction to make the forecasts either too high or too low, the uncertainty they represent as regards total energy requirements should be about 5%. [1])

[1]) If final demand for national accounting purposes in France had shown the same structure in 1959 as in 1950, energy consumption would only have been 6% less than it actually was.

E — *Energy prices*

The influence of energy prices on the rhythm of economic expansion and on energy demand is studied in the following chapter, the main conclusion of which is that our present knowledge is insufficient to enable us to state precisely what energy price hypothesis underlies the growth rates adopted, so if we provisionally accept these as data for our energy studies, the effect of changing energy prices will be limited to the structure of industrial production and the intensity of energy utilisation. As we shall see in the following chapter, total energy consumption in the Community does not seem to be affected very much by price fluctuations of less than an average of 10%. [1])

F — *Overall uncertainty*

As already noted, certain factors making for uncertainty cannot be superimposed on each other. In particular, it is highly unlikely that the sum total of uncertainty as to technical advances can be added to that arising from doubts as to the rate of economic expansion, and the other factors may operate in the same way. The overall uncertainty for 1975 could, by reason of structural elements, amount to 10—15% less and about 10% more. [2])

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1) This low overall elasticity does not rule out the possibility of sectoral or regional repercussions on a much larger scale.

2) It should be borne in mind that these figures are based on average business, climatic and rainfall conditions. The correction for a boom or a slump may amount to about 5% of overall consumption, but this need not be taken into account in a long-term study (the effect of cyclical fluctuations will be dealt with in the last chapter of this report).

Chapter 4

Energy prices and requirements

The energy requirement forecasts given in Chapter 3 do not allow for the price of energy. Insofar as they are based on relationships worked out for the past between energy consumption and various economic activity indicators, they imply either that these relationships are independent of the price of energy or that the price of energy will continue to move in the same way as in the past in relation to general price levels. The fact that these hypotheses are generally assumed in any study on demand forecasts does not preclude our asking to what extent they are valid.

The relationship between energy prices and demand is very complex and to measure it would mean making allowances for several mechanisms which condition economic development; this is difficult enough qualitatively, but even more so quantitatively. We thus make no claim to have solved the problem and shall restrict ourselves to giving certain information on the part played by energy expenditure in cost formation, followed by some remarks on the relationship between prices and demand. [1])

Section 1 — Energy expenditure in cost formation

The share represented by energy expenditure in cost formation can be estimated with the aid of national accounting figures and input-output tables. We shall give an overall view first of all, followed by detailed information on product categories.

A — *Share of energy in the national product*

An overall assessment of the share of national or regional production factors devoted to providing the economy with its energy requirements may be made by comparing the sum of the values added by the various energy sectors and of the value of net energy imports with the national product.

[1]) The E. E.C. Commission has asked a group of independent experts to make a thorough study of the economic influence of energy prices, particularly on general economic growth and the level of energy consumption.

This gives us figures which differ only slightly from one country to another and average about 9%.

This percentage includes not only energy used in production sectors but also that consumed by domestic purchasers. If we disregard the latter, the figure is about 6%.

A somewhat more detailed view can be gained from the relationship between energy purchases and value added in the major sectors :

agriculture 2— 4%;

industry 7—10%;

transport about 15% (including motor fuel tax).

B — *The share of energy expenditure in the cost of production*

Input-output tables can be used to determine the share of energy expenditure in the production costs of various groups of products; this can than be compared with other cost elements, particularly labour costs and capital expenditure. The first column in Table 20 gives the overall results for the Community and Table 20 gives the overall results for the Community and Table 21 gives more detailed results for France.

As will be seen from Table 21, direct energy costs always work out below, and usually well below, labour costs, and in many cases even below depreciation on fixed assets. This is a point of some importance in dealing with factors affecting location of industrial activities.

Table 20 — Share of Energy Costs in Total Cost of Certain Products for the Community as a whole

Sector	Direct energy purchases as a percentage of product value	Direct and indirect cumulative energy purchases as a percentage of product value
Agricultural and food industries	1.4	4.2
Building materials and glass	8.6	11.5
Iron mines and iron and steel industry	20.8	24.3
Non-ferrous ore and metals	11.4	14.8
Mechanical and electrical engineering industries	1.5	8.2
Chemicals	7.8	10.7
Textiles, clothing, leather	2.8	5.9
Miscellaneous industries	2.2	4.6
Building and civil engineering	0.9	5.4
Transport	11.6	13.7

Table 21 — Shares of Energy Costs, Labour Costs and Depreciation in Turnover in Major Sectors — France 1956

Sector	Energy costs	Labour costs-wages[1])	Depreciation
	as percentage of turnover (including tax)		
Agriculture and fisheries	3.0	13	7
Agricultural and food industries	2.1	11	2
Ore extraction, minerals	5.7	41	15
Glass, ceramics, building materials	13.0	28	5
Chemical industries, rubber	7.0	30	6
Metal production	19.4	30	12
Mechanical engineering industries	2.4	39	5
Electrical engineering	2.1	34	3
Cars, cycles	2.4	32	5
Shipbuilding and aircraft	1.8	40	4
Textile industries	2.8	24	4
Clothing	1.0	13	1
Leather and skins	1.3	18	1
Timber and furniture	2.6	23	2
Paper and board	6.3	24	5
Printing and publishing	0.9	35	3
Miscellaneous industries	3.3	18	2
Building and public works	2.8	29	2
Transport and telecommunications	10.5	58	17
Miscellaneous trade	3.7	24	4

Source: Les comptes de la nation, volume 1, *Les comptes*, Paris 1960.
1) This figure does not include the income of individual proprietors, so that it appears abnormally low in sectors.

These figures only give a partial view of the phenomena, however, and they are totally incapable of disclosing the effect of an alteration in energy prices on the cost of production of any given product, because they do not allow for all the energy ultimately included in a particular product.

Energy can play three different parts in the cost of a given product, for example an agricultural tractor :

(a) the manufacturer of the product incurs certain energy expenditure, which figures expressly in this turnover. This is direct energy, the volume of which depends on the degree of integration of the undertakings involved. In 1951 direct energy in France reprented 1.9% of the ex-words value of agricultural machinery;

(b) the manufacturer uses raw materials and semi-finished products and incurs costs. The total energy embodied in these products and services constitutes the indirect energy. This represents 7.1% for agricultural machinery;

(c) finally, operating costs include depreciation, roughly approximate to the services rendered by the capital assets, which, being the result of building or civil engineering work and the installation of machinery, incorporate energy. The share of energy included in the cost of the product manufactured by the services rendered by the capital assets can be calculated, and we shall term it "depreciation energy" (0.3% for agricultural machinery).

The sum of these three items — direct, indirect and depreciation energy — may be regarded as representing the share of energy costs in the value of the manufactured product. In the case of agricultural machinery, this share amounts to 9.3%.

The second column in Table 20 gives fairly overall results for the Community; Table 22 shows more detailed results for France in 1951.

The ratio between indirect and direct energy increases as the products move forward in the process of industrial conversion. Looking at the total, products can be divided into three major groups :

— the first group comprises basic intermediate products, for which the percentage is 15% or over; iron and steel products (20—25%), primary steel conversion products, cement, plaster, stoneware, ceramics, glass, chemical products (average 15%), paper pulp and transport;

— in the second group the percentage is about 10%; this comprises mechanical and electrical engineering industry products and paper;

— with other manufactured products and food products the percentage seldom exceeds 5% and may be considerably less.

It is notable that the more finished the product the lower the energy costs. This applies for the other countries also, though the percentages may vary within a certain range.

Table 22 — Share of Energy Costs in Total Costs of Certain Products in France in 1951

Description of product	Direct energy	Indirect energy	Depreciation energy	Total
I — *Intermediate products*				
Iron and steel products	19.0	2.1	0.8	21.9
Primary steel conversion products	5.1	14.5	0.6	20.2
Non-ferrous metals	8.8	4.4	0.3	13.5
Castings	2.9	6.4	0.2	9.5
Chemical products	10.4	4.9	0.4	15.7
Artificial and synthetic fibres	5.8	3.4	0.2	9.4
Bricks and tiles	15.8	0.9	0.5	17.2
Cement, plaster	15.5	2.0	0.3	17.8
Paper pulp	13.6	6.6	—	20.2
II — *Transport*				
Internal transport of passengers and goods	15.4	0.8	1.5	17.7
Postal- and telecommunications	2.9	1.4	0.8	5.1
III — *Food products*				
Flour, semolina, groats	0.8	0.5	—	1.3
Bread, macaroni products	1.1	0.3	0.2	1.6
Fish	14.2	0.1	0.1	14.4
Preserves	0.9	0.6	0.2	1.7
Dairy products	0.4	0.3	0.1	0.8
Wines and spirits	2.3	0.6	0.1	3.0
Sugar and sugar products	4.6	1.0	0.3	5.9
IV — *Finished products*				
Semi-finished metalworking products, metal articles	0.8	7.8	0.3	8.9
Agricultural machinery	1.9	7.1	0.3	9.3
Industrial machinery	0.8	6.0	0.4	7.2
Aircraft equipment	1.8	3.9	0.5	6.2
Cars, motor-cycles, cycles	1.4	7.0	0.3	8.7
Electrical machinery and equipment	1.2	4.3	0.4	5.9
Pharmaceutical products	1.0	6.3	0.4	7.7
Tyres, rubber articles	1.7	1.7	0.2	3.6
Textiles	1.3	1.5	0.3	3.1
Clothing products	1.2	1.4	—	2.6
Tanner leather	1.4	2.0	—	3.4
Footwear	0.2	1.7	—	1.9
Glass	12.4	1.9	0.4	14.7
Stoneware, ceramics	14.7	1.3	0.7	16.7
Furniture and bedding	1.0	1.6	0.2	2.8
Paper and board	5.1	6.8	—	11.9
Newspapers, books and printed items	0.1	4.1	0.2	4.4
Building	0.8	4.5	0.2	5.5

N. B. The direct energy figures may differ from those given in Table 21, which relate to 1956 and are more accurate.

Section 2 — The influence of energy cost and prices on requirements

The effect of a change in energy cost and price levels on the volume of demand is extremely complex. Some idea of the problem can be gained from a step-by-step examination of the following :

(i) overall effect on the rate of economic growth;

(ii) influence on national production structure, i.e. on the relative share of various activities;

(iii) influence on unit consumption.

These three factors are obviously not independent of each other and there are clear links between the rate of economic growth and the relative share of each activity in national production. At the same time the rate of growth controls wage and salary trends, which are not unconnected with the level of unit consumption (especially as regards electricity, the consumption of which depends on the degree of mechanisation). Nevertheless our present knowledge is insufficient to provide us with an overall answer to the question and all we can do is to give certain indications regarding the factors enumerated above.

A — *Overall effect on the rate of economic growth*

This is an extremely difficult problem, because the facts do not offer a clear and unambiguous answer. For the time being we shall confine ourselves to a theoretical analysis of the question.

It seems possible to distinguish two methods whereby fluctuations in energy cost or prices are reflected in the rate of growth : [1])

(i) firstly, physically or mechanically : any alteration in the volume of production factors (labour and capital) devoted to the supply of energy is reflected in the volume of such factors available for other activities. The important element is then the actual cost of the energy to the economy;

(ii) secondly, psychologically : an alteration in energy prices (price to the consumer) may influence the behaviour of economic operators, particularly heads of business, to an extent which considerably exceeds the field of strict repercussions on the cost of production

[1]) To avoid any ambiguity it should be noted that the present analysis relates solely to the influence of energy prices on the overall requirements of an entire country (or larger area). Regional effects, particularly the stimulus which a region with several underemployed production factors gains from the existence of cheaper or more abundant energy than other regions, will not be touched on here.

and the choice of production techniques. A reduction in price, for example, could set off a substantial investment movement or, more generally, lead to a more intensive employment of available factors (particularly labour in certain areas). It is likely that these effects cannot be assessed until the fluctuation exceeds certain limits and that they only make themselves felt after a certain lapse of time.

(a) Mechanical repercussions

An attempt may be made to estimate these with the aid of an extremely overall model.

To say that the cost of energy drops, means that a lesser fraction of the country's production factors needs to be devoted to its supply. [1] [2]

The effect on the rate of growth of a fall in energy costs will obviously vary according to whether the resulting growth in the national product occurs entirely in consumption, entirely in investment or simultaneously in both. Let us examine two typical cases.

If the increase in national product affects both consumption and investment equally in relative value, in other words if investment continues to represent the same percentage of the national product, the rate of economic growth will remain practically the same. Consumption rises at the same speed, but every year remains higher than what it would be with a higher energy cost. If the cost fluctuation is 10% and if the energy cost represents 10% of the G.N.P., the increase in G.N.P., consumption and standard of living is about 1%.

It is worthwhile examining the effect of another extreme hypothesis, in which the increase in the national product takes place solely in investment and the consumption trend remains the same.

The crux of the problem lies in determining the effect on the rate of growth of an increase in the volume of investment (and of the rate of investment). This increase starts off modestly with a price fluctuation of 10% in an economy in which energy cost represents 10% of G.N.P., reflected by an increase of 1% in G.N.P. (at general constant price level); if consumption remains unchanged, investment rises to approximately 20—21% of G.N.P. Over the long term, however, there is a cumulative effect. Calculations on an extremely global model suggest that ultimately the repercussion on the

[1] It must be emphasized that we are talking here of the cost of energy to the economy. Actual price alterations caused by taxation or subsidies need not have any noticeable effect on the global level (although they may of course influence the level of activity in certain industries; cf. infra).

[2] It seems more realistic to discuss the problem in terms of a fall rather than a rise, since existing protection against imported energy is fairly substantial in many countries and the question arises as to whether and to what extent this protection should be lowered.

national product would be about 2.5—3%, i.e. a drop of 10% in the cost of energy would advance economic growth by a few months at the outset and nearly a year at the end of 15 to 20 years. [1]

The above calculation ignores the international context. If we now work on the basis of an economy trading regularly with countries in which the price of energy remains unchanged, either an increase in wages or a fall in domestic prices and an alteration in the rate of exchange must take place when the cost drops. This, however, is a non-recurring phenomenon; subsequently there is no *a priori* reason why the rate of exchange should alter. [2] Nevertheless there may be repercussions on the level of activity in certain sectors, a phenomenon which will be dealt with under B below.

(b) Psychological repercussions

This is a problem which cannot be treated theoretically, since it presents itself in very different terms from one country to another and probably even from one region to another. Probably the only way to achieve a better understanding of the scope and mechanisms of such repercussions is by concrete analyses of past trends and present situations, possibly supplemented by motivational research. [3]

B — *Influence on the structure of national production*

The price of energy influences the structure of national production in two different ways :

(i) since the share of energy expenditure varies considerably according to the finished product, an alteration in energy prices entails different alterations in the prices of various finished products, and this alteration in relative prices may be accompanied by changes in the final demand structure, particularly from households;

(ii) the comparative price of energy inside a country and abroad influences the competitiveness of various national activities abroad.

[1] The global result may conceal wider variations at sectoral and regional levels.

[2] This is a specific example of a wider problem: can the rate of exchange remain stable between two economies in which the general level of domestic prices is constant but the growth rate different? It is very difficult to give a theoretical reply and for the time being all we can do is to observe the coexistence of economies with very different growth rates and unaltered rates of exchange.

[3] This problem will shortly be embarked upon by a specially appointed group of experts.

As long as price fluctuations do not exceed 15—20%, the first effect will probably not be very great, since the corresponding alterations in relative prices will lie between 1% and 3%, which is a very much lower level than the price differences practised under commercial distribution methods. [1] [2]

The second effect, on the other hand, may be of far-reaching importance in certain activities, particularly those situated at the beginning of the conversion process, in which energy costs represent an appreciable proportion of their production costs.

It is extremely difficult to assess the alteration in competitiveness which would arise from a change in energy prices, since the exact level of production costs in various countries is not known. Nevertheless the following fragmentary indications may be given.

Competition between two factories is measured at consumer level. This means that a drop in an industry's costs results in a shift in the consumer price-indifference line *(ligne d'équiprix).* [3] Table 23 shows the approximate extent to which this line shifts for certain products with a variation of 10% in energy prices. The degree of shift is proportionate to the share of energy expenditure in production costs and inversely proportionate to the value per ton of manufactured product; it thus varies considerably from one product to another.

Table 23 — Shift in Price-Indifference Lines *(lignes d'équiprix)* produced by a 10% Energy Price Variation

Products	Cost per metric ton in dollars	Share of energy expenditure in costs in %	Effect of 10% increase in cost of energy		Transport costs in cents per metric ton-kilometre	Shift in price-indifference lines in kilometres
			in %	in $		
	1	2	3: col. 2x0.1	4: $\frac{\text{col. 1xcol. 3}}{100}$	5	6: $\frac{\text{col. 4}}{\text{col. 5}}$ x 0.5 x 100
Steel	100	25	2.5	2.50	1.2	100
Cement	12	25	2.5	0.30	0.8	18
Aluminium	500	17	1.7	8.50	1.2	350
Woollen yarn	3,200	3	0.3	9.60	1.6	300
Cotton yarn	1,000	3	0.3	3.00	1.6	95
Paper pulp	120	14	1.4	1.70	1.2	70
Nitrogenous fertilisers	155	30	3.0	5.00	1.0	250
Cars	per unit 2,000	5	0.5	10.00	12	40

[1]) With an alteration of 20% in energy prices, the mechanical repercussions are 0.5% in the price of clothing and 3% on glassware. The difference in relative prices is 25%.

[2]) This conclusion does not apply to household energy consumption. The influence of price fluctuations on this consumption is very difficult to assess, since care must be taken to distinguish it from the effect of income; moreover it is to a certain extent linked with the purchase of new appliances.

[3]) The price-indifference line is the locus of the points at which the cost to the consumer is the same irrespective of the factory from which he obtains his supplies.

C — *Influence on unit consumption*

A drop in the price of energy would probably entail an increase in unit consumption by encouraging industrialists where possible to adopt production techniques which make a greater call on energy (more intensive mechanisation, new processes) and possibly by lessening the incentive to achieve fuel economies at all stages.

Nevertheless it is extremely difficult to advance a figure. We can only assume that heavy consumers of energy have already made considerable efforts to reduce their unit consumption and that light consumers find that the moderate place occupied by energy expenditure in their production costs leads them to concentrate on improving efficiency in other cost fields. It is therefore likely that the effect on unit consumption of a not very high fluctuation in energy prices will be fairly slight. [1])

D — *General conclusions*

The above observations are inadequate to enable accurate conclusions to be drawn about the sensitivity of energy requirements to fluctuations in energy cost and prices, and all we can say is the following :

(i) our knowledge of the processes of economic growth is not yet sufficiently complete to enable us to state the energy cost level corresponding to the rates of growth adopted in Chapter 1. For the time being it is therefore necessary to proceed as if the rates were independent of the cost of energy, bearing in mind that this is only an approximation;

(ii) although working on the basis of a single growth rate, there is no doubt that an alteration in the price of energy can effect the level of activity of certain consumers and the level of unit consumption. These two effects both operate in the same direction; a fall in prices tends to raise the level of activity of heavy consumers and increase unit consumptions, whereas a moderate fluctuation probably affects only a few industrial consumers;

(iii) to sum up, it is highly probable that an alteration in the cost of energy affects energy consumption, but at the present time we lack sufficient information to enable the effect to be calculated in terms

[1]) It should be borne in mind that this applies to overall energy consumption, where as there is no doubt that the breakdown between various forms of energy is highly susceptible to alterations in their prices.

of figures. All we know is that an alteration in the cost tends to produce an alteration in demand in the opposite direction, and when the fluctuation in cost does not exceed 10—15% it seems that the alteration in demand, without being negligible, is less marked than when influenced by the other uncertainties affecting energy demand dealt with in the previous chapter.

Part Three

Developments Affecting Supply

Chapter 5

General remarks

There are two aspects from which developments affecting supply can be examined — available quantities and costs. Both are closely linked, in that often production costs are only valid for a given quantity when rising or decreasing returns — a frequent phenomenon in mining operations — has to be allowed for. Moreover estimates of reserves depend at any particular moment on technical and economic operating conditions, and we are therefore led to speak of the volume of reserves which can be extracted under such conditions without exceeding a certain cost of production.

In the remarks which follow we shall therefore concentrate on giving the available information on costs, although we cannot go far in this direction in our present state of knowledge. Nevertheless it is possible to give certain indications and approximations, and the object of this part of the study is to recapitulate the information at present available on Community coal, imported coal, brown coal, petroleum, natural gas, hydro-power and nuclear energy.

In this introductory chapter we shall describe the spirit in which the trend of economic conditions affecting supply has been forecast and the basic hypotheses assumed in doing so. The general principle has been to adopt the economic growth hypotheses noted earlier, to assume that growth will be regular (i.e. to ignore cyclical fluctuations), to work on a general constant price level and to allow for the most likely technological developments. These points will now be briefly reviewed, followed by a closing section on differences between costs and prices.

A — *Economic growth prospects*

The outlook adopted for Community countries is as described in Part One, namely fairly rapid expansion.

B — *General constant price level*

We have entirely disregarded inflation phenomena, i.e. we have assumed that the general price level will be the same as in the reference period (usually 1960). This assumption implies no particular view on the actual trend of general price levels in particular countries but is simply an aid to calculation which enables exchange rate fluctuations to be ignored. The latter fluctuations will in fact offset any disparity in general price level trends in individual countries. The object of this chapter is thus to establish the trend in costs and prices of different sources of energy by comparison with the general constant price level, using present exchange rates as the basis for comparisons between countries. [1])

The assumption of a general constant price level in no way implies that all prices will remain constant. Technological progress and thus productivity varies from one sector to another and some prices will therefore fall while others rise. All we assume is that the weighted average will remain constant. The analysis itself provides an example of such a movement, since we shall see later on that the cost of Community coal seems likely to rise by comparison with the general price level.

In addition the rise in *per capita* national product implies that *per capita* income will increase at approximately the same rate. In the cost calculation we shall be more precise in assuming an increase in wages which on average will equal that of the national income per head of working population.

C — *Regular growth*

All our calculations will be based on a steady growth in the economy. This means, at least at this stage, that we shall deliberately ignore the influence of cyclical fluctuations (these will be dealt with in a separate chapter in Part Five).

We shall therefore assume full employment of production capacity and make our cost calculations accordingly. To give an example, in the past cyclical fluctuations have produced very substantial fluctuations in demand for shipping space and consequently in freight levels, which over a short period of years have varied up to threefold. Whereas the bottom level has

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[1]) An enquiry is in progress to determine the extent to which growth rate disparities between individual countries are capable of altering rates of exchange so as to stabilize foreign trade balances.

not always covered normal depreciation, the top level has provided substantial profits. The coherent method used in the following calculations is to assume that the vessels whose costs will be calculated will be regularly traded not only throughout the year but also throughout their lifetime.

The concept of full employment of production capacity must obviously be viewed in the light of demand conditions and anticipated working hours. We shall assume, for example, that nuclear power stations will be employed to cover the base of the load curve, which corresponds to about 6,500—7,000 load hours per annum (80% annual load factor), at least until 1975. Likewise we shall allow for probable trends in colliery working hours, and in addition all normal maintenance shut-downs will be taken into consideration.

D — *Probable technological developments*

Technological progress, although very difficult to forecast, has been allowed for in working out future costs. In certain cases we already know possible lines of advance in fair detail, but generally speaking such information is only valid for the next few years. For a more long-term view our assumptions are based on what seems possible, especially after consulting various experts, bearing in mind that the fairly high economic growth rates adopted imply continued technological progress throughout the economy. We have, however, deliberately avoided assumptions implying revolutionary changes about which no information is yet available. In the coalmines, for instance, we have assumed a fairly steep rise in the underground output per manshift but have not departed from present technological conditions in the European coal industry. This does not mean that we reject the possibility of very different methods being employed eventually, for example, highly intensive robbing of seams; although research by some engineers suggests that these methods are possible it is too early as yet to have any serious idea as to what the effect might be on costs. In the same way the calculations ignore the possibility of transporting coal by pipeline and are based solely on conventional methods.

E — *Costs and prices*

All the information to be given in this part of the Study relates to production costs, and care must therefore be taken when turning from this concept to that of prices. We know that the energy sector is characterized by the production of linked products and by the existence of "diminishing returns" phenomena in the primary energy field. The result is that prices depend on producers' selling strategy. This applies to refined petroleum products for example, where to a certain extent refining and distribution costs can, particularly over a short period, be loaded on to one product rather than another in the light of market conditions, particularly elasticity between demand and prices. Oil companies also prospect in various parts of the world where prospection and production costs vary considerably and to a certain extent they can even these up. In the same way, colliery undertakings often own several pits producing the same grade of coal at a different cost, which means that they can sell either at marginal pit cost or at average production cost. The same dual strategy can be employed at coalfield level, particularly when there are selling agencies or the undertaking is the only one in the field.

Chapter 6

Community coal

A series of studies has been carried out in an attempt to establish the conditions under which coal can be mined in Community coalfields in 1965 and 1975.

A tentative cost curve has been worked out for each coalfield, indicating the tonnage produced in relation to the production costs of the marginal pit — in other words, the tonnage which can be produced at each cost level so that the production costs of the highest-cost pit work out precisely equal to such level.

Plotting these curves raises a number of problems, especially as regards cost component trends, types of coal and the items comprising costs (total cost, "regression" cost). The cost curves can then be linked to various supply curves, depending on whether sales are at marginal or average cost. All these points will be examined below. [1])

[1]) For further details see Annex 9 to full Community-language edition : The Community coal production costs.

A — *Cost component trends*

Coal production costs comprise three main items :

(i) labour costs;

(ii) materials;

(iii) depreciation and financial charges.

The factors making for uncertainty in cost forecasts are such that we must avoid excessive detail and concentrate on the more important of them. Table 24, which shows the cost breakdown between the three main items in various Community coalfields, demonstrates that the main factor is labour costs, the movement of which depends on wage levels and output per man-shift.

(a) Movement in labour costs

The movement of colliery wages and salaries (including social security charges) is closely related to that of national income per worker.

For the period up to 1965, the following forecasts as to wages are based on the trend which the experts consulted considered to be the most likely; beyond that date it has been assumed that the wages in question will rise at the same rate as national income per worker. The forecast rates are as follows :

Country	1960-1965	1965-1970	1970-1975
Germany (Fed. Rep.)	4.2	3.7	3.9
Belgium	3.2	3.2	3.2
France	4.0	3.85	3.9
Netherlands	2.8	3.7	3.7

Roughly speaking, these rates indicate that the relative difference which existed in 1960 between miners' pay and the average for other workers will remain unchanged. These figures should be taken as minima.

As regards social security charges, it is assumed that contributions under this head will rise at about the same rate as wages, so that the ratio between the two will remain as before. [1]

[1] This in fact involves the further assumption that any additional burden resulting from a higher ratio of retired miners and other pensioners to miners in active employment, due to reductions in the labour force, will not have to be borne by the collieries.

Table 24 — Coal Production Cost Structure in Various Community Coalfields in 1960 (%)

Coalfield	Labour costs	Materials	Depreciation and financial charges	Total
Aachen, Ruhr	53	34	13	100
Saar	54	36	10	100
Campine	53	28	19	100
Nord and Pas-de-Calais	63	19	18	100
Lorraine	56	23	21	100
Dutch Limburg	61	21	18	100

(b) Movement of productivity

Following discussions with various Community experts, hypotheses have been adopted as to the trend in productivity in each coalfield.

As regards 1965, a very thorough study has been made by the experts, account being taken of the special features of each pit. Rates of increase forecast vary appreciably from one pit to another. Given a production volume approximately equal to that of today (allowing for closures and improvements in capacity utilisation), the O.M.S. improvements and other relevant figures work out as shown in Table 25. (The very low rate of increase for France allows for a large amount of preparatory work which will not bear fruit until after 1965).

Table 25 — Trend in Average Coalfield Underground O. M. S. between now and 1965

Coalfield	Index		Average annual rate of increase	O.M.S. in kilograms1) ton for ton)	
	1960 1	1965 2	3	1960 4	1965 5
Ruhr and Aachen	100	123	4.3	2,185	2,700
Saar	100	131	5.6	2,055	2,700
Campine	100	131	5.5	1,790	2,350
S. Belgium	100	121	4.1	1,450	1,760
Nord and Pas-de-Calais	100	108	1.5	1,560	1,680
Lorraine	100	110	2.0	2,580	2,850
Dutch Limburg	100	122	4.1	1,830	2,240

1) Assuming there is no change in the number of shifts worked per year.

For the period from 1965 to 1975, the rate of increase in productivity is assumed to be the same for all pits in a given coalfield. This of course is an over-simplification not strictly in accordance with the facts, but it has not been possible on the basis of the data available to indicate separate figures for individual pits. The output figures arrived at are shown in column 3 of Table 26.

With production volumes (exclusive of anthracite) in keeping with the fully utilized production capacity forecast by the experts for 1965, the average underground O.M.S. for the different coalfields would be as shown in column 5.

Closures after that date would of course send the averages up, owing to the elimination of pits with the lowest O.M.S. The rise in such cases is not so great as is sometimes supposed, however : individual pit output rates may range from 35% below to 30% above the coalfield average, with the result that the closure of 10% of the capacity may raise that average by only 2—3%.

Table 26 — Trend in Average Coalfield Underground O. M.S. between 1965 and 1975

Coalfield	Index		Annual rate of growth	O.M.S. in kilograms under production conditions assumed by experts for 1965[2]	
	1965	1975		1965	1975
	1	2	3	4	5
Ruhr and Aachen	100	137	3.2	2,700	3,750[1]
Saar	100	137	3.2	2,700	3,700
Campine	100	136	3.2	2,350	3,200
S. Belgium	100	136	3.2	1,760	2,390
Nord and Pas-de-Calais	100	148	4.0	1,680	2,490
Lorraine	100	148	4.0	2,850	4,220
Dutch Limburg	100	144	3.7	2,240	3,230

1) This figure allows for increased utilization of capacity between 1965 and 1975.
2) Excluding anthracite.

In the case of surface labour, it has been assumed that the increased output would equal the increased average productivity for the economy as a whole (see Table 4).

(c) Other production cost items

It has been assumed that the materials cost per ton will remain at the same absolute level as in the reference year. This does not preclude the possibility that the prices of certain materials and equipment will move in different directions or that the future materials expenditure structure will alter from that of 1960 owing to changes in both volume of consumption and relative prices (we can thus expect a higher electricity consumption in the future owing to the change-over from compressed air). We have nevertheless assumed that these alterations will cancel each other out. This is doubtless a fairly favourable assumption, since the forecast heavy increase in productivity is likely to lead to increased consumption of materials and spare parts per ton of output.

As regards depreciation and financial charges, it has been assumed that these will remain the same per ton of capacity, resulting in a decrease per ton produced. The cost calculations relate to pits operating at full production capacity in 1970 and 1975, unlike the present situation where only a fraction of the capacity is used in many pits, even by 1965 the hypothesis of full employment will not be entirely borne out by all Community coalfields. [1]) This assumption that charges will remain the same per ton of capacity is probably somewhat optimistic, since increased productivity will doubtless be accompanied by intensified mechanisation and we cannot be certain that this will be offset by reductions in the relative prices of equipment.

The combined effect of the above two hypotheses and of the more rapid rise in wages than productivity will distort the production cost structure and the share of labour costs will tend to increase.

B — *Types of coal*

Both production costs and outlets differ very greatly according to the type of coal, but it is difficult to take the classification very far because a given pit often produces two or more types and there is considerable latitude in the treatment of the coal after it has been mined (washing, screening etc.). We have therefore restricted ourselves to three main types, namely anthracite, coking coal and steam coal.

At this early stage of the work we have ignored anthracite (which represented about 9% of total Community production in 1960) and have plotted only two cost curves, one for coking coal and the other for steam coal, for all fields except Campine and Dutch Limburg, for which only a coking coal curve has been prepared. [2])

It is not always easy to distinguish between different types of coal and a given pit producing both coking and steam coals may be unable to allot its costs accurately between the two types. In some cases we have endeavoured

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[1]) At a pit where depreciation and financial charges represent 20% of the cost, the transition from 80% to 95% utilization of capacity results in a cost reduction of about 3%.

[2]) The distinction between coking coal and steam coal lies in the *nature* of the coal, but does not affect its actual utilization. As we shall see in Part Four, the latter depends on outlets, and in certain cases coking coal has to be sold on the steam coal market because coking outlets are restricted.

to get round the difficulty by allocating each pit to one group or the other according to the type it mainly produces.

The rough classification adopted makes it impossible to allow for all differences in grades and qualities, and it may also distort competitiveness, since a pit producing at a lower rate of productivity and higher cost than another may eventually be in a better competitive position if the difference in the market value of their outputs is greater than the difference in costs. We have endeavoured to correct for these differences in grades and qualities on the basis of present valuation differences.

With steam coal we have assumed that the degree of preparation in the future will be similar to that practised at present. If preparation were limited to rough hand-cleaning without any subsequent treatment the coal obtained would only be usable at power stations, but the production cost by comparison with present washed coal would be about \$ 1.00—1.50 lower per metric ton hard-coal equivalent to 7,000 calories. [1])

C — *Results at present available*

It has been possible to carry out a fairly detailed analysis of the cost curves for coking and steam coals in the major Community coalfields in 1965.

The studies are less complete for 1975 and the results less accurate, owing to the greater uncertainty about the trend in productivity.

For reasons of industrial secrecy it is impossible to reproduce detailed results, but we can give some idea of the general shape of the curves and the main trends.

The curve costs are shown in the following graph, which covers all Community coalfields. [2]) The slope of the marginal cost curve varies with the coalfield, but the following phenomenon is fairly general : to the left,

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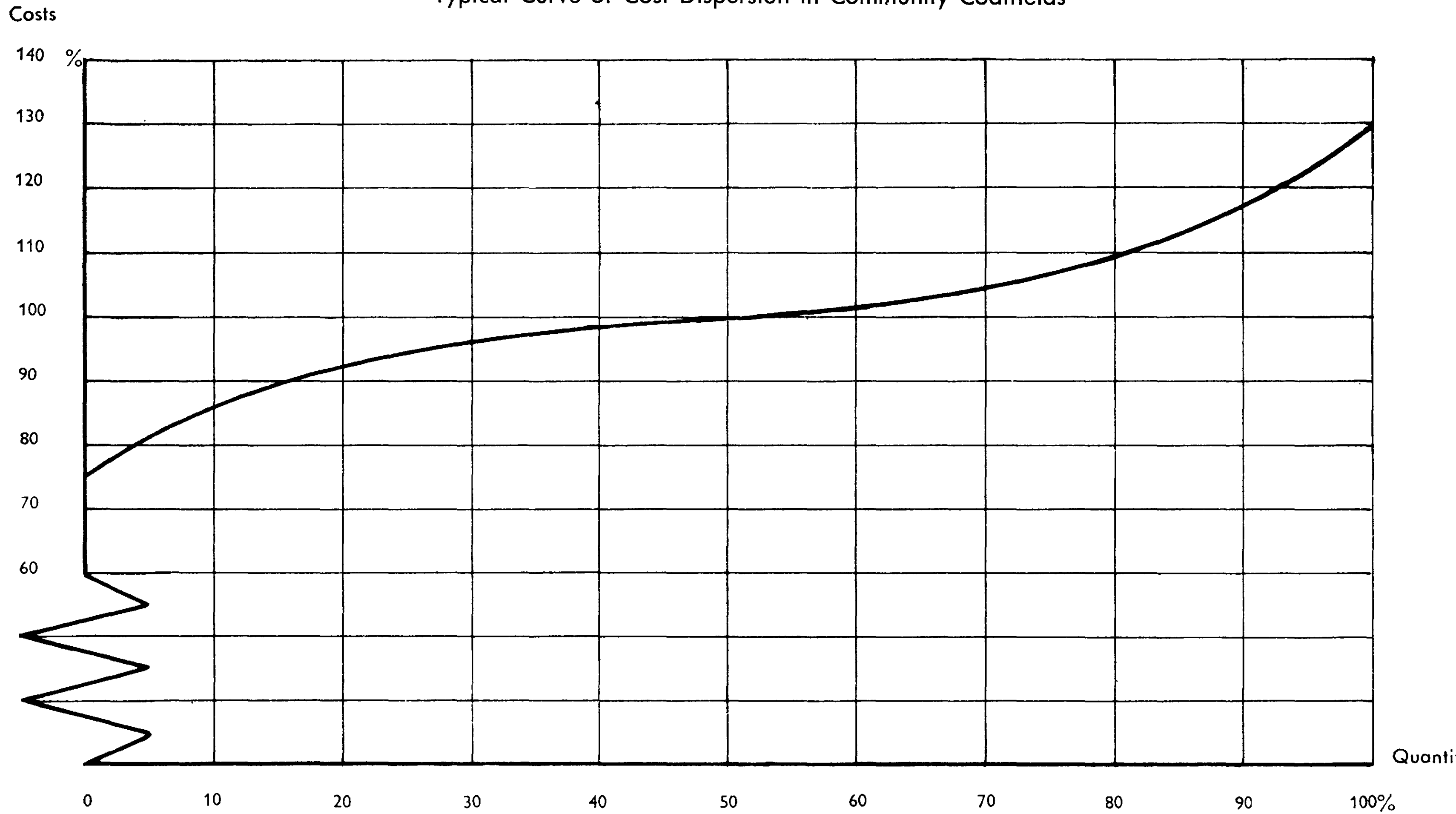
1) The actual weight of these 7,000 calories would then be increased by 15 to 20% and the cost of using this coal at power stations would be increased (especially owing to ash extraction) by an estimated \$ 0,40 per metric ton hard-coal equivalent. All these points require further investigation.

2) This curve is given solely for purposes of illustration. No conclusions can be drawn as to the level of competitiveness of Community coal; studies are needed for each coalfield, with requirements regionalized (see Part Four).

Graph III

Typical Curve of Cost Dispersion in Community Coalfields



several low-cost pits; then the main body of pits with fairly similar costs; lastly, to the right, marginal pits with high costs. The same phenomenon can be expressed by stating that average coalfield cost only moves slowly in relation to the reduction in output. [1])

We must nevertheless guard carefully against inferring from this that even a substantial reduction in production will only have a slight effect on the competitiveness of a given coalfield against imported energy, since such a reduction not only leads to lower average costs but, more important still, enables outlets further away from the mine to be abandoned and those closest to it to be concentrated on, with a consequent saving in transport costs (which may amount to 25% or more of the pithead price). The combined effect of these two factors will be analysed in Part Four.

As regards the trend in time, it may be noted that the largest Community coalfields tend to show a more rapid rise in wages than in productivity; hence an increase of nearly 10% in coalfield costs as a whole between 1965 and 1975.

To be more specific, in the period 1960—1965 :

(i) the Ruhr, Aachen, Saar and Dutch Limburg coalfields can expect more or less constant costs;

(ii) in the Campine coalfield costs will probably drop;

(iii) the French coalfields in Lorraine and Nord-Pas-de-Calais must expect increased costs, since the anticipated increase in output per man-shift will not suffice to offset the rise expected in wages.

During the period 1965—1975, the possible increase in productivity in all coalfields will not suffice to offset the increase in wages, but the resulting rise in overall costs will be less noticeable in French than in German coalfields. In order to resolve any ambiguity, it should be stressed that these indications offer no conclusions as to the comparative competitiveness of various coalfields, which can only be deduced from analyses based on the geographical location of each field.

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[1]) It should be borne in mind that the costs relate to pits working to full capacity.

D — *Accuracy of foregoing results*

The two main sources of inaccuracy have already been mentioned :

(i) uncertainties about wage trends in European mines due to uncertainty as to rates of economic growth, working hours and miners' wages by comparison with those of industrial workers;

(ii) uncertainty about the productivity trend in European mines.

Even assuming the rate of economic growth, it is virtually certain that the wage increase rate adopted in the calculations is a minimum figure. In addition the position of the miner by comparison with other industrial workers may have to be raised in order to obtain the required number of qualified workers in 1970 and 1975.

As regards productivity, it is more difficult to state the direction in which the inaccuracy operates. Certainly the growth rates adopted for the period between now and 1975 are high, since they are average figures maintained over a long period. The experts consulted nevertheless think them possible. Moreover we cannot rule out the possibility of a technological revolution, although this may not produce a more rapid rise in productivity unless more intensive mechanisation is adopted, which would raise depreciation and financial charges (and perhaps expenditure on materials). Lastly, it must be borne in mind that so far attempts to improve productivity have concentrated mainly on coal-cutting, which occupies less than 40% of the total underground and surface labour. Further efficiency drives at other stages might perhaps have a considerable effect, but would not bear fruit until alterations, doubtless major ones, had taken place in the organisation of coal undertakings, and thus after a very considerable lapse of time.

Chapter 7

Imported coal

We shall only deal with American coal, since no other source seems capable of regularly supplying an annual tonnage proportionate to Europe's supplementary coal requirements over the next fifteen years. [1])

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[1]) Eastern European coal has not been taken into account, since it is felt that as regards both volume and price it would not really be suitable for regular supplies to the Community as a whole.

In the reference year 1960 the cost breakdown of American coal was roughly as follows :

1960 cost of American coal ($/m. t.)

	Steam coal	Pocahontas coking coal	Coking coal mixture[1]
Pithead price	4.40	6.50	5.25
Carriage to Hampton Roads	4.50	4.50	4.50
Transatlantic freight	3.50	3.50	3.50
Total	12.40	14.50	13.25

1) 50% low-V.M. Pocahontas-type coal and 50% high-V.M. coal.

The main factors of uncertainty in the future are the pithead cost and transatlantic freight rates. [1]

A — *Pithead cost*

Output per man-shift, which varied only slightly between 1930 and 1940, rose by about 30% between 1940 and 1950 and then more rapidly still by 80% between 1950 and 1959, due to two factors :

(i) increased efficiency in all types of mines owing to mechanisation and the introduction of new methods such as the "continuous miner" in underground mines;

(ii) an increased share accounted for by output from opencast mines, in which productivity is two to three times as high as in deep mines (the share rose from 9% in 1940 to 24% in 1950 and 30% in 1959).

In the future these two factors are likely to continue to play an important part. Wage increases may be more than offset by rising productivity with an unchanged production level. There is, however, every reason to suppose that the United States' own coal requirements will increase sharply in coming

1) For a more detailed account see Annex 10 to full Community-language edition.

years; the increase has been estimated at 67% from 1955 to 1975, giving a consumption of 745 million short tons in 1975. Prices are unlikely to be effected by this in the period immediately ahead, and for 1965 it has been assumed that pithead export prices will be in line with the slightly higher price for the home market. After 1965, on the other hand, costs may be expected to rise quite considerably, especially in the case of coking coal, most of which is deep-mined and therefore costs more.

The increase may be smaller for steam grades, a larger proportion of which comes from thicker seams or opencast workings. To sum up, the pithead price per metric ton could therefore rise as follows :

(i) for Pocahontas coking coal, from \$ 6.50 in 1960 to \$ 7.00 in 1965 and \$ 7.70 in 1970;

(ii) for Pocahontas-Clintwood mixture, from \$ 5.25 in 1960 and 1965 to \$ 5.75 in 1970;

(iii) for steam coal, from \$ 4.40 in 1960 to \$ 4.65 in 1965 and 1970.

B — *Internal transport and transhipment in the United States*

Certain factors, such as the use of block trains of 240 eighty-ton wagons suggest that present rates may fall, but the extent of the reductions cannot be estimated at the present time. Long-term c.i.f. price forecasts are not likely to be seriously affected.

If coal situated further west has to be called on, transport to the coast will be more costly, but the coal itself will probably be produced more cheaply.

C — *Transatlantic freight rates*

The huge fluctuations in freight rates during recent years (\$ 2.90 in June 1959, \$ 10.00 at the beginning of 1956 and \$ 15.00 in December 1956) suggest that serious estimates are impossible, but these fluctuations relate to a very irregular volume of traffic intended to meet occasional requirements and arising from political or cyclical disturbances of an essentially transitory nature. Here, on the other hand, we are seeking the cost of regularly transporting substantial tonnages, which would thus be carried by large-capacity colliers plying regularly throughout their lifetime.

We should thus look for the operating costs of vessels of this kind built during the coming years. This gives an estimated rate of \$ 3.50—5.00 per metric ton Hampton Roads-Rotterdam according to the size of the collier; the freight rate may differ considerably for other Community ports.

D — *c.i.f. cost of steam coal*

The foregoing data give us the following estimates in dollars per metric ton for 1970 :

Pithead cost	4.50 — 5.00
Transport to Hampton Roads and handling	4.20 — 4.70
Transatlantic freight	3.50 — 5.00
c. i. f. cost	12.20 — 14.70

We can thus take $ 13.00—13.50 as the central value.

E — *c.i.f. cost of coking coal*

For coking coal from the United States there could be a wide range of prices according to the type of coal. The dearest would be low-V.M. Pocahontas-type supplementary coal for mixing with high-V.M. European coal. In 1970 the price of this coal would be about $ 16.50 per metric ton c.i.f. North Sea Port. The cheaper coal would be merchants' mixtures of low and high-V. M. coals, the price of which would be about $ 14.50.

Chapter 8

Brown coal

Since about 94% of the Community's brown coal is mined in Germany, the present position and future outlook for this item in the E.C.S.C. depends on operating conditions in the Federal Republic. Since the problem has already been dealt with in the Germany energy survey, we shall confine ourselves to summarising the main findings of the latter document. [1])

Depending on calorific value, a rough distinction can be drawn between recent brown coal and old brown coal. Since the entire Community production

[1]) See *Untersuchung über die Entwicklung der gegenwärtigen und zukünftigen Struktur von Angebot und Nachfrage in der Energiewirtschaft der Bundesrepublik unter besonderer Berücksichtigung des Steinkohlenbergbaus,* Berlin 1962.

in 1960 was approximately 98 million metric tons of recent brown coal and only 3 million metric tons of old brown coal, the analysis will mainly be devoted to the recent variety.

A — *Reserves*

Brown coal reserves ready for cutting by present methods are estimated at about 9,000 million tons or 2,500 million tons hard-coal equivalent. [1])

B — *Movement of costs*

(a) Recent brown coal

In 1959 the average production costs in the Rhineland field, which contains the major pits, were $ 2.00 per metric ton of brown coal or $ 7.60 per metric ton hard-coal equivalent. The breakdown into major items of expenditure is as follows :

	$/m. t.	%
Operating costs	0.60	31
Depreciation and interest	0.70	35
Other expenditure	0.70	34
	2.00	100

More than half the operating costs are accounted for by removal of overburden; the remainder are mainly due to compensation for mining damage and the cost of crop reinstatement as laid down by law. In *other producing areas* in Germany, the cost of cutting varies between $ 2.20 per metric ton (Bavaria) and $ 5.70 per metric ton (Hessen), the difference being mainly due to the depth of the deposits.

Outlook for 1965—1975. — Assuming an annual wage increase of about 5%, a reduction to a 40-hour week from 1963 onwards and the generalized use of heavy mining machinery, the production costs of Rhineland brown coal will probably rise by 30% by 1975.

[1]) Hard-coal equivalent to 7,000 kcal/kg.

Operating costs. — The trend in operating costs will reflect the deterioration in geological conditions. In the Rhineland field, one quarter of the present production of brown coal comes from the southern region, where there is usually only half a cubic metre of overburden per metric ton. As reserves in this area gradually become worked out (present reserves are estimated to last until 1970), it will be necessary to work the northern deposits, where the average overburden/coal ratio is 3 : 1. Full transition to large-scale mechanized operation will not offset this deterioration, and even at 1959 wage rates we must expect a rise of $ 0.25 per metric ton in operating costs.

Depreciation and interest. — The deterioration in the overburden/coal ratio will entail an increase in capital expenditure on *heavy machinery*. Even assuming a longer life for the new installations and the maintenance of existing wages, interest and depreciation are expected to rise from $ 0.70 per metric ton in 1959 to $ 1.10 per metric ton in 1975.

Total costs. — The fact that Rhineland total production costs will only increase by $ 0.60 per metric ton is due to a substantial reduction in compensation and crop reinstatement costs offsetting two-thirds of the rise in operating expenditure.

In *other German fields* the rise in total costs is expected to vary between nearly $ 1.00 per metric ton and $ 2.10 per metric ton of brown coal produced.

(b) Old brown coal

The survey of Bavarian old brown coal shows that production costs of pech-coal were $ 20.00 per metric ton hard-coal equivalent in 1959. A price increase of at least $ 6.00 is expected by 1975.

(c) Summary

Allowing for the calorific value of different types of coal and assuming a 5% wage rise per annum, we can expect the average price of Rhineland brown coal to be a maximum of $ 10.00 per metric ton hard-coal equivalent by 1975.

C — *Movement of production*

The German brown coal mines appear to have based their operating programmes on the following trend (recent brown coal in millions of metric tons) :

	Rhineland	Other areas	Fed. Rep. total
1960	81.4	14.7	96.1
1975	95.0	15.5	110.5

The main expansion will therefore take place in the Rhineland field.

Assuming that the production of *old brown coal* in Germany and the total production of brown coal in the *other Community countries* remains approximately stationary, i.e. at the 1961 level, we obtain a ton-per-ton production figure of 117 million metric tons in 1975, i.e. approximately 34 million metric tons hard-coal equivalent by comparison with 29 million metric tons hard-coal equivalent in 1960.

The increase is expected to be due solely to rising power-station requirements. The production of brown coal briquettes will probably drop to about 8 million metric tons or 5 million metric tons hard-coal equivalent as against in 1961.

Chapter 9

Petroleum products

To form an idea of the trend in the supply of petroleum products in the Community it is essential to study the world oil market, owing not only to the geographical distribution of crude oil production but also to the structure of the industry.

Only two countries in the world are both large-scale producers and consumers — the U.S.A. and the U.S.S.R. Other major production areas are in low-consumption countries with little industry; conversely the highly industrialised countries of Western Europe and the Far East have a totally inadequate local output.

These circumstances, arising from natural conditions, [1] are accompanied by the predominance in most markets, apart from that of the U.S.A., of companies which produce, refine and distribute oil in nearly all countries. This vertical and international integration explains the links between the outlets of the major oil producing centres, which export to all Continents.

For the last forty years world oil consumption has doubled nearly every ten years. Estimates suggest that total consumption, with the exception of that of the U.S.S.R., Eastern Europe and China, may double between

[1] Or rather from our present knowledge of them and from current technological advances.

1960 and 1975. U.S.A. requirements are expected to increase by about 50%, those of Europe to be approximately two-and-a-half times greater and those of other countries two-and-a-half to three times greater. The latter include a large number of developing countries whose rate of economic growth is especially difficult to forecast and for which the above figures may be somewhat on the low side, although this is not likely to affect the total to any great extent. World demand exclusive of the Eastern countries is likely to be approximately 2,000 million tons per year by 1975.

To this figure must be added consumption by Eastern European countries, the U.S.S.R. and China. Only very global retrospective data are available on consumption in these countries, but we do know that hydrocarbons (petroleum and natural gas) will occupy a rapidly growing position in the energy supplies of the U.S.S.R. and Eastern Europe. After allowing for trade between these countries, they are at present left with an export surplus to the rest of the world and it seems reasonable to assume that this situation will continue; [1]) the level of supply will nevertheless depend on prospection results and the availability of oilfield and transportation equipment. In addition exports from these countries are covered by bilateral agreements and the quantities involved depend strictly upon the trading policy of the purchasing countries. We have therefore worked on the basis that the probable export surplus range will increase substantially in the future.

Two questions arise in the light of the above remarks. The first is whether the physical amounts of crude oil available will suffice to meet the increase in world demand. This will be dealt with in Section 1.

The second problem concerns the cost and price conditions at which this demand could be met. Section 2 will deal with the development of price formation mechanisms and illustrate the doubtful nature of the present system of posted prices and rebates. Since the uncertainties regarding price data prevent us from determining long-term trends, Section 3 will examine objective elements, i.e. costs. The latter will then be used to outline the prospects for heavy fuel oil prices in Europe in Section 4.

[1]) The production outlook in the Soviet Union, based on the potential of her sedimentary deposits, should be 240m. tons per annum in 1965, 350m. in 1970 and a possible 700m. in 1980. No figure can be given at present for China, although the Government is trying to develop domestic oil production in view of the apparently favourable geological conditions.

Section 1 — Amounts involved

Proved recoverable reserves are at present put at 41,000 million tons, [1]) representing nearly forty years' production at *current operating rates.*

These, however, form only part of the total world potential, i.e. the output which can be expected from oilfields already discovered plus those yet to be discovered. A figure of 240,000 million tons has been suggested for the quantities capable of being extracted economically by present methods. although there are those who think that this estimate errs too much on the side of caution. The fact remains that even if these figures are not high enough to enable us to conclude that oil reserves are unlimited, they at least point to the conclusion that from the purely quantitative standpoint and given normal circumstances it should be possible to keep the world supplied without serious difficulty for the next twenty to twenty-five years.

At the same time these figures are a measure of the volume of prospection which must be carried out in the near future. Even if we are content with a stock of proved reserves amounting to only twenty-five years' current production by 1975, it will still be necessary to discover 25—30,000 million tons of fresh reserves by that date. This means that efforts must be concentrated along three lines :

(i) a survey of the extent of recently discovered deposits which have been inadequately surveyed and may therefore be underestimated;

(ii) discovery of new deposits;

(iii) the improvement and application of techniques enabling final recovery to be increased. [2])

In order to gain an objective idea of the present situation and the outlook for the future, these global estimates require to be supplemented by a study of the present geographical distribution of reserves. The breakdown is given in Table 27, which shows the following :

(i) the heavy concentration of reserves in three major areas, namely the U.S.A., Venezuela and the Middle East, which together contain 88% of world reserves; [3])

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[1]) Including Eastern Europe, the U.S.S.R. and China (accounting in all for slightly under 5,000 million tons).

[2]) Proved reserves in the Middle East are estimated today at about 25,000 million tons, whilst on the basis of deposits discovered so far probable reserves may amount to approximately 40,000 million tons.

[3]) Percentage of total reserves, excluding those in the U.S.S.R., Eastern Europe and China.

(ii) the marked predominance of the Middle East, which has about 67% of the world's proved reserves;

(iii) the low share of Western Europe in the world total, namely less than 1%; [1])

(iv) the as yet slender volume of proved reserves in North Africa, namely less than 3%; [1])

(v) the traditional importance of the U.S.S.R., whose recoverable reserves were estimated at approximately 4,500 million tons at the end of 1960, namely 11% of the world total. [2])

Table 27 — Estimated Present Proved Oil Reserves

	1960 reserves		1960 production		1960 ratio between reserves and production
	'000,000m.t.	%	'000,000m.t.	%	
Middle East	24,570	67.2	259	28.0	95
U.S.A.	4,980	13.7	388	41.9	13
Venezuela	2,650	7.2	148	16.0	18
Indonesia	1,270	3.5	21	2.3	61
Arica (including Egypt)	1,155	3.2	17	1.8	68
North America (excluding U.S.A.)	860	2.4	40	4.3	21
Caribbean and South America (excluding Venezuela)	600	1.6	31	3.4	19
Western Europe	240	0.7	15	1.65	16
Far East (excluding Indonesia)	185	0.5	6	0.65	31
Total	36,510	100.0	925	100.0	40
U.S.S.R. - Eastern bloc	4,500		167		27
Grand total	41,010		1,092		38

Section 2 — Development of price formation mechanisms

A — *Crude oil*

For a long time the U.S.A. was the biggest producer and exporter of oil. This is why American prices were universally recognised for very many years; those of American exporters' competitors aligned themselves on American

[1]) Percentage of total reserves, excluding those in the U.S.S.R., Eastern Europe and China.

[2]) This seems a cautious estimate, but it is difficult to judge the published information in the absence of precise details on discovered deposits and the methods adopted in the U.S.S.R. to estimate reserves, especially as regards the recovery factor.

oil prices at any given point of consumption, irrespective of the production area. This was particularly true of Middle East oil, for which the system adopted until after the second World War meant that f.o.b. prices differed according to destination. At the instigation of the Economic Co-operation Administration the multiple price system was replaced by a single quotation at each loading port. Initially these quotations were calculated so that Middle East crude could compete with that of Venezuela in the United Kingdom. Subsequently the north-east coast of the United States took the place of the Channel ports as the zone of c.i.f. price parity.

The system of posted prices reflected actual market conditions fairly closely for a decade or so, but as soon as the U.S.A. introduced import controls in 1958, the Middle East posted prices plus transatlantic freight became appreciably lower than American domestic prices. These circumstances, combined with the increasing pressure of supply, gradually led to a situation in which some oil was sold on the international market at less than posted prices. This was particularly true of Middle East oil but also applied to Venezuelan and other origins. Under these circumstances there might perhaps have been some justification for a greater reduction in posted prices than actually took place, but governments in the producer countries induced the companies not to alter the posted prices. The level of the latter has become common practice to allow rebates, the extent of which is not fully known.

Generally speaking posted prices are still the rule for internal accounting purposes within the big groups, but since they serve as a basis for the payment of royalties and taxes in producer countries they are subject to political pressure and — at least *a priori* — cannot possibly correspond to the average prices actually charged by producing companies. Individual rebates, on the other hand, only relate to that portion of their crude which the companies sell to independent buyers, and these sales only represent a marginal fraction of the market, which is also subject to pressure from Russian supplies. It is thus impossible to assess the price of crude by simply extrapolating these rebates to the market as a whole, and in any case the rebates vary for each sale.

Lastly, the average price actually charged for crude is no longer a straightforward item because the predominance of vertical integration tends to make it depend on a valuation based on the selling prices of refined products in major consuming areas.

B — *Refined products*

The story here is much the same as with crude. For a long time the principle of parity with American prices at all points prevailed, but again the system was modified as a result of official action : a desire expressed by the British Admiralty during the second World War led to Persian Gulf refineries replacing multiple prices by f.o.b. quotations approximately equalling those of the United States and the Caribbean. Known as the basing point system, this meant that refined product prices in Western Europe were fixed at an ex-Caribbean or ex-Gulf of Mexico import parity, although local circumstances, price controls, special refining industry structures, etc., affected the application of the rule to varying degrees. Generally speaking, however, the product price structure in Western Europe was widely influenced by that of the United States. This method of price-fixing, which continues to be used as a basis for the tariffs published by the major companies, no longer reflects actual conditions on all European markets. This is particularly true of heavy fuel oil, for which rebates are frequent, and since 1958 the actual prices of products on European markets have moved swiftly.

Generally speaking the fall in prices has been less marked with white products (especially gasoline) than with black (heavy fuel oil). This is mainly because the major companies continue to control the gasoline market, whereas competition is much more lively in fuel oil owing to the existence of several independent importers, some of whom buy cheaply, particularly from the U.S.S.R.

Such market behaviour is easily explained by the fact that the establishment of a gasoline distribution network entails a much more complex organisation and much higher capital costs than selling fuel oil.

The fall in prices, by profoundly affecting the competitive structure of the European energy market, has produced varying reactions from the authorities, such as taxation of liquid fuel, restrictions on tariff rebates and compulsory limits on gasoline prices. This has led to considerable differences in taxed prices according to the country of destination, partly as a result of tax discrimination, regulations, trading policies, etc.

The trend in European product prices has provoked a large number of often contradictory analyses. The major surveys centre on price relationships between individual products and are usually based on the idea that it is impossible to allocate costs to individual products because they arise from joint production.

Details on these various points, together with a historical analysis of prices, will be found in the section devoted to prices in Annex 11. [1]

In any event the complexity of the situation means that investigations of future market trends must entail a study of production cost elements at each stage, including prospection and extraction.

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[1] See Annex II, Section IV, to full Community-language edition.

Section 3 — Costs

A — *Crude oil cost elements*

The costs in question are long-term costs, i.e. they include expenditure on prospection, opening-up (or development) and operation and allow for the often considerable time which elapses between the outlay and the extraction and marketing of the crude.

As thus defined, development costs are exceptionally difficult to assess in the case of oil owing to two considerations peculiar to the petroleum industry, namely the uncertainty inherent in prospection and the considerable dispersion of extraction costs resulting from natural conditions. This means that it is impossible to calculate either the cost of replacing proved reserves or that of operating undiscovered deposits except by statistical extrapolation, which is only valid if based on a sufficiently long period of experience covering a wide enough area and enough deposits for significant averages to be worked out. This is why it is usually limited to a study of conditions in the U.S.A., where such extrapolation is not regarded as indicating anything more than a trend.

Everywhere else speculations of this kind are likely to have very unreliable results and for major producing areas outside the U.S.A. it is only possible to give representative information on costs on the basis of deposits *so far discovered*, with any expenditure already incurred on surveying allowed for. These are not therefore development costs in the strict sense of the term, but "present costs". This restricts the value of the figures worked out for areas such as Venezuela or North Africa, although for the Middle East the proved reserves are so enormous that average "present" costs are still valid for at least double and probably treble the output of 1960, i.e. approximately throughout the period under review.

The details given in Annex 11 to full Community-language edition analyse the three main economic elements entering into the price of crude :

(i) local technical extraction costs (including prospection costs);

(ii) royalties and taxes [1]) paid to governments;

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[1]) Royalties and taxes must be considered as costs, except that the tax paid by producer companies in the country of origin may be reduced by concessions.

(iii) a margin varying from time to time and differing from one company to another, and including both profit and provision for overheads which are common to all the activities of the group in question, including compensation for capital losses incurred on prospection campaigns in other areas.

(a) Local technical costs

The average technical extraction costs for crude are about seven times as high in the United States and nearly three times as high in Venezuela as in the Middle East (see Table 28). The latter region today contains the largest oilfields in the world; it covers very wide tracts of territory with deposits in a variety of geological formations, many of which have not been surveyed. In short, it holds more oil than has ever been discovered anywhere else in the world.

Table 28 — Estimated Average Crude Oil Production Costs in Four Major Areas[1])
(current position)

($ m. t.)

Zone	Prospection	Development	Operation	Total excluding royalties
United States	7.00-8.00	9.00-10.00	2.00-3.00	18.00-21.00
Venezuela	1.50-2.00	4.00- 5.50	[2])	5.50- 7.50
Middle East	0.30-0.50	1.50	0.50	2.30- 2.50
Sahara and Libya	2.00	4.00- 5.00	3.00-4.00[3])	9.00-11.00

1) United States, at well;
Venezuela, f.o.b. port of shipment;
Middle East, f.o.b. Persian Gulf;
Sahara and Libya, f.o.b. Mediterranean Coast.

2) Included in development.

3) Including transport to coast.

Table 29 — Approximate c.i.f. Cost of Crude of Varying Origins at Different Ports

($ m. t.)

Destination	Persian Gulf			Sahara			Venezuela		
Origin	A	B	C	A	B	C	A	B	C
Freight rates	1. *Excluding royalties and taxes*								
Scale flat (freight average for 1959-1960)	8.50	10.50	12.00	11.50	13.00	14.50	12.00	11.50	9.50
Scale - 20 (freight average over several years)	7.50	9.00	10.00	11.00	12.50	13.50	11.00	10.50	9.00
Scale - 30 (long-term trend)	7.00	8.50	9.50	11.00	12.00	13.00	10.50	10.00	8.50
	2. *Including current royalties and taxes*								
Scale flat	13.50	15.50	17.00				19.00	18.50[1]	16.50
Scale - 20	12.50	14.00	15.00				18.00	17.50[1]	16.00
Scale - 30	12.00	13.50	14.50				17.50	17.00[1]	15.50

N.B. Destinations A: Genoa.
B: Rotterdam.
C: U.S.N.H. (North-east coast U.S.A.).

1) With average royalty.

(b) Royalties

The term "royalties" is used here in its widest sense and includes not only royalties proper but also profits taxes levied by governments in producer countries.

There are a large number of tax systems in operation throughout the world and in order to assess their effect and the competitive position of each region the mechanisms adopted must be analysed in detail. To take only Venezuela and the Middle East, the main distinctions are as follows :

(i) in Venezuela the royalty is 1/6th and in the Middle East 1/8th of the selling price;

(ii) local profits tax (i.e. including the "margin", the third cost element listed above) is such that, after including royalties, the government ultimately receives more than two thirds of these "local profits" in Venezuela and about half in the Middle East;

(iii) in Venezuela the turnover adopted in the calculations is generally based on actual selling prices, subject to controls and restrictions by the fiscal authorities, whereas in the Middle East calculations are based on posted prices.

Average royalties and taxes today are approximately as follows :

Venezuela, $ 7.00 per metric ton; [1]
Middle East, $ 5.00—6.00 per metric ton according to grade and country.

Obviously this is more often a political than an economic problem, although it does depend on whether supplies are long or short in relation to demand.

(c) Provision for expenses and profit

The third element is made up of various miscellaneous expenses and equalisation charges affecting deposits operated in different countries with different productivity ratings. At the most these equalisation charges are purely and simply to offset losses on unsuccessful prospection campaigns.

Oil companies re-invest most of the apparent profits of their Middle East extraction in a complex of operations. *A priori* it is difficult to assess the exact proportion of actual profit comprised in this item for the reasons set forth above concerning the uncertain cost of replacing reserves. In any event this margin may vary according to both the prospection expenditure of a given company and its financial policy. If, for example, an attempt is made to diversify capacity geographically, the financial resources arising from apparent Middle East profits must be raised. In the immediate future this possibility is counteracted by competition between the companies, which is likely to carry on for some years as long as on a net basis supply exceeds demand. [2]

B — *Freight rates*

Rather than forecasting freight rates the aim is to determine the trend in the cost of shipping oil regularly from overseas production sources to Community ports on the basis of the existence and growth of a tanker fleet consisting of vessels of different sizes and characteristics.

The details given in the Annex to full Community-language edition enable us to assume the following approximate *average* costs in dollars per metric ton:

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[1]) As calculations are based as far as possible on real prices, the actual charge may be appreciably less on tonnages shipped to markets in which Venezuelan crude and products have to be sold at a substantial rebate.

[2]) Our earlier remarks on available quantities show that the surpluses position may persist for some years yet unless serious political disturbances occur.

	Rotterdam		Genoa	
	today	in a few years	today	in a few years
Persian Gulf[1])	6.70	5.00-5.70	5.20	4.00-4.40
Eastern Mediterranean	3.10	about 2.50	1.80	about 1.40
Caribbean	4.40	about 3.20	4.20	about 3.40

1) Assuming approximately constant Suez canal dues.

Assuming that surplus tanker tonnage will have disappeared in a few years' time, the currently well below average spot rates should fluctuate around these average levels in a few years' time.

This gives us the approximate c.i.f. costs in Table 29.

C — *Refining*

Refining costs vary according to the type of crude, the respective proportions of the resulting products and certain requirements as to quality. On straight refining the cost in Europe today is \$ 5.00—6.00 per metric ton of crude.

Since the refining process yields various linked products, cost allocation involves a number of difficult theoretical problems :

(i) working on a short-term basis and assuming constant refinery facilities, a satisfactory allocation of costs is difficult because the marginal costs for each product vary considerably according to the conditions of origin and the processes used in developing production of a particular product, etc.;

(ii) in the long-term, however, increased supply of a product presupposes an extension of refinery facilities, in which case the product in question must normally bear the corresponding charges.

The refining costs attributable to heavy fuel oil will thus include expenditure not only on crude reception, storage and distillation facilities and product storage but also on fuel and miscellaneous handling. These costs at present amount to approximately \$ 1.50 per metric ton. [1])

1) To the costs analysed above must be added overheads and reserve storage costs, making a total of approximately \$ 1.00 per metric ton.

Section 4 — Long-term price trends

On the basis of the above remarks we can now attempt to establish landmarks which will enable us to plot the long-term trend of heavy fuel oil prices in Europe. This can be done in two different ways : firstly by starting with crude oil prices and examining the cost elements throughout the entire production-consumption chain and secondly by analysing North Atlantic market conditions.

A — *Crude price*

To confine ourselves to the Middle East, which accounts for more than 80% of Europe's present supplies, the posted price is about \$ 1.80 per barrel, i.e. about \$ 12.60 per metric ton. Companies grant rebates of up to \$ 0.30 per barrel on these prices to independent buyers, corresponding to an f.o.b. price of \$ 1.50 per barrel or \$ 10.50 per metric ton. [1]) These prices include royalties of about \$ 5.00 per metric ton to governments in the producer countries.

In the long term two main factors may tend to force oil prices upwards :

(i) increased prospecting and operating costs;

(ii) pressure by producer countries to increase their oil income.

Apart from the possible effect of stipulations by producer countries, the trend towards higher prices may nevertheless be counteracted by competition between the oil companies, which may persist as long as supply exceeds demand.

Under these circumstances the most likely assumption is that for some years prices will remain more or less where they are now, i.e. including the rebates allowed on the posted prices.

Looking further ahead and allowing for a reasonable margin of uncertainty, we can assume that they will tend to harden around the present posted level with no rebate.

[1]) This concerns the relatively small proportion of Middle East output sold under fixed-term contracts to non-integrated buyers.

B — *Fuel oil price trend*

The 1975 estimates show that fuel oil consumption is very likely to rise more rapidly than that of gasoline and other refined products. We can imagine that this trend might induce the oil companies to look for a higher profit on fuel oil. Taking a long-term view and ignoring purely temporary factors, fuel oil should, generally speaking, bear the costs represented by the facilities involved in its manufacture if its production is to continue to be justified economically.

Nevertheless the price of fuel oil cannot much exceed that of crude for long, otherwise consumers will start looking for methods of burning crude direct in boilers. The maximum price difference will be the cost of the plant necessary to ensure that consumers' apparatus can operate reliably.

On the basis of the above assumptions on crude prices and freight rates we can thus adopt a fuel oil price of about $17.00—19.00 per metric ton c.i.f. Channel port (f.o.b. crude price $10.50—12.50; freight $5.00; refining $1.50) and $16.00—18.00 c.i.f. Mediterranean port (f.o.b. $10.50—12.50; freight $4.00; refining $1.50).

This result is corroborated by the cost element analysis undertaken above over the entire integrated system from extraction to refining. [1]

C — *The North Atlantic heavy fuel oil market*

Another factor to be borne in mind is the pressure exerted by American coal on energy prices in the huge consumption area constitued by the north-east coast of the U.S.A. This means that Caribbean f.o.b. prices have to be adjusted so that heavy fuel oil from this region can compete on the American market, which is its major outlet.

At the present time the lowest price in New York, Philadelphia, Boston, etc., is $ 2.25—2.30 per barrel, i.e. approximately $ 15.00—16.00 per metric ton, as against a coal price of about $14.00 per metric ton of fuel oil equivalent; [2] the difference signifies that the fuel oil prices incorporate an estimated 10—15% advantage to consumers of using the latter product. This c.i.f. Atlantic coast U.S.A. price corresponds to the present Caribbean posted price of $2.00 per barrel, equivalent to $13.30 per metric ton.

Another point is that the distance between American coal shipment ports and Caribbean port refineries on the one hand and Northern Europe on the

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1) See Annex 11 to full Community-language edition.

2) $ 10.00 per metric ton of steam coal (see Chapter 7).

other are very similar, whereas the cost per calorie of transporting fuel oil is less than that of coal: the long-term (lower limit) Atlantic freight rate for American coal has thus been estimated at about $5.— per metric ton of fuel oil equivalent [1]) as against about $4.40 now and $3.20 ultimately for heavy fuel oil from the Caribbean. This means that the latter would cost $18.00 per metric ton now and $ 17.00 per metric ton ultimately c.i.f. North European ports.

These c.i.f. prices must be compared with the estimate of $13.00—13.50 per metric ton for imported American steam coal (i.e. $17.50—19.00 per metric ton fuel oil equivalent); they constitute a theoretical ceiling for fuel oil prices (excluding discharging and distribution costs) in the Channel-North Sea area, but this is only valid as long as present fuel oil-coal competition conditions persist in the United States. [2])

Generally speaking, therefore, heavy fuel oil from the Caribbean should remain at a premium over American steam coal imported into Europe, all the more so if we bear in mind its advantages to the consumer.

Our analysis therefore points to long-term fuel oil prices tending to lie within the $17.00—19.00 per metric ton range c.i.f. North Sea. [3])

It should be noted that in some markets fuel oil is being currently quoted very much lower, the lowest offers recorded in 1960 and early 1961 being about $12.50 c.i.f. Channel port. These prices, so markedly below the lowest long-term production costs, in point of fact represent the cost per additional ton ex-Middle East shipped at spot rates and do not cover refining costs — in other words, they are surplus-production prices which are not expected to yield normal return upon the capital invested in the whole supply system.

In certain markets prices are nevertheless observed to be hardening; in Northern Europe, as a result of the various factors mentioned above, they have risen to about $14.00 and even $15.00 per metric ton. Obviously, even though they may be expected to remain at this level for a while, there is always the possibility of a further rise, so that it would be absurd to base energy policy on the lowest quotations recorded. The level just indicated, $17.00—19.00 per metric ton, can therefore be adopted as a basis of calculation for Part Four of the report. This price is obviously not a forecast, but represents a number of coherent working hypotheses which aim at allowing as fully as possible for the various uncertainties involved, including the following :

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[1]) See Chapter 7, pp. 80 and 81.

[2]) i.e. as long as the demand for American coal, both in the U.S.A. and for export (particularly to Europe) is covered by supply at present costs.

[3]) Total price, including storage, discharging etc. costs but excluding taxes.

(i) the unforeseen element in oil prospection and the possibility of fresh major discoveries;

(ii) the amount of natural gas which may become available to the European consumer;

(iii) producer countries' efforts to increase their oil income;

(iv) the United States government's oil import policy;

(v) the U.S.S.R.'s policy to expand exports of crude and products;

(vi) the energy policy to be adopted by the Community and the machinery set up to supervise the market;

(vii) lastly, the pace and scope of developments in atomic energy (this factor will become especially important after 1970).

The price we have adopted is a trend price and is noticeably higher than current prices and lower than the level which might develop in the absence of any stabilisation policy. As such it reflects the cost of such a policy whilst at the same time anticipating its success.

Chapter 10

Natural gas

Section 1 — Community deposits

A — *Reserves*

Prospection for hydrocarbons, stimulated by favourable organisational conditions, has intensified in a number of Community countries in an effort to meet increasing demands for energy and to supply consumers with forms of energy which are especially suited to their needs.

This conjunction of circumstances has resulted in the discovery of a number of new deposits, some of very considerable proportions. Table 30 shows the proved reserves situation in the Community countries.

Table 30 — Estimated Proved Natural Gas Reserves[1]) ('000,000,000cu.m.)[2])

Country	Proved reserves[3])	
	Lower estimate	Upper estimate
Germany (Fed. Rep.)	25	42
France	130	255
Italy	105	160
Netherlands	300	400
Community	560	857

1) Excluding production linked to extraction of crude oil.

2) Conversion factor one cu.m. = 1.29 kg. hard-coal equivalent.

3) In view of continual prospecting operations and, still more important, the technical nature of the work involved in determining the workable extent of new deposits, we give two separate sets of figures.

The location of natural gas deposits and pipelines, the only possible means of bulk transport, constitutes a notably inflexible complex which substantially affects the economics of this form of energy. It is therefore worthwhile giving figures for smaller areas than a whole country.

Present known reserves are distributed as follows:

Germany	north 80%; south 20%;
France	100% south-west;
Italy	75% Po valley (north) and 25% south and Sicily;
Netherlands	100% north-east.

The locations and lengths of the pipelines at present in operation depend on national or regional economic objectives which at the same time allow for market requirements, including those of the competing energy market.

We thus find the following:

(i) in *Germany*

the main network is concentrated in the north with less than 1,000 kilometres of pipeline. Alongside this Germany has a huge coke-oven gas network linking the main industrial centres (14,000 kilometres of pipeline);

(ii) *France*

has made a big effort to reach areas situated a long way from deposits and several thousand kilometres of major pipeline now enable 38% of the present production to be marketed in the north-west, 27% in the Lyons-Dijon area, 24% in the Paris region and 11% in the Nantes-Angoulême area;

(iii) in *Italy*

nearly all the 5,000 kilometres or so of pipeline are in the north, in the south and in Sicily; new pipelines are under construction, particularly to Rome and Terni;

(iv) in *the Netherlands*

the extent of the gas network still reflects the situation prior to recent discoveries and some 1,500 kilometres of pipeline are supplemented by approximately the same quantity for piped coke-oven gas.

B — *Production potential*

Since 1953 Community production has more than quadrupled. Owing to the technical benefits which natural gas provides in several major consumption sectors, no difficulties have been found in marketing the quantities which have gradually become available. In 1962 more than one fifth of the Community's total gas production was in the form of natural gas; this represented 70% of the total in Italy, 30% in France, 15% in the Netherlands and 4% in Germany.

Any indication as to production prospects must naturally be based on the anticipated relationship between natural gas prices and those of other forms of energy capable of giving equal service to the consumer.

Whilst recognising that price formation involves a large number of factors, including the relative location of production and consumption points, demand characteristics (nature, volume and dispersion), transport systems and their flexibility etc., it is none the less true that the point of departure remains production costs.

Not only is a substantial proportion of these costs accounted for by prospecting, owing to the uncertainties involved in the latter, but also they often relate to the joint production of gas, oil and sometimes non-hydrocarbon products.

Under these conditions it is often difficult :

(i) to allocate prospecting costs when they cover a much larger area and longer period of time than the specific case in question;

(ii) to make an objective distinction between natural gas and other associated products, which sometimes determine the conditions under which the former is produced.

Consequently the cost of producing gas from a given deposit often primarily reflects direct development and operating costs, to which must be added prospecting costs for replacement of worked-out reserves.

In the light of the foregoing, the figures most commonly put forward in the Community cover a fairly wide range from 0.08 to 0.20 U.S. cents per 1,000 kcal. (The profitability of gas at such varying costs depends directly on the considerations advanced at the beginning of this sub-section.)

On the basis of present reserves we can reasonably assume that minimum production from Community deposits over the period 1960—1975 will be as shown in Table 31 (for 1975 it is advisable to adopt two sets of figures, particularly for the Netherlands).

Table 31 — Natural Gas Production ('000,000,000cu.m.)

Country	1960	1965	1970	1975	
				Low hypothesis	High hypothesis
Germany (Fed. Rep.)	0.7	1.7	2.5	3.0	4.5
Belgium	0.1	0.1	0.1	0.1	0.1
France	3.1	5.5	6.0	7.5	7.5
Italy	6.5	7.5	8.6	10.0	10.0
Netherlands	0.3	2.0	7.0-10.0	12.0	20.0
Community	10.7	16.8	24.2-27.2	32.6	42.1
Do. ('000,000 m. t. H.C.E.)	13.8	21.7	31.9-35.0	42.0	54.3

Section 2 — Possible imports of natural gas

Non-European reserves are very high :

North-Africa (mainly Sahara)	800,000—1,400,000	million	cubic	metres
Iran	1,800,000	„	„	„
Iraq	650,000	„	„	„
Kuwait	900,000	„	„	„
Saudi Arabia	1,300,000	„	„	„

(The U.S.S.R. also has very substantial reserves.)

The regular consumption of these volumes away from production areas mainly depends on an economic solution to the technical problem of transport, because the cost of imported gas to the consumer is largely influenced by transport costs. [1])

On the basis of existing technical data on submarine pipelines, we can estimate that by 1970 the cost to a consumer on the Mediterranean coast may be about $ 2.00 per million kilocalories (i.e. approximately $ 14.00 per metric ton hard-coal equivalent). This represents the price of the natural gas (20—35%) at point of extraction plus the cost of piping from the deposit to the Mediterranean coast of Europe (45—50%) plus storage and distribution charges (about 30%). In more remote areas, e.g. the Ruhr, the cost would be about $ 3.00 (i.e. $ 21.00 per metric ton hard-coal equivalent).

Transport by methane tanker seems more costly and will probably be confined to meeting peak requirements.

The price of natural gas to consumers near the North Sea coast would be approximately $3.20 per million kilocalories ($23.00 per metric ton hard-coal equivalent). [2])

As regards the amount of imported gas which can be marketed throughout Europe, the Economic Commission for Europe has recently given an estimate of some 22,000 million cubic metres with a selling price of about $16.00—17.00 per metric ton hard-coal equivalent. If the price were lower this quantity would rise.

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[1]) Recent studies on the shipment of African gas to Europe refer to an inclusive expenditure of some $ 1,000 million per 12,000 million cubic metres = 15 million metric tons hard-coal equivalent). Financially this amount should be compared with the expenditure of $ 6,000 million per annum which the Robinson report states will be needed to meet Western European energy requirements in the period 1955-1965.

[2]) With a 35,000-ton tanker carrying 25,000 cubic metres thirty times per year from Algeria to Great Britain, making a total of 420 million cubic metres of gas per annum.

On the basis of these hypotheses it seems that the Community can envisage importing from 6,000 to 9,000 million cubic metres (8—12 million metric tons hard-coal equivalent) in 1970 and 15,000—20,000 million cubic metres (20 to 26 million metric tons hard-coal equivalent) in 1975.

In all the amount of natural gas available in the Community would be between 31,000 and 37,000 million cubic metres (40—48 million metric tons hard-coal equivalent) in 1970 and between 48,000 and 62,000 million cubic metres (62—80 million metric tons hard-coal equivalent) in 1975.

Chapter 11

Hydro power and geothermal energy

The amount of electricity generated from water power and geothermal sources [1]) and its relative share in the total electricity resources of each Community country differ considerably according to local orographical, hydrological, economic and other conditions.

The future trend seems to depend on the following factors :

(a) the reserves of water power which can be developed economically on the basis of present constructional techniques are already largely harnessed, particularly in Italy and Germany. In France, however, about 40% of the country's water power remains to be developed (50% if we allow for tidal energy).

(b) From an economic point of view, hydroelectric production must be divided into base-load energy (run-of-river plants) and peak-load energy which deals with regular or occasional load fluctuations, either daily, weekly or seasonal (pumped storage, pondage and reservoir plants). The engineering involved differs in each case.

Such a classification, based on the average producibility for the year, gave the following percentages for 1960 :

1) Geothermal production only exists in Italy where its contribution to national output is minimal. In the present chapter geothermal production is included under hydro power since both are primary forms of energy.

	Germany	France	Italy
1. Base-load energy (run-of-river plants)	83	52	62
2. Peak-load energy (pumped storage, pondage and reservoir plants)	17	48	38

(c) In view of the growing demand for electricity, its fluctuation over a period of time and the need to satisfy it mainly by thermal output from the principal base-load stations (initially conventional, subsequently nuclear), the peak-load output of reservoir and similar plants (pondage and pumped storage plants) will be called upon to play an increasing part unless there are striking developments in the use of high-capacity turbines. This is why we can already discern a tendency to build reservoirs upstream offering the maximum possible storage and to provide them with substantial installed capacity which can go into operating quickly and on a large scale, basically to meet peak loads.

Such developments, by storing summer energy in the form of water for use in the winter, also contribute to the producibility of all the plants downstream.

(d) Peak-load output will go hand in hand with the development of interconnecting networks between individual regions in the same country. Interconnections will also enable hydro-thermal exchange systems to be operated with countries bordering on the Community, particularly Switzerland and Austria and later on Scandinavia. Circumstances may encourage the building of pumped storage plants, of which the Vianden plant in Luxembourg is an example, again for the purpose of load balancing.

Subject to our earlier reservations on the significance of an over-rigid classification of hydro power stations, we can accordingly put forward certain estimates regarding the trend in peak energy between now and 1975.

Share of Peak Energy in Total Hydroelectric Production (%)

	Germany	France	Italy
1960	17	48	38
1975	20/25	55/60	50/60

In view of the foregoing, the production of hydro power and geothermal energy per country is expected to be as shown in Table 32.

Table 32 — Trend in Hydro and Geothermal Electricity Generation

A — Gross output in TWh per country

Country	1950	1955	1960	1965	1970	1975
Germany (Fed. Rep.)	8.6	12.0	13.0	15.0	19.5	21.0
Belgium	—	0.1	0.2	0.3	0.3	0.3
France	16.4	26.0	40.9	43.5	51.0	61/55
Italy	22.7	32.6	48.2	51.0	57.5	63.0
Luxembourg	0	0	0	1.1	1.4	1.4
Netherlands	—	—	—	—	—	0.2
Community	47.7	70.7	102.3	110.9	129.7	146.9-140.9
Do. ('000,000 m. t. H.C.E.)[1]	19.1	28.3	41.0	44.4	51.9	58.8-56.4

B — Percentage in relation to country's total gross electricity output[2]

Country	1950	1955	1960	1965	1970	1975
Germany (Fed. Rep.)	18.7	15.2	11.1	9.1	8.9	6.9
Belgium	0	1.0	1.3	1.5	1.1	0.9
France	47.5	50.5	54.9	40.7	34.5	28.3/25.5
Italy	91.9	85.6	85.8	61.4	48.6	38.9
Luxembourg	0	0	0	37.9	41.2	40.0
Netherlands	—	—	—	—	—	0.5
Community	39.0	36.7	36.5	27.8	23.2	19.2/18.4

C — Detailed geographical distribution in 1960 and 1975

	1960[3]	1975		1960[3]	1975
Germany (Fed. Rep.)			*France*		
1. Schleswig-Holstein (plus Hamburg)	0.2	0.3	1. Paris 2. Paris basin	0.1	0.2
2. Lower Saxony (plus Bremen)	0.3	0.6	3. North	0	—
			4. East	4.6	6.9
3. North Rhine-Westphalia	0.8	0.8	5. West	0.3	0.8
			6. Massif Central	7.4	6.6
4. Hessen	0.3	0.3	7. South-West	7.6	8.9
5. Rhineland-Palatinate	0.2	1.8	8. South-East 9. Mediterranean	21.1	34.6
6. Baden-Württemberg	3.8	6.2			
7. Bavaria	7.4	11.0			
8. Saar	—	—			
9. Total	13.0	21.0	10. Total	41.1	58.0
Italy					
1. Northern Italy	34.9	46.1			
2. Central Italy	5.4	9.2			
3. Southern Italy	5.2	7.0			
4. Sicily and Sardinia	0.6	0.7			
5. Italy as a whole	46.1	63.0			

1) Coefficient of conversion: 1 kWh = 0.4 kg. hard-coal equivalent.
2) Based on the electricity demand estimated in Chapter 3.
3) Year of very high runoff.

These tables call for the following remarks :

(i) in all the hydro-power-producing countries, the share of hydro-electric energy in the total supply is a falling one;

(ii) the data for 1950, 1955 and 1960 refer to actual production, 1960 being a year of very high runoff; [1]) those for 1965, 1970 and 1975 have been estimated on an average runoff basis. In this connection it should be noted that at present the possible divergence of hydro output from the average figures in the case of an exceptionally wet or dry year is about ±12,000 million kWh. This figure will increase in proportion to the increase in average producibility;

(iii) as regards France, the range given for 1975 is mainly due to uncertainties regarding the extent to which nuclear power stations will be built. If the nuclear programme goes ahead as planned, hydro producibility would drop by about 6 TWh and would thus be concentrated on meeting peak demand.

In order to assess its competitiveness with other primary sources of energy more accurately, the hydro power produced in each country acquires increased significance when broken down, even if only roughly, according to its geographical location at present and as forecast for 1975 (see Table 32 C).

In connection with our earlier remarks on interchanges with countries producing hydro power outside the Community, it should be noted that although exchanges generally balance out in the case of Belgium, France, Italy and the Netherlands this is not so of Germany and Luxembourg, which show the following import balances :

Import balances in TWh

	1950	1955	1960	1965	1970	1975
Germany (Fed. Rep.)	0.9	1.2	4.0	4.0	5.0	5.0
Luxembourg	—	—	—	0.6	0.9	1.4

Whereas the German balance is mainly of hydro power, that of Luxembourg is thermal and is largely directed towards the Vianden pumped storage plant.

[1]) According to U.C.P.T.E., the producibility factor in the three hydro-power-producing countries in the Community was a follows for 1950, 1955 and 1960:

	Germany	France	Italy
1950	1.01	0.92	0.95
1955	1.10	0.96	0.98
1960	1.05	1	1.36

The production trends indicated above are the most likely today if we assume a price of about \$13.00 per metric ton hard-coal equivalent c.i.f. Rotterdam and \$12.00 c.i.f. Genoa. A slightly higher price might accentuate the trend, but the level would still be susbstantially the same in 1975, whereas a slightly lower price would probably result in the transfer of some base-load energy to peak-load energy and here again the 1970 and 1975 levels would be substantially as forecast.

Chapter 12

Nuclear energy

The building of nuclear power stations involves writing off large capital sums over long periods. Decisions to build are therefore linked to medium and long-term energy economy prospects. The alternatives offered by the Community's energy policy would thus have considerable repercussions on the future of nuclear energy in the six countries.

It is also clear that nuclear energy possibilities in future years will constitute a determining factor in formulating an energy policy for the Community. In this respect we need only mention the effect which the generation of cheap nuclear electricity will have on price trends in competing forms of primary energy, particularly oil.

In order to gain some idea of the significance and extent of these mutual influences, we shall examine in turn the development of production costs as a factor in determining the use of nuclear energy for generating purposes, the most likely production outlook as foreseeable today and the contribution which nuclear energy can make to the security of energy supplies in the Community.

Section 1 — Trend in generating costs

The trend in competitiveness between nuclear and conventional thermal electricity will ultimately depend not only on demand (level and shape of load curve) but also on the conditions under which conventional energy is supplied on general industrial and financial conditions and on technical progress. These factors, particularly the first three, will interact to introduce a geographical dimension, in that the same degree of competitiveness will not be achieved on the same date in all areas in the Community.

A comparison between the generating costs of competing forms of energy is not the only factor involved, although in our present state of knowledge it constitutes the most useful means of assessing the prospects of nuclear energy.

A — *Generating costs*

The generating costs of thermal electricity, whether conventional or nuclear, basically consist of the following three items :

(i) fixed overheads;

(ii) fuel cycle costs;

(iii) operating and maintenance costs.

The limited experience at present available mainly relates to three "families" of reactors which can be regarded as having proved themselves industrially, namely the pressurised-water reactor, the boiling-water reactor and the gas-graphite reactor, the first two of which use slightly enriched uranium and the third natural uranium.

The following details on the present generating costs of nuclear energy and their probable trend in the future are mainly based on existing information on power stations either under construction or in the planning stage (see Table 35a in Section 2 of this chapter). These have been obtained from the operators or manufacturers as regards Community power stations, from the publications of the U.S. Atomic Energy Commission for American stations and from the United Kingdom Atomic Energy Authority for British stations. The installation costs relate to stations supplied ready for use and the fuel cycle costs to contracts entailing guaranteed supplies, burn-up and fuel element life.

The manufacturers' and operators' calculations are nevertheless based on data which may differ, sometimes considerably. Interest rates in the electricity sector, for instance, vary from 5.5% to 7% and taxes are between 0% and 5% per annum on the capital invested. In addition the depreciation periods are fifteen years in the Netherlands, seventeen years in the Federal Republic and between twenty and twenty five years in the other countries, the differences being due to tax requirements.

The various departments of Euratom have endeavoured to work out co-ordinated figures from the information available for various reactors in course of construction or in the planning stage.

Owing to the diversity of interest rates and depreciation periods, the generating cost per kilowatt-hour has been worked out for three different annual fixed overhead rates, namely 8.6%, 10% and 13%. These figures are based on a probable nuclear power station life of 20 years, which corresponds to the minimum life universally recognised.

As regards annual loads, it is reasonable to assume that nuclear power stations will be used to meet the base of the load curve. Calculations have accordingly been worked out for two hypotheses of 6,000 and 7,000 hours' annual load.

The cost of generating electricity at a nuclear station of current design not destined to enter service until 1965—1967 owing to the length of the building period is as follows :

(i) enriched uranium (light water, boiling or pressurised) :

installation cost	:	\$200—250 per kWe
fuel cycle costs [1])	:	2.4—3.5 mills per kWh
operating and maintenance costs	:	\$5.00—8.00 per kWe installed

(ii) natural uranium (gas-graphite) :

installation costs	:	\$250—280 per kWe
fuel cycle costs [2])	:	2.1—2.5 mills per kWh
operating and maintenance costs	:	\$4.00—7.00 per kWe installed

The prospects for nuclear power stations with a unit capacity of at least 400 MWe entering service about 1968—1970 are as follows :

(i) enriched uranium and light water :
installation costs may drop to \$175 per kWe [2]) and fuel cycle costs to 2 mills per kWh or less;

(ii) natural uranium :
gas-graphite reactors are still capable of considerable improvement technologically and this should enable installation costs to be brought down to below \$250 per kWe and fuel cycle costs of between 1.6 and 2 mills per kWh to be achieved.

The generating costs of stations entering service about 1968—1970 would thus seem to be roughly the same for the different families of reactors.

It should be pointed out that these prospects are somewhat less optimistic than those given by the U.S. Atomic Energy Commission in its declaration of

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[1]) This allows for the price at which the U. S. Atomic Energy Commission buys back plutonium, i.e. \$ 9.50 per gram of plutonium metal for 1966 and \$ 8.00 per gram for 1970. A certain amount of recoverable plutonium is produced when uranium is burned in a reactor.

[2]) This hypothesis is justified by the tendency on both sides of the Atlantic to increase unit sizes at both conventional and nuclear power stations.

June 25, 1962, according to which installation costs of $170 and $135 per kWe and fuel cycle costs of 1.8 and 1.5—1.7 mills per kWh could be expected for 600 MWe stations in 1966 and 1970 respectively.

If we now supplement the above information for the periods 1965—1967 and 1968—1970 with co-ordinated generating costs for the best power station of each type placed in service in 1962 or expected to commission in 1963, we obtain the figures given in the following table.

Table 33 — Estimated Nuclear Energy Generating Costs (mills/kWh)

	Annual fixed charges as percentage of capital invested					
	8.6 %		10 %		13 %	
Annual load hours	6000	7000	6000	7000	6000	7000
Date of entry into service						
1962-1963						
enriched U	9.1	8.3	9.8	8.9	11.3	10.2
natural U	8.7	7.8	9.5	8.5	11.3	10.2
1965-1967						
enriched U	6.8	6.2	7.4	6.7	8.7	7.8
natural U	6.7	6.1	7.4	6.7	8.8	7.9
1968-1970	5.5	5.0	6.0	5.4	7.0	6.3

B — *Competitiveness with conventional thermal power stations*

The competitiveness of nuclear power stations has been estimated by comparison with a conventional thermal power station having the following costs :

(i) installation costs are $150 per kWe for stations commissioning in 1962—1963, $140 for those entering service in 1965—1967 and $125 for those commissioning subsequently [1]);

1) The following should be noted regarding these figures :

(i) they apply solely to coal-fired stations; the unit installation cost of fuel oil stations is somewhat lower and that of dual fired stations somewhat higher;

(ii) they include the cost of the coal-yard and handling installations (but not of coal stocks) and of ash extraction and disposal equipment;

(iii) they are based on net kWe;

(iv) they include interest during the construction period;

(v) they relate to new stations on virgin land and not to extensions to existing power stations.

Apart from (i) these conditions correspond most closely to those adopted in determining the present and future installation costs of nuclear power stations.

(ii) the following specific fuel consumptions have been assumed :

1962—1963 : 2,350 kcal/kWh, i. e. 335 g H.C.E. [1])/kWh net;
1965—1967 : 2,200 kcal/kWh, i. e. 315 g H.C.E./kWh net;
1968—1970 : 2,100 kcal/kWh, i. e. 300 g H.C.E./kWh net;

(iii) operating and maintenance costs are estimated at $5.00 per kWe per annum in the first two periods and $4.00 for the end of the present decade.

We can now estimate the price level per metric ton of hard coal equivalent to 7,000 kcal/kg delivered to a coal-fired power station and enabling the latter to generate electricity at the same price as the nuclear stations examined above.

Table 34 — Fuel Price Ensuring Equivalence between a Thermal and a Nuclear Power Station on Different Dates and under Different Conditions ($/m.t. H.C.E. to 7,000 kcal/kg)

	Fixed annual charges as percentage of capital invested					
	8.6 %		10 %		13 %	
Annual load hours	6000	7000	6000	7000	6000	7000
Date of entry into service						
1962-1963						
enriched U	18.80	17.60	19.40	18.10	21.60	20.00
natural U	17.40	16.00	18.40	16.80	21.40	19.40
1965-1967						
enriched U	13.10	12.30	13.50	12.60	15.20	14.10
natural U	12.90	12.10	13.50	12.60	15.80	14.50
1968-1970	10.70	10.10	10.80	10.20	12.10	11.30

The above figures obviously entail some margin of uncertainty, but they are reasonably likely indications of the rate of diminution in nuclear station generating costs.

It should also be noted that they imply no revolution in processes and that they err on the side of caution, since a nuclear power station life of twenty years may now be thought a somewhat low estimate.

[1]) H.C.E. : hard-coal equivalent to 7,000 kcal/kg.

Assuming a coal fuel reference price of $13.00 per metric ton hard-coal equivalent, therefore, in line with the results adopted as a hypothesis in earlier chapters, [1]) nuclear power stations may be expected to become competitive in many parts of the Community between 1965 and 1967 and throughout the Community by 1968—1970 with 6,000 load hours and over per annum.

Since generating costs will continue to fall after that, nuclear stations may even become competitive at less than 6,000 load hours per annum, which means that their use will tend to extend accordingly.

Thus from 1970 or so onwards there will no longer be any reason, from the point of view of generating costs, why nuclear energy should not be used on an increasing scale; the main limiting factor will be the difficulty of installing further capacity at an economically desirable speed. Reliable sources generally take the view that for a large number of technical and industrial reasons it will be difficult to more than double the annual capacity installed every three years.

For several years now the Euratom Commission, in conjunction with interested circles, has been endeavouring to overcome this obstacle as far as possible and to lay the foundation for the rapid development of nuclear energy in the future.

Section 2 — Production outlook

On December 31, 1961, the net electrical capacity of nuclear power stations in service was 73 MWe. The commissioning of new plants and increased capacity at existing plants will raise this figure to 175 MWe by the end of the present year and subsequently to over 700 MWe by the end of 1963 and more than 1000 MWe by the end of 1964. In 1965 production could amount to 6,500 million kWh. In addition, stations representing a capacity of at least 1,500 MWe are at present under construction or in the planning stage and will be commissioned between 1965 and 1967 (see Table 35a).

From then onwards production is obviously uncertain; the figures quoted below are taken mainly from publications or statements made by senior representatives of national and international bodies or by these bodies themselves. The range of possibilities as to production in 1970 is comparatively

[1]) Imported American steam coal, $ 13.00; fuel oil, $ 17.00-19.00 per metric ton.

narrow — somewhere between 20 and 25 TWh for the Community overall. For 1975 the uncertainty is much greater, of course; a rough estimate suggests between 60 and 100 TWh, although it should be noted that these figures are considerably below those given in a recent UNIPEDE study which suggested an installed capacity of between 11,000 and 26,000 MWe, corresponding to an output of between 65 and 150 TWh.

In terms of installed capacity, the above figures correspond to about 10,000 and 16,000 MWe for 1975. It will be seen that a reasonable extrapolation of these figures up to 1980, based on the hypothesis of doubled nuclear capacity every three years (or treble every five years), would produce estimates substantially agreeing with the prospective figure of 40,000 MWe for 1980 quoted by the Euratom Commission in its third annual report.

Data for individual countries are given in the following table. Fairly broad estimates have been made for countries whose intentions are as yet unknown, but the small quantities involved are not likely to have any great effect on Community totals.

Table 35 — Outlook for Nuclear Electricity Generation (TWh)

Country	1960	1965	1970[1]	1975[1]
Germany (Fed. Rep.)	—	0.2	4-6	19-30
Belgium	—	0.1	0.5	1-5
France	0.1	2.5	10-12	19-30
Italy	—	—	6-8	20-30
Netherlands	—	3.7	0.3	1-5
Community	0.1	6.5	20-25	60-100

[1] Uncertainties make it necessary to give two sets of figures.

As regards regional distribution, we can assume that nuclear power stations will mainly be built in areas which hitherto have had no local source of energy but which are reasonably close to consumption centres and can easily be connected to the interconnecting network.

Table 35a — Nuclear Power Stations completed (C), planned (P) decided on (D) or begun (B) in Community Countries by October 1, 1962

Location and description	Country	Net capacity (MWe)	Type	Critical date	State of progress
Mol. - Br. 3	Belgium	10.5	Pressurised water	30. 8.62	B
Kahl (Main) - Vak	Fed. Rep.	15	Boiling water	13.11.60	C
Jülich - Avr	Fed. Rep.	15	High temperature	1963	B
Karlsruhe - Mzfr (Multipurpose experimental reactor)	Fed. Rep.	50	Nat. U-heavy water	1965	B
Grundremmingen (Donau) Krb (RWE-Bayernwerk)	Fed. Rep.	237	Boiling water	end 1965	D
Obrigheim - Kbwp (Baden-Württemberg)	Fed. Rep.	150	Organic moderator	1967	P
Chooz (Ardennes) Sena (Soc. énerg. nucl. des Ardennes)	France Belgium	210-242	Pressurised water	end 1965	B
Marcoule (Gard)	France				
G. 1		5	Graphite-gas	7. 1.56	C
G. 2.		37	Graphite-gas	21. 6.58	C
G. 3		37	Graphite-gas	11. 6.59	C
Chinon (Indre-et-Loire)	France				
EDF 1		70	Graphite-gas	16. 9.62	B
EDF 2		170-190	Graphite-gas	1963	B
EDF 3		375-480	Graphite-gas	1965	B
St-Laurent-des-Eaux (Loir-et-Cher)	France				
EDF 4		400-500	Graphite-gas	1967	D
Brennilis (Brittany)	France				
EL 4		80	Nat. U-heavy water	1964	B
Garigliano (Campania) Senn (Soc. Elettronucleare Nazionale)	Italy	150-230	Boiling water	1963	B
Latina (Latium) Simea (Soc. Ital. Merid. Energia Atomica)	Italy	200	Graphite-gas	1963	B
Trino Vercellese (Lombardy) Selni (Soc. Elettronucleare Ital.)	Italy	257	Pressurised water	1964	B
GKN (Gelderland) (Gemeensch. Kernenergiecentrale Nederland)	Netherlands	50	Boiling water	1967	P

Section 3 — The contribution of nuclear energy to the Community's security of supply

As we shall see in Chapter 17, the volume of imports necessary to meet energy demands from 1970 onwards endows the question of security of supply with a particular importance and makes it necessary to forecast the extent to which the development of nuclear energy is capable of making an increasing contribution towards meeting demand.

The extent of this contribution depends on nuclear fuel supply conditions and the ease with which the products involved can be stored.

A — *Nuclear fuel supplies*

Nuclear energy suffers from no supply problem, because the market is more than abundantly supplied and is also backed up by strategic stocks.

Proved reserves of uranium workable at a price of $8—10 per lb. of U_3O_8 in the form of concentrates represent about 600,000 metric tons of uranium metal content. They are mainly located in three continents, namely Canada, the U.S.A. and South Africa, and to a lesser extent in Australia; this constitutes a favourable geographical distribution amongst politically stable countries in the free world.

As regards the Community in particular, production is steady and is even slightly increasing, despite the fact that extraction and concentration costs are higher there than in some other parts of the free world.

The prices quoted above are those generally adopted in calculating electricity generating costs, although the influence of the price of uranium concentrate on the generating cost per kilowatt-hour of nuclear energy is low (e.g. $\pm$ 0.4 mills per kWh for present types of reactors, i.e. about 5% of the generating cost). This means that a price increase enabling more substantial reserves to be worked than those mentioned above would only slightly raise the cost per kilowatt-hour and in any case to lesser extent than reductions arising from possible future improvements as referred to below.

As regards enriched uranium, although the Community has no enrichment plant and in practice the U.S.A. has a sales monopoly, agreement has been reached on supplying the Community and other countries in the free world under existing bilateral agreements, whereby the same terms are available to foreign as to American reactors. The U.S. Atomic Energy Commission is also prepared to conclude long-term supply contracts.

It should also be pointed out that existing American enrichment plants have sufficient production capacity to maintain normal supplies to enriched-uranium power reactors totalling 40,000 MWe, and the forecasts show that the entire free world will only reach this level with all types of reactors in the early part of the next decade.

According to a report in *Forum Memo* for December 1959, a new isotope separation plant to be built in the U.S.A. would have been capable of covering production costs at the selling price then charged. Since recent price cuts are based on reductions in the purchasing price of natural uranium and enrichment costs, this remark must still be true today.

Despite this we must not, when investigating the various aspects of an energy policy which is intended to guarantee security of supply to the Community, fail to consider steps capable of enabling nuclear energy to make an increasing contribution to such security.

We should be especially aware of the need to conclude long-term uranium purchasing contracts at advantageous prices outside the Community, to build up stocks of nuclear fuel, to encourage prospection in the Community and perhaps in a number of third countries and lastly to stimulate research into improvements in uranium extraction and concentration processes, and eventually thorium ores, in order to gain access to substantial reserves which are not workable at present prices.

Security will also be helped by research into improved operation of known types of reactors and by the development of more efficient versions. Increased thermodynamic efficiency in power reactors will produce more energy from known uranium reserves. In addition plutonium re-cycling, the use of plutonium in fast reactors, particularly breeder reactors, and the use of thorium and stocks of spent uranium should lead to a very considerable multiplication of reserves and of their potential energy content.

Progress would thus be along the following lines :

(i) about 50% of the fissile energy in natural uranium would be utilized, as against less than 1% at present;

(ii) spent uranium, of which unworkable stocks at present exist in abundance, would be re-utilized;

(iii) thorium reserves, which are more abundant and more widespread than those of uranium, would be developed;

(iv) the already low influence of fissile material prices on generating costs would be reduced, thus increasing workable reserves without raising these costs.

The conclusion can thus be drawn that under these circumstances nuclear plants could count on virtually unlimited supplies.

B — *Storage*

The storage of nuclear fuel can also contribute to security of supply. We have therefore endeavoured to determine the effect on generating costs of building up adequate stocks to ensure one year's operation of conventional or nuclear stations.

In doing so we have allowed for the financial and maintenance charges on the special installations required (coalyard, storage tanks or fuel depot), interest and taxes, together estimated at 9% of the value of the stored fuel, handling costs, withdrawal costs and loss of value due to storage. The last three items only apply to coal and are negligible in other cases. We have also assumed that fuel stocks are financed out of the station's own resources; this also applies to enriched-uranium stations where fuel is at present hired.

We thus arrive at the following estimates :

Storage point	Coal-fired power stations	Fuel-oil-fired power stations	Nuclear power stations	
			Natural U	Enriched U
	Pit	Lower station	Fuel element plants	
Basic price of fuel (in dollars)	$14.00 per metric ton	$20.00 per metric ton	$8.00 per lb.	Present tariff according to degree of enrichment
Increase in cost of coal and fuel oil due to storage (in dollars per metric ton)	3.00-3.50	3.00-3.50	—	—
Increase in cost of electricity (in mills per kWh)	1.00	1.00	0.10	0.20

The comparison shows that under the conditions referred to above the storage of fuel for one years' operation is between five and ten times dearer for conventional than for nuclear stations, without allowing for the fact that in any case nuclear reactors have more than one year's reserve represented by their fuel charge.

C — *Conclusions*

The foregoing details show that nuclear energy generation meets the highest possible security of supply requirements :

(i) present and future reserves of natural uranium in politically stable countries are sufficient to ensure supplies for an extensive reactor programme;

(ii) enriched uranium reactors obtain their fuel supplies from the U.S. Atomic Energy Commission, which under its present supply policy is prepared to conclude long-term contracts. In addition enrichment plants are capable of meeting the long-term forecast demand for enriched uranium;

(iii) to store nuclear fuel for one year's operation costs one third or one quarter of the expense of storing fuel for conventional stations;

(iv) in view of anticipated technical progress, nuclear energy will eventually constitute a virtually inexhaustible source offering a high degree of security. Its contribution to the Community's security of energy supplies will therefore be capable of measuring up to the use made of it.

The formulation of principles for a common supply policy for fossil and fissile material would obviously help to improve medium and long-term security of supply even further.

Part Four

The Supply and Demand Position in 1970

The object of Part Four is to see how the overall demand for energy, as assessed in Part Two, can be met from the various primary energy sources under the supply conditions described in Part Three.

The guiding principal is that this breakdown should be made on the basis of comparative costs to the consumer in the light of the advantages inherent in each form of energy. [1]) The strict application of this principle would entail examining the position of each class of consumer step by step, with comparable consumers grouped together in each region, but at the present time we cannot hope to undertake such an investigation in full.

We are thus led to carry out a less rigorous procedure involving various stages. Firstly, the present state of technology and its probable development means that even in ten to fifteen years time some energy requirements will only be met by specific products, for instance coke for blast furnaces and motor fuel for road, rail and inland waterway transport; this also applies to energy producers' own consumption.

Secondly, some items will find a readier market than others owing to inevitability or cheapness — the former including blast furnace and coke-oven gas and the latter hydro power, brown coal and natural gas from deposits already discovered.

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[1]) It seems superfluous to recall that we are in no way attempting to plan an energy breakdown pattern but merely to determine the shape this pattern is likely to take in an economy characterised by free consumer choice.

The remainder of the demand will be met by various fuels according to their relative cost to the consumer, although the advantages inherent in some types will lead certain consumers to use those forms only as long as the relative prices continue to lie within the probable range suggested by earlier chapters.

A close investigation of all these factors, as attempted in Chapter 13, enables us to considerably narrow down the portion of the demand for which two or more products will actually compete. The breakdown of this demand amongst the various products entails more detailed analyses at regional level; this will occupy Chapters 14 and 15, in which several alternatives will be examined for different imported energy prices at varying levels of assistance for Community coal.

In due course we shall thus arrive at an overall energy position for the Community.

Chapter 13

Specific, sure-market and sectors of competition

We shall deal first with specific demand, secondly with products which have a sure market owing to their cheapness and lastly with coverage of the remaining demand, thus enabling us to estimate the extent of the area of competition in energy products and the sphere of influence of an energy policy.

Section 1 — Specific demand

This category contains blast furnace coke, motor fuel and energy producers' own consumption.

A — *Blast furnace coke*

Energy consumption in the iron and steel industry at present consists of about two thirds coke, the remainder being accounted for by heating fuels for furnaces and rolling mills and by electricity.

As noted above, the estimated coke consumption is based on the pig iron production forecast and on probable developments in processes. Blast furnace requirements are expected to be 53 million metric tons in 1970 and 58 in 1975, as against 48 in 1960. [1]

By adding on the forecasts for the use of dust in sintering plants and other uses of coke in iron and steel production, we can give a final estimate of 61 million metric tons in 1970 and 66 million in 1975 for total coke consumption by the iron and steel industry.

On the basis of employing the latest processes in coking plants, some 92 million metric tons of coking coal need to be burnt to produce 61 million metric tons of coke suitable for iron and steel production, the comparable figure for 1975 being 98 million metric tons.

B — *Motor fuel*

The total motor fuel demand for road, air, rail and inland waterway transport and agricultural machinery is expected to be 65 million metric tons in 1970, i.e. 95 million metric tons hard-coal equivalent and 126 million metric tons hard-coal equivalent in 1975.

C — *Energy producers' and converters' own consumption*

This demand can be considered as more or less specific, with a few minor exceptions.

The exact amount cannot be determined until the general breakdown of demand into various forms of energy is known, although we can suggest a figure of approximately 50 million metric tons hard-coal equivalent in 1970.

D — *Summary*

One or two other specific demands must be added to the above figures, including coal for cement works and the coal chemicals industry and oil products for petrochemicals. These quatities are very difficult to estimate, and since the size of the genuinely specific demand is probably small in relation to total energy requirements we propose to ignore it.

Table 36 now summarises specific energy requirements, which are expected to account for about one third of the total demand. This figure will remain fairly constant, since the sharp rise in motor fuel requirements will offset the very slight increase in demand for coking coal in the iron and steel industry.

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[1] It was found in Chapter 3 that the 1975 figure could be reduced by 10-15% if natural gas reduction processes developed quickly.

Table 36 — Specific Energy Requirements ('000,000m.t. H.C.E.)

	1960	1965	1970	1975
Coking coal to meet iron and steel industry coke demand	76[1]	82	92	98
Motor fuel	44	70	95	126
Energy producers' and converters' own consumption	43	47	51	58
Total specific demand	163	199	238	282

1) This figure only includes coking coal for the iron and steel industry and is thus lower than the total coking plant output for 1960.

Section 2 — Sure-market products

Two types of output may be regarded as having a certain market :

(i) primary products whose cost is obviously competitive;

(ii) secondary products associated with production for specific demand.

A — *Sure-market primary products*

These are items which will certainly be competitive because their production costs are low owing either to geological conditions or to the fact that expenditure has already been incurred (for instance on dam building or discovering oil and natural gas deposits) and future production costs are thus fairly low.

The items concerned are brown coal, hydro power and the natural gas and crude oil already discovered in the Community, plus the amount of nuclear energy disclosed by the minimum forecasts.

On the basis of our earlier conclusions as to the trend in supply, we can estimate these figures as shown in Table 37. The output involved would meet about 20% of the total demand for energy.

Allowing for present projects, about 60% of the brown coal would be burnt in thermal power stations and the rest divided between the domestic sector and industry.

Initially, natural gas will supply markets in which its use offers substantial specific advantages (e.g. controlled atmosphere heat treatment, glass works, ceramics, chemicals and the domestic sector). These at present represent about

60% of the total consumption of natural gas, but the need to utilise pipelines to a fuller extent will entail the acquisition of more competitive markets in which natural gas will find its place commercially (e.g. intermittent contracts), tariff-wise (two-part tariffs) and technically (peak demand plant and underground storage).

B — *Sure-market secondary products*

Gas is a by-product of both coke production and blast furnace operations (in the latter case its volume per ton of pig iron and calorific power decrease owing to the drop in the coke rate). [1])

In addition a certain amount of fuel oil is bound to arise from motor fuel production, although we have already reached the stage where European refinery operation is not directed, as in the United States, to maximum output of motor fuel; under the American pattern the 1975 output of fuel oil would be lower than the Community's present consumption. Owing to the anticipated increase in fuel requirements, there is no doubt that the minimum liquid fuel output associated with motor fuel production which is imposed by technical conditions would have no difficulty in finding a market, even allowing for the substantial part to be played by natural gas. [2])

Table 37 — Sure-Market Products ('000,000m.t. H.C.E.)

	1960	1965	1970	1975
Primary products				
Brown coal	29	30	32	34
Hydro and geothermal power[1])	43	46	54	60
Community natural gas	14	22	33	42-54
Community oil	17	18	19	20
Nuclear electricity	—	2	8	24-36
Total	103	118	146	180-204
Secondary products				
Coke-oven gas	23	23	24	25
Blast furnace gas	26	24	24	25
Refinery fuel oil and gas	for record only			

1) Including net imports.

[1]) See Annex 3 to full Community-language edition : The energy requirements of the iron and steel industry.

[2]) Care must be taken to avoid duplicating certain items when adding sure-market output to specific demand. Amongst primary products, Community oil is used to produce motor fuel (approximately 4 million metric tons hard-coal equivalent in 1970) and amongst secondary products coke-oven gas is already included under coking coal.

Section 3 — Remainder of demand

Specific demand and sure-market products represent somewhat over half the total demand. The remainder consists solely of fuel requirements and can be met by coal or fuel oil or by nuclear generation in excess of the minimum figures suggested above.

The part to be played by each of these various sources of energy mainly depends on two types of factor : the comparative cost of the fuel (and of the corresponding plant) required to obtain the same degree of efficiency, and various supplementary factors such as flexibility, ease of handling, purity, etc.

These can be no sudden transition, however, from the present situation to another balanced situation determined by the above factors, because the trend is retarded by inertia, including the need to retain existing installations which, if fairly modern, cannot be scrapped without considerable expenditure and which in any case could not all be renewed simultaneously. Apart from these technical factors, purchasers' habits and views on safety, as well as the fairly close financial links between energy producers and consumers, have to be reckoned with. The influence of these financial links must not be over-estimated, although they will probably be quite significant for four or five years' time. In ten or fifteen years' time, on the other hand, the effects will certainly be much less marked and can probably be ignored in our initial approach to the problem. Consequently, our calculations need only allow for the technical rigidity represented by current installations; the effects of the financial links can then be examined on a purely qualitative basis.

This means that the present situation cannot be considered as a balanced one. Even if relative price levels were not to change, certain trends which are already under way would continue, resulting in an alteration in the relative shares of different forms of energy. Some consumers will clearly go over to liquid or gaseous petroleum products without hesitation, which gives us a lower limit for oil product consumption and thus a ceiling for the market available to coal. On the other hand the specific nature of certain requirements and the factors of inertia mentioned above will help to maintain a fair level of coal consumption. The following sub-sections will briefly review the trend in recent years and suggest the limits between which a balanced level may be expected to lie if the ratio of fuel prices per calorie to that of coal remains between 0.8 and 1.2.

In order to determine the extent to which this ratio can vary, we shall now examine the major consumption sectors individually.

A — *Iron and steel industry*

In addition to blast furnace coke and electricity, the iron and steel industry's energy requirements cover heating operations in the furnace itself (injecting of pulverised coal, fuel oil or gas) and in accessory installations (including blast heating) and in steel works and rolling mills (reheating furnaces). These requirements can be met by coal, fuel oil or gas.

Future blast furnace gas output will rise less rapidly than coke consumption owing to the drop in the coke input coefficient.

Allowing for likely technical developments, the above needs suggest a coal consumpiton figure of 3 million metric tons in 1975, the uncertainty involved being perhaps 0.5 million metric tons.

B — *Other industries*

Before passing on to a breakdown of energy consumption between various fuels it is worthwhile briefly reviewing the trend over the last ten years.

Table 38 and Graph IV show the decreasing share of solid fuel during the period 1950—1960, a tendency which was most marked in Italy, the Netherlands and Belgium. In the Federal Republic the trend accelerated rapidly after 1957, whereas France shows a much steadier tendency than the other countries.

Mechanical extrapolation of these curves would give a share of solid fuel in the sector's non-electrical energy not exceeding 20% in 1970 and below 10% in 1975 for the Community as a whole.

Nevertheless we cannot accept the results of this extrapolation just as they stand, partly because the present situation is one of imbalance owing to reactions to relative price fluctuations being influenced by inertia, but mainly because energy consumption in industry shows a non-homogeneous pattern owing to widely differing uses. At this point certain technical aspects must be examined.

A comparison between the relative advantages and disadvantages of various types of fuel must allow for the following technical and economic factors :

Firstly, efficiency often differs from one fuel to another, i.e. the same efficiency is obtained with a different number of calories according to the fuel used.

Then there is the economic aspect : at a given degree of efficiency operating costs and depreciation may vary from one fuel to another or a particular fuel may have special advantages over its competitors by virtue of its flexibility or purity, thus enabling product quality to be improved and manufacturing costs to be reduced.

To pursue the analysis in terms of figures we should need to know the effect of all these factors on various types of industrial operations, as well as a breakdown of total energy consumption according to use. Although only partial information, often difficult to extrapolate, is available on these points, we can nevertheless draw certain conclusions.

Firstly we know that of the two major categories of industrial operation, steam production absorbs about 55% of energy consumption and furnace heating about 35%; the remainder is represented by specific uses, including the supply of raw materials.

The information available on steam production suggests that the calorie price ratio to equate fuel oil and coal is about 1 at major plants, particularly thermal power stations, rising to 1.2 at small and medium-size plants. In the case of furnaces, on the other hand, the ratio appears to exceed 1.2 and in some cases to rise considerably above 1.3.

In the past it seems quite likely — as borne out by existing data — that the change-over from coal to fuel oil (or gas) initially took place in operations with the highest equivalence ratio (furnaces).

There is little to suggest that by 1975 the *breakdown between uses* will be substantially different from what it is now. Despite the fact that chemicals will probably expand quicker than cement and glassware, the effect of this expansion may be largely offset by increased energy economies in the former.

By 1975 it can be estimated that about 80% of furnaces will have turned over to fuel oil or gas, assuming that the calorie price ratio remains between 0.8 and 1.2. Since furnace life is about fifteen to twenty years, the influence of technical inertia factors will be low. Coal should nevertheless retain a market in the lime and cement industries [1]) if the calorie price ratio is sufficiently close to 1.

As regards steam production we must first of all bear in mind that an increasing portion of the chemical industry is becoming integrated with the oil industry and will thus obtain its heat from fuel oil. [2]) Outside this sector coal should retain a substantial share in steam production.

The ceiling to the coal market thus constituted by non-petrochemical steam production and a portion of the furnace requirements in the lime and cement industries would therefore be about half the industrial demand, although this result is only valid in countries in which coal retains more than 50% of the industrial market. If we assume that its present share would be maintained in Italy, Belgium and the Netherlands and that it will be 50% in the other countries, we reach a figure of about 40% for the Community as a whole, i.e. a ceiling of 55 million metric tons in 1975. For 1970 a slightly higher percentage may be envisaged, corresponding to approximately the same tonnage.

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1) In 1955 this branch accounted for 37% of the energy consumed by furnaces in France. Coal's share of this was 84%, whereas it only accounted for 14% in the glass industry.

2) In 1955 chemicals accounted for 27% of the energy consumed by steam production in France. The share of coal in this figure was 71%.

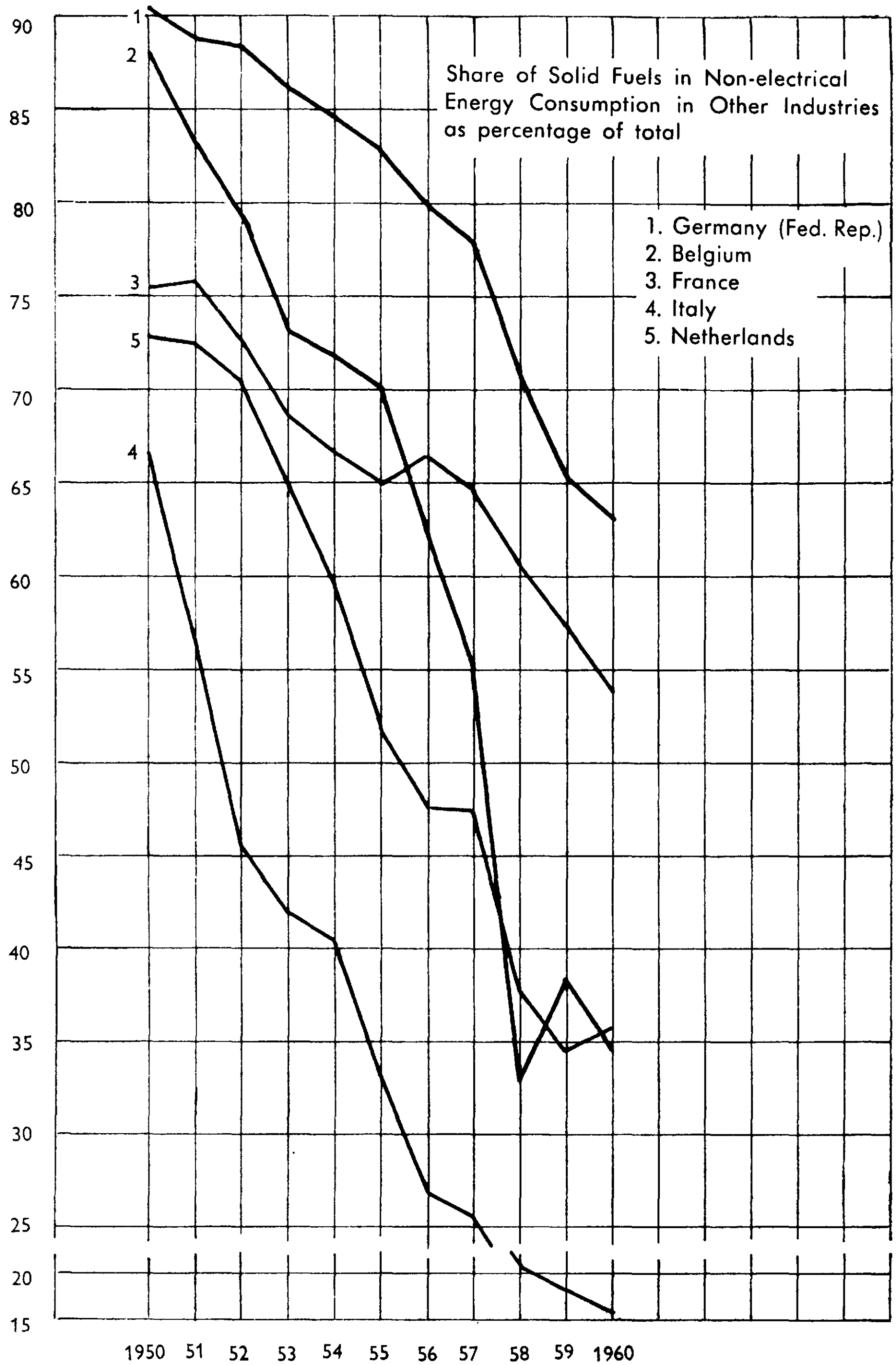
Table 38 — Fuel Consumption Breakdown in Other Industries Sector (%)

Region	Solid fuel	Liquid fuel	Gas	Total
Community				
1950	82	12	6	100
1955	68	20	12	100
1960	48	36	16	100
Germany (Fed. Rep.)				
1950	90	2	8	100
1955	83	5	12	100
1960	63	24	13	100
Belgium				
1950	88	9	3	100
1955	70	24	6	100
1960	34	53	13	100
France				
1950	75	20	5	100
1955	65	30	5	100
1960	54	35	11	100
Italy				
1950	67	26	7	100
1955	33	39	28	100
1960	15	50	35	100
Luxembourg				
1950	100	—	—	100
1955	72	14	14	100
1960	50	38	12	100
Netherlands				
1950	73	17	10	100
1955	52	35	13	100
1960	36	55	9	100

Extrapolation of the trend for the past ten years would give us a figure of about 25 million metric tons. A lower figure may be envisaged on the basis of today's equipment which will still be in use in ten years' time, and in fact the only really guaranteed market is from certain types of vertical integration, particularly the coal chemicals industry.

To sum up, we can provisionally estimate that the consumption of coal and coke in industry in 1970 will be between 20 and 55 million metric tons, that of fuel oil and gas between 65 and 100 million metric tons hard-coal equivalent and that of brown coal 4—5 million metric tons hard-coal equivalent. Gas will be used mainly in furnaces, where its flexibility of operation is particularly appreciated; its consumption will lie at between 25 and 40 million metric tons hard-coal equivalent. There thus remains between 25 and 75 million metric tons hard-coal equivalent for fuel oil.

Graph IV



Share of Solid Fuels in Non-electrical Energy Consumption in Other Industries as percentage of total
1. Germany (Fed. Rep.)
2. Belgium
3. France
4. Italy
5. Netherlands
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
1950
51
52
53
54
55
56
57
58
59
1960

C — *The domestic sector*

During the past decade the fall in the share of *solid fuels* in consumption in this sector was less marked than in industry. Not only did inertia factors probably play a greater part but some consumers continued to prefer the coal-burning stove.

Graph V shows that these factors help to maintain solid fuel at a higher level than in the other industries sector. In addition in countries such as Germany the fall in the solid fuel share only became marked in the second half to the decade. Moreover Italy, in which the share (50%) in 1950 was already well below that of other countries, underwent a development similar to that of Belgium and the Netherlands, where the initial level exceeded 80% in 1950.

It should also be noted that the relative share of gas remained extremely stable.

The future trend will largely be conditioned by the form of new housing (flats or houses) and in the case of the latter by the choice between central heating or stoves. Coal seems to stand the greatest chance of holding its own in big blocks of flats and in homes heated by stoves.

Quantitatively it is difficult, in the absence of information on existing appliances, to do more than extrapolate the past trend and assume a gradual slackening-off in the rate at which the solid fuel share will drop. This gives us a figure of about 60 million metric tons hard-coal equivalent in 1965 and 40 million in 1975, by comparison with 65 million in 1960, for solid fuel. The 1970 limits for the coal and coke markets can be estimated at 45 and 75, plus some million metric tons of brown coal and brown coal briquettes. For gas we can visualise a figure of between 15 and 20 (12—13% of the demand), leaving between 35 and 70 to be covered by oil products (including liquefied petroleum gas).

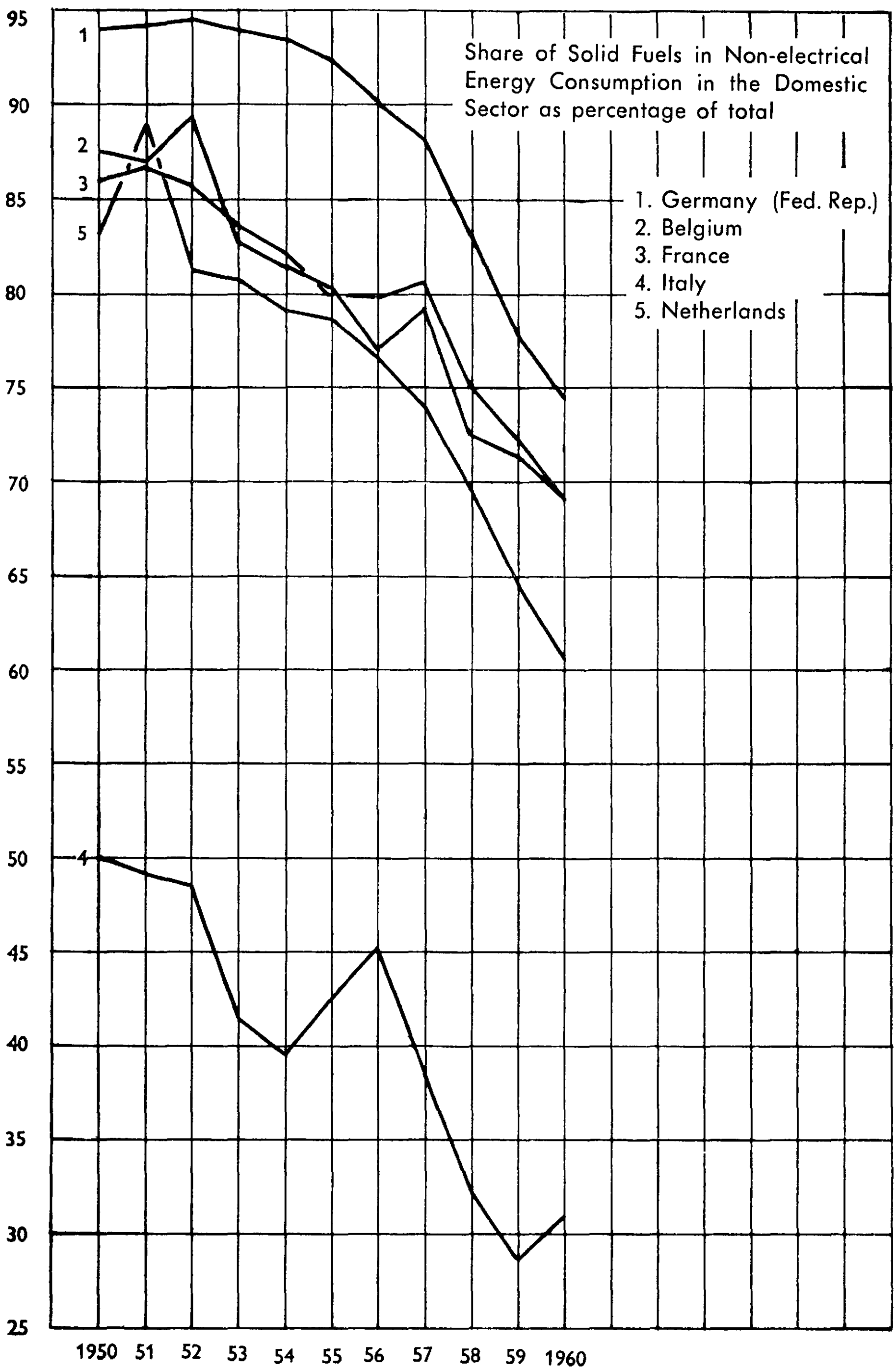
Table 39 — Fuel Consumption Breakdown in Domestic Sector (%)

Region	Solid fuel	Liquid fuel	Gas	Total
Community				
1950	87	7	6	100
1955	83	11	6	100
1960	67	26	7	100
Germany (Fed. Rep.)				
1950	94	1	5	100
1955	92	4	4	100
1960	74	21	5	100
Belgium				
1950	87	9	4	100
1955	80	16	4	100
1960	69	27	4	100
France				
1950	86	7	7	100
1955	80	14	6	100
1960	69	24	7	100
Italy				
1950	50	37	13	100
1955	42	44	14	100
1960	31	54	15	100
Luxembourg				
1950	88	8	4	100
1955	87	10	3	100
1960	72	25	3	100
Netherlands				
1950	83	9	8	100
1955	79	12	9	100
1960	61	29	10	100

D — *Rail transport*

As noted above, far-reaching changes are taking place in rail traction methods for economic reasons. Steam (using coal, brown coal and a very slight amount of fuel oil) is giving way to electric or diesel haulage, the division between the two depending on the volume of traffic, permanent way conditions and various other factors. The result is a very clear trend towards reduced direct coal consumption on the railways. In the Netherlands and Italy this process is virtually complete; in Belgium and France it is well advanced and has recently begun in Germany. Coal consumption by Community railways will probably drop to 7—8 million metric tons in 1965 and about 1—2 million in 1975, an infinitesimal figure.

Graphique 5



Share of Solid Fuels in Non-electrical Energy Consumption in the Domestic Sector as percentage of total
1. Germany (Fed. Rep.)
2. Belgium
3. France
4. Italy
5. Netherlands
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
1
2
3
5
4
1950
51
52
53
54
55
56
57
58
59
1960

E — *Thermal power stations*

Electricity demand has been estimated at 574 TWh in 1970 and 790 TWh in 1975. These figures can be regarded as being correct to the nearest 5% under the economic growth hypothesis adopted and to the nearest 10% generally.

Part of the output will come from "sure-market" forms of energy, namely hydro and geothermal power and stations using brown coal and blast furnace gas. This output is estimated at 206 TWh in 1970, i.e. 34% of the total (as against 53% in 1960). The corresponding figure for 1975 is about 225 TWh, i.e. 28%. 362 TWh in 1970 and about 555 TWh in 1975 thus remain to be generated from coal, fuel oil, natural gas and nuclear energy.

For the latter we envisage an output of 20—25 TWh in 1970, corresponding to 3.5 million kW installed, and an output of 60—100 TWh in 1975, corresponding to 10—16 million kW installed. [1])

We are now in a position to attempt to give maximum and minimum estimates for coal consumption.

For 1965 existing programmes allow relatively little latitude; output at coal-burning power stations (including other industries' own production) is expected to be about 177 TWh.

For 1970 and 1975 the range is obviously considerably greater for technical reasons.

The *maximum* would correspond to the following hypotheses :

(i) no new stations using fuel oil or natural gas built after 1965, continued operation of those in existence in 1965 (assuming maximum coal consumption);

(ii) lower limit for nuclear generation.

[1]) It should nevertheless be noted that although the anticipated competitive advantage will become felt from 1968-1970 onwards, the amount of electricity produced by nuclear stations in 1975 could be greater than the above figures if expansion is not limited by the difficulty of installing further capacity at an economically desirable rate. Suitable encouragement from government policies and Euratom intervention under the second five-year programme should nevertheless remove some of these obstacles and enable a higher output to be achieved. For reasons of caution this possibility has not been entertained in our present calculations, which are based on the following working hypothesis of nuclear generation : 1970 : 20 TWh; 1975 : 80 TWh.

We thus obtain an output of about 290 TWh for coal-burning power stations in 1970, corresponding to a consumption of 105 million metric tons hard-coal equivalent.

Table 40 — Electricity Generation Breakdown by Form of Primary Energy Used (TWh, gross) (Revised table)

Line		1960	1965	1970	1975
1	Consumption	285	409	574	789
2	Balance of trade (net imports)	4	5	6	6
3 = 1 — 2	Gross aggregate production From sure-market sources :	281	404	568	783
4	Hydro and geothermal power	102[1]	111	130	141-147
5	Brown coal and peat	32	51	63	71
6	Blast-furnace gas	13	13	13	12
7	Other sure-market sources[2]	3	6	6	7
8=4+5+6+7	Sub-total	150	181	212	231-237
9 = 3 — 8	From other sources	131[3]	223	356	547-552

1) Very high water run-off in 1960.
2) Slurry, household refuse, industrial waste, etc.
3) 111 from coal, 20 from fuel oil and natural gas.

The *minimum* would represent keeping the coal-burning stations commissioned by the 1965 in service after that date without any new stations being built. All the increase in production would thus come from oil products or nuclear reactors. In this case we get an output of about 180 TWh in 1970, necessitating the use of about 65 million metric tons hard-coal equivalent.

To a certain extent these two limits correspond to physical concepts. The fundamental factor in the analysis now becomes the calorie price ratio to equate kilowatt-hour costs as between coal-burning and fuel-oil-burning power stations with the same load curve. Calorific equivalence is approximately unity, the efficiencies being roughly the same. The building costs of a coal-fired power station, on the other hand, are about 10—15% higher than that of a station using fuel oil. Since costs are divided into about 30% for depreciation, 60% for fuel and 10% for overheads, the calorie price ratio at the station to ensure equivalence must be between 0.9 and 0.95. A more detailed study at regional level is therefore necessary in order to be certain of the breakdown. In addition there is the possibility of building mixed power stations operating either on coal or fuel oil.

Section 4 — Summary. Extent of influence of energy policy on energy source structure

The above data can be summarised as follows (in millions of metric tons hard-coal equivalent) :

	1960	1965	1970	1975
Total demand (Table 9)	461	570	700	847
Specific demand (Table 36)	163	199	238	282
Demand covered by inevitable primary products[1]) (Table 37)	99	114	141	179
Balance	199	257	321	386

1) Corrected for duplication with specific demand.

As regards the breakdown of the balance, the analysis has shown that virtual certainty exists as to the breakdown in the iron and steel industry and rail transport, whereas in the other sectors relative prices must be borne in mind. Finally it must not be forgotten that coal markets can be supplied either with Community coal or imported coal.

The figures given in the foregoing pages are summarised in Table 42, which compares the probable structure of demand in various sectors in 1970 with the actual structure in 1960. It should be remembered that the 1970 figures can only be regarded as approximate.

To sum up, subject to the fact that we have provisionally adopted a single working hypothesis for nuclear production, consumption in the genuinely area of competition where the relative price level will be the decisive factor and where the energy policy can therefore play its part is likely to be as follows in 1970 :

(1) Competition between coal, fuel oil and natural gas :

(i) fuel for industry : some 50 million metric tons H.C.E.;

(ii) fuel for the domestic sector : some 30 million metric tons H.C.E.;

(iii) fuel for power stations : some 40 million metric tons H.C.E.;

— making a total of 110—120 million metric tons H.C.E. (a little less than 20% of the demand);

(2) Competition between Community and imported coal :

(i) the same consumers as in (1);

(ii) part of the coking coal requirements, the total of which amounts to 92 million metric tons.

Table 41 — Primary Energy Consumption Breakdown in 1960 by Sectors and Products[1]) ('000,000m.t. H.C.E.)

Sector \ Product	Hard Coal	Brown coal	Oil	Natural gas	Manu-factured gas	Blast furnace gas	Hydro and geo-thermal power	Nuclear electricity	Total
I. **Energy producers, converters[3]) and energy distributors**									
a) Own consumption and conversion and trans-mission losses	17.3	2.6	8.6[2])	0.6	9.0	4.9	—	—	43.0
b) Manufactured gas equivalent in terms of primary energy	+24.9	—	+1.2	—	—26.1	—	—	—	—
c) Total a+b)	42.2	2.6	9.8	0.6	—17.1	4.9	—	—	43.0
II. **Iron and steel industry[3])**									
a) Gross consumption	51.6	0.5	4.8	1.2	6.0	13.9	—	—	78.0
b) Blast furnace gas production						—26.0		—	—26.0
c) Net consumption of sector (a+b)	51.6	0.5	4.8	1.2	6.0	—12.1	—	—	52.0
III. **Other industries[3])**	35.6	6.5	31.2	7.1	6.6	0.6	—	—	87.6
IV. **Transport[3])**	13.3	0.1	45.2	0.4	—	—	—	—	59.0
V. **Domestic sector[3])**	55.3	9.4	25.4	2.2	4.2	—	—	—	96.5
VI. **Power stations[4])**	50.0	15.4	6.3	2.0	0.3	6.6	42.5	0.1	123.2
VII. **Total primary energy requirements** (Ic + IIc + III + IV + V + VI)	248.0	34.5	122.7	13.5	—	—	42.5	0.1	461.3

Totals are as in the tables in Annex 2 to the full Community-language edition.

1) These figures represent the **end** consumption of the different products in a number of sectors. Thus the item "hard coal" for the iron and steel industry indicates the industry's consumption of **coke,** not the amount of hard coal required for that consumption of coke; the difference is allowed for under "energy producers, converters and distributors".

2) Less refinery losses, and minus 1.5 million metric tons H.C.E. (benzole, etc.) produced from hard coal.

3) Less electricity.

4) Ton for ton in the case of coal.

Table 42 — Primary Energy Consumption Breakdown in 1970 by Sectors and Products. Approximate zones of substitutability[1] [2]) ('000.000m.t. H.C.E.)

(Revised table)

Sector \ Product	Hard Coal	Brown coal	Oil	Natural gas	Manu-factured gas	Blast furnace gas	Hydro and geo-thermal power	Nuclear electricity	Total
I. Energy producers, converters[3]) and energy distributors									
a) Own consumption and conversion and transmission losses	12-15	2	24-21	1	7	5			51
b) Manufactured gas equivalent in terms of primary energy	19-26		8		·(27-34)				—
c) Total a+b)	31-41	2	32-29	1	·(20-27)	5	—	—	51
II. **Iron and steel industry[3])**									
a) Gross consumption	61	—	15-12	5-5	6	14			101
b) Blast furnace gas production						—			-24
c) Net consumption of sector (a+b)	61	—	15-12	5-8	6	10			77
III. **Other industries[3])**	20-55	4	75-25	20-31	6-10	—	—	—	125
IV. **Transport[3])**	3	—	99		—	—	—	—	102
V. **Domestic sector[3])**	45-75	3	70-35	7-9	8-11	—	—	—	133
VI. **Power stations**	65-105	23	55-15	2	—	5	54	8	212
VII. **Total primary energy requirements** (Ic + IIc + III + IV + V + VI)	225-340	32	341-218	40-48[4])	0	0	54	8	700

1) See footnote 1 to preceding table.
2) **Lines:** in each line, the coefficients of uncertainty for hard coal, for natural gas and for manufactured gas are taken as independent; the sum of the three gives the coefficient of uncertainty for oil.
Column: in the case of hard coal and natural gas the sums of the individual maxima and minima do not equal the overall maxima and minima, inasmuch as the ranges are not all independent; the hypothesis is thus ruled out that the consumption of these products will ever be simultaneously at either minimum or maximum in all sectors.
3) Less electricity..
4) Of which 8-12 imported.

Chapter 14

Coverage of competitive requirements based on comparative costs at the consumer's level

We have now reached some sort of breakdown of energy requirements according to source. This is more or less independent of the ratio of coal to fuel oil prices, provided that the latter remains within the range 0.8—1.2, although two factors of uncertainty persist : the margin of doubt as between coal and oil products, particularly as regards the other industries sector, households and power stations and the margin of doubt as to the breakdown of coal into Community and imported coal.

In order to reduce these margins we must carry out a fairly detailed geographical analysis so as to make at least an approximate comparison of costs at the consumer's level; this must allow for transport costs from the point of production or entry to the point of consumption.

The breakdown into energy sources, and especially the position to be occupied by Community coal, will depend not only on the comparative production costs of the products involved but also on the energy policy adopted. The latter will mainly consist in controlling comparative consumer costs for various fuels either by levying duty on imports or granting subsidies to Community producers.

For the time being we shall confine ourselves to examining a number of specimen calculations based on the supply and demand position as outlined in previous chapters. Each specimen calculation will show the combined influence of various hypotheses as to future imported energy prices and the extent of price intervention in the form of duty and subsidies. [1])

Section 1 — Basis of calculations

It is possible to make at least an approximate estimate of the possible market available to each coalfield in the face of competition from direct imports of coal or indirect imports of fuel oil through refineries.

The basic data used in the calculation are as follows :

(i) prices and costs :

- p_i c.i.f. price per ton of imported product at port A;
- c_m pithead cost of Community coal;
- t_i inland transport charges per ton from port A to place of consumption;
- t_m inland transport charges per ton from pit to point of consumption;

(ii) coefficient of physical equivalence e between one metric ton of Community coal and one metric ton of imported product;

[1]) These specimen calculations are restricted to non-electrical energy, since power stations are treated as final consumers.

(iii) the vaue *a* of the specific advantages to the consumer in using a competing product instead of one metric ton of Community coal :

(iv) forms of intervention available to the authorities :
D duty per metric ton on imported product;
S subsidy per metric ton on Community coal.
The respective prices to the consumer are as follows :

$p_i + D + t_i$ for imported product;
$c_m - S + t_m$ for Community coal,

there being indifference to the consumer between the two products when $e\ (p_i + D + t_i) - a = c_m - S + t_m$ so that Community coal is competitive in the consumption zone in question when the pithead cost (before any subsidy) is $e\ (p_i + D + t_l) - a + S - t_m$ or below. (It will be readily apparent that as regards the consumer's choice between the two products a subsidy of *x* has the same effect as a duty of $\frac{x}{e}$). In the case of an open market (where there are no subsidies) the equation comes down to [$e\ (p_i + t_i) - a = c_m + t_m$.]

We can thus determine the maximum pithead cost at which the output of a particular coalfield will be competitive for each consumer group located in the same place. By carrying out the same calculation for all the consumption zones we obtain a demand curve for the output of the *coalfield* in question and by comparing this curve with a supply curve based on the cost curve plotted in Chapter 6, which corresponds to an assumed efficiency trend, we can calculate the proportion of the coalfield's output which can be marketed in face of competition from imported products under given protection or subsidy conditions. [1])

Before applying these specimen calculations, five points require definition:

A — factors involved in coal-coal and coal-fuel oil-gas comparisons;
B — regional breakdown of energy requirements;
C — calculation of transport costs;
D — definition of supply curves;
E — privileged outlets.

A — *Factors involved in coal-coal and coal-fuel oil-gas comparisons*

In determining the comparative consumer cost of various fuels, we must bear in mind differences in the efficiency of equipment and any specific advantages (cleanness, ease of handling, flexibility etc.) possessed by given products; these items have been represented above by *e* and *a*.

[1]) In practice the calculations which follow use $D = o$ and different values of S, but the results are the same if we replace S by $\frac{D}{e}$ or even by S' and D' so that $S = S'$ plus $\frac{D}{e}$

The comparisons for coal-coal (Community and imported coal, or coal from different fields) are the simplest, since *a* is not involved. The only correction to be made is for quality differences between imported and Community coal. The following table shows that these differences range from 4% to 10% for coking coal and 7% to 16% for steam coal. [1])

Table 43 — Coal Quality Differences according to Origin

Origin	Fall in value by comparison with American coal (%)	
	steam	coking
U.S.A.	—	—
Ruhr	— 7.2	— 4.1
Nord-Pas-de-Calais	— 9.4	— 8.2
Lorraine	— 16.0	— 7.5
Belgian coalfields	— 11.5	— 10.3
Saar	— 13.7	— 8.2
Dutch Limburg	— 15.0	— 6.8

The coal-fuel oil, coal-gas and fuel oil-gas comparisons are more tricky, however, and involve technical and economic data which at present are only available to a very limited extent.

In order to overcome this difficulty, we shall proeeed in stages:

(a) Coal-coal comparison

Since they have different markets, coking coal, steam coal and anthracite should be examined separately, although the outputs of the first two types are not absolutely independent of each other in that coking coal consists of fines, the production of which is automatically accompanied by that of a certain volume of graded coal. We have assumed a figure of one metric ton of graded coal, used for steam raising, for every three metric tons of fines.

[1]) These coefficients are the result of estimates which are open to some doubt. A group of experts consulted by the High Autority has put forward the following somewhat different set of figures :

	Steam coal	Coking coal
Ruhr	—	— 8.6
Nord-Pas-de-Calais	— 4.6	— 5.0
Lorraine	— 13.2	— 2.8
Belgian coalfields	— 2.8	— 10.3
Saar	— 0.1	— 8.6
Dutch Limburg	— 0.1	— 5.7

Unfortunately these coefficients only refer to about 25% of the output marketed in 1960. The tonnages involved do not constitute a representative sample of the entire output, since they mainly consist of certain specified grades for particular uses. The coefficients representing this portion of the output are thus useless for the present study, which deals with the market as a whole.

It should also be noted that coke for the iron and steel industry only represents a fraction of the total output of cokes-ovens. We have assumed that in 1975 this fraction, which comprises not only blast furnace coke but also coke dust for sintering plants, will represent 87% of the total coke output.

Allowing for the fact that Community coking coal is relatively more competitive than steam coal by comparison with the corresponding imported varieties, we can proceed with our investigation in the following order :

(i) joint production, a certain output of graded steam coal and coke for demand for coke in the iron and steel industry, which implies, as a joint production, a certain output of graded steam coal and coke for consumers outside the iron and steel industry;

(ii) satisfaction of fuel demands.

(b) Incorporation of fuel oil and gas into the analysis

First of all we shall see to what extent competition between fuel oil and gas is capable of altering the marketing pattern outlined above for Community coal.

We shall then examine the competitive position of coal and fuel oil more concisely.

B — *Regional breakdown of energy requirements*

The first stage is to break down the estimated future energy requirements of each country into *regions*. At the present time we have no information on future growth rates of individual regions by comparison with national figures, and consequently *as a working hypothesis*, subject to eventual correction, we have assumed that all regions will develop at the same rate as the country as a whole, except as regards iron and steel production (see below). [1] The regional demarcation adopted is based on that given by the E.E.C. in its *Essai de délimitation régionale de la C.E.E.*, with Germany divided into eight *Länder* and France into nine regions. [2] Each region is then represented by a consumption centre.

It will be obvious that for large regions whose consumption is not concentrated around the centre selected (e.g. the *Länder* south of North Rhine-Westphalia) this is only a very approximate method.

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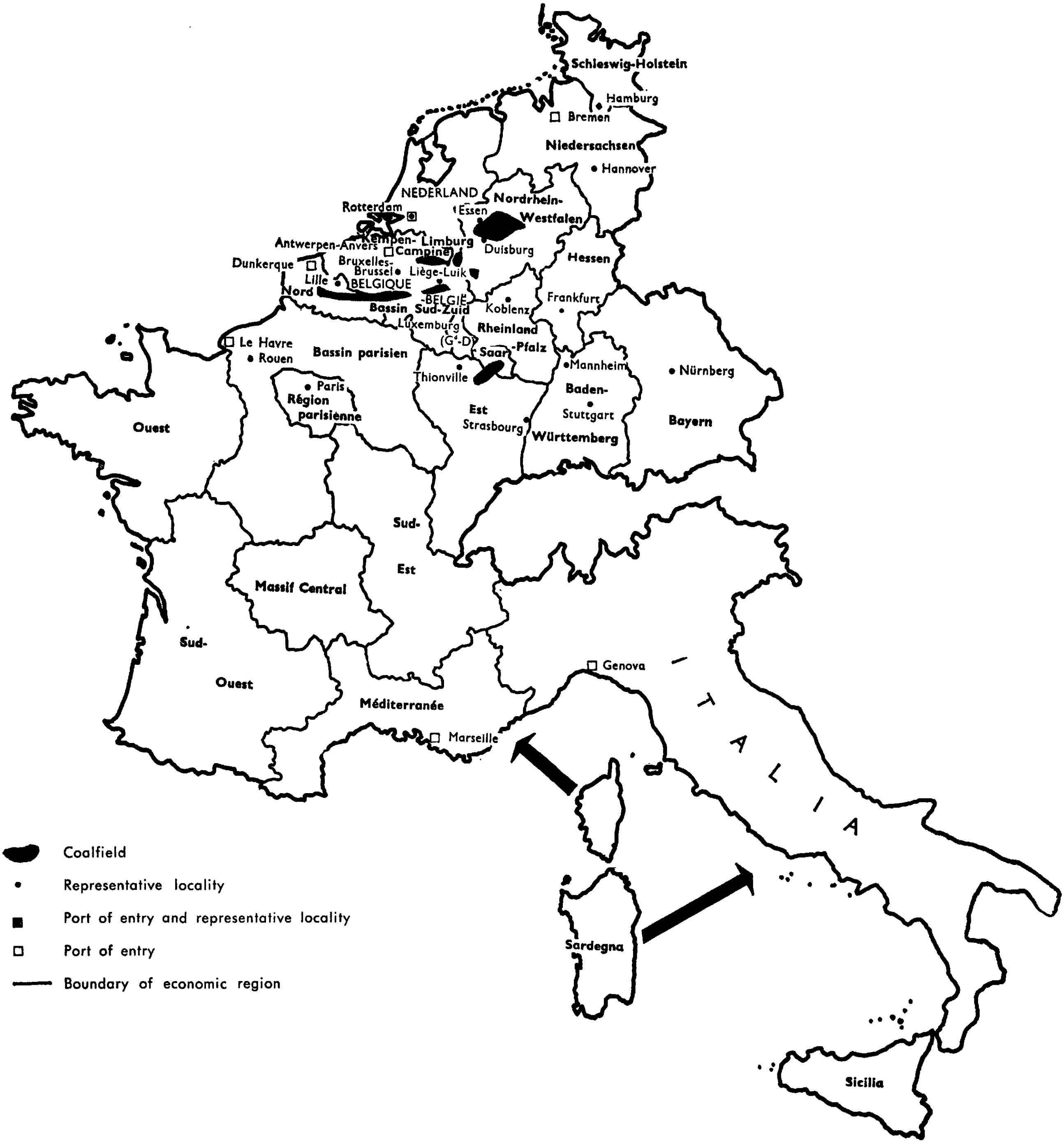
[1] We shall find later on that the differences by comparison with this homothetical trend are not likely to make much difference to the conclusions reached on Community coal outlets.

[2] For the time being we have considered Italy as a single unit (although the E.E.C. distinguishes six regions), since there is no likely outlet for Community coal in Italy.

Graph VI

Map of the Community showing Regional Boundaries, Ports of Entry and Representative Localities



As regards fuel requirements, the results of the calculation are summarised in Table 44. It will be noted that power station requirements which are bound to be covered by inevitable or quasi-inevitable sources, i.e. blast furnace gas and brown coal, are excluded.

Table 44 — Regional Fuel Requirement Outlook in 1970 ('000,000m.t. H.C.E.)

	Other industries	Domestic sector	Thermal power stations (excluding brown coal and blast furnace gas)[1]	Total
Germany (Fed. Rep.)				
Schleswig-Holstein	3.0	4.6	3.1	10.7
Lower Saxony	4.8	7.3	5.9	18.0
North Rhine-Westphalia	21.0	17.0	23.1	61.1
Hessen	3.0	5.1	4.0	12.1
Rhineland-Palatinate	3.7	3.6	5.2	12.5
Baden-Württemberg	4.7	8.2	5.2	18.1
Bavaria	5.6	10.1	4.7	20.4
(Saar)	—	—	1.9	1.9
Total	45.8	55.9	53.1	154.8
France				
Paris and Paris Region	4.8	8.6	7.2	20.6
Paris Basin	4.8	5.1	5.6	15.3
North	6.0	6.7	6.2	18.9
East	4.5	4.2	4.1	12.8
West	1.3	2.7	0.7	4.7
Massif Central	0.8	1.1	—	1.9
South-West	2.8	2.9	1.7	7.4
South-East	4.6	4.3	4.5	18.2
Mediterranean	2.6	2.2		
Total	32.0	37.8	30.0	99.8
Belgium	5.8	10.6	8.8	25.2
Italy	33.0	18.0	18.9	69.9
Luxembourg	0.14	0.49	0.20	0.83
Netherlands	8.4	10.2	11.0	29.6
Community Total	125.1	133.0	122.0	380.1

[1] Adjustment to the total requirements of the sector as determined in Part Two is achieved by adding the demand met by brown coal and blast furnace gas, viz.:

Country	Table 44 total	Blast Furnace gas	Brown coal	Other com-bustibles	Total require-ments of thermal power stations
Germany (Fed. Rep.)	53.1	1.4	21.2	0.5	76.2
France	30.0	2.0	1.0	—	33.0
Belgium	8.8	0.6	—	—	9.4
Italy	18.9	0.3	0.7	—	19.9
Luxembourg	0.2	0.7	—	—	0.9
Netherlands	11.0	0.1	—	—	11.1
Community	122.0	5.1	22.9	0.5	150.5

The method adopted for fuel requirements nevertheless requires correction when applied to the geographical distribution of pig iron production. We must allow for the fact that iron ore production in the Community cannot increase much after 1965 and that the rising demand will mainly be met from imported ore. This means that the present tendency in the iron and steel industry to shift towards the coast will probably continue and that pig iron output in the present inland production areas will increase less rapidly than total output.

To sum up, we have worked on the basis of two hypotheses for pig iron production (Table 45): the main hypothesis A corresponds to the shift towards the coast, the results of which are contrasted with those of hypothesis B, representing a homothetic development of the anticipated 1965 position in the years between 1965 and 1970 (and 1975).

Table 45 — Pig Iron Production Location Outlook in 1970 and Regional Breakdown of Coking Coal Requirements ('000,000 m. t.)

	Pig iron Production			Coking coal requirements 1970	
	1960	1970			
		A	B	A	B
Germany (Fed. Rep.)	25.7	34	34	38	38
North Rhine-Westphalia	18.0	23	24	26	27
Schleswig-Holstein, Lower Saxony	3.2	6	5	6	5
Saar	3.3	4	4	5	5
Remainder	1.2	1	1	1	1
France	14.0	21	21	25.5	25.5
East	10.5	12.5	15	16	18
North (non-coastal)	2.3	3	3	3.5	4
North (coastal)	—	3	1	3	1
West	0.8	1	1	1	1
South (coastal) and other regions	0.4	2	1	2	1
Belgium	6.5	9	9	10.5	10.5
Interior	6.5	7	7.5	8.5	9
Coast	—	2	1.5	2	1.5
Italy	2.7	9	9	9	9
Luxembourg	3.7	4	4	6	6
Netherlands	1.3	3	3	3	3
Community	54.0	80	80	92	92

The foregoing table gives the anticipated location of blast furnaces in 1970, although the coking coal is actually consumed by the coke-ovens, and it is the location of the latter which must be taken into account in comparing the costs of Community and imported coal.

As the present time we have pithead coking plants and blast furnace coking plants (Table 46). In view of the long life of these plants, we shall assume that the present capacity of pithead coking plants will be maintained in the years to come and that any other plants required will be located at iron and steel plants.

This table supplements Table 45 and relates to four coalfields; Nord and Pas-de-Calais, Lorraine, South Belgium and Dutch Limburg. In the Ruhr and the Saar we have assumed that pits and iron and steel plants are located in the same place and in the Campine there are no pit head coking plants.

The previous tables relate to 1970. The figures for 1965 and 1975 represent a regular trend between now and 1975.

Table 46 — Coking Plant Production Capacity ('000,000m.t.)

Region	1960 output	Capacity	
		actual, beginning 1961	anticipated, beginning 1966
Pithead coking plants			
Ruhr	31.7	40.9	40.8
Aachen	1.9	1.9	1.9
Lower Saxony	0.1	—	—
Saar	1.6	1.6	1.7
Belgium and Netherlands	4.3	4.5	4.4
North-Pas-de-Calais	4.8	4.9	5.8
Lorraine	1.9	1.9	3.1
Centre/Midi	0.7	0.8	1.0
Total[1])	46.9	56.5	58.7
Blast furnace coking plants			
Germany	9.5	11.1	10.8
Belgium and Netherlands	6.0	6.3	6.3
France	4.4	4.7	4.8
Italy	1.9	2.3	5.1
Total[1])	21.8	24.3	27.0
Independent coking plants			
Belgium and Netherlands	1.8	1.9	1.6
France	—	—	—
Italy	1.8	2.5	2.6
Total[1])	3.6	4.4	4.2
Grand Total[1])	72.2	85.3	89.9

Source: Investment in the Community Coalmining and Iron and Steel Industries, July 1961, page 44, and July 1962, page 44.

1) Rounded figures, which may therefore differ slightly from the sum of the individual items.

C — *Calculation of transport costs*

Estimates of future transport costs are extremely difficult. An investigation of the probable trend in costs of different forms of transport would have been desirable, but the extreme complexity of cost calculations in the transport sector, due to the provision of a large number of related services and the fact that transport capacities do not increase at a predictable steady rate, but rather in a series of erratic laps, has prevented upon us embarking on a study of this kind. It should also be noted that the important factor in energy studies is not costs but charges, and that an element of uncertainty thus arises as to the transport charges policy which will operate in the Community.

In view of these difficulties we have worked on the basis of 1960 transport charges and the cheapest form of transport on each route, except in two cases where major projects now in hand will considerably improve inland waterway facilities, namely the canalisation of the Moselle as far as Metz and of the Main as far as Nuremberg.

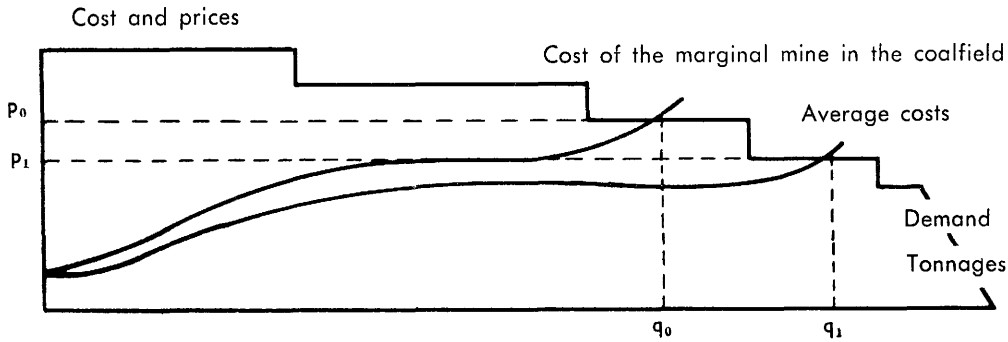
The fact that 1960 rates have been utilised in no way anticipates future trends in transport policy, especially as regards the harmonisation of tariffs for different forms of transport. The differences between the specimen calculations worked out below can equally well be interpreted in terms of the influence of transport policy measures or as expressing trends in imported energy prices or the influence of official policy in the energy sphere proper.

D — *Definition of supply curves*

The volume of Community coal capable of competing with imported products depends on the supply curve used in the calculations. Several different types of curve can be envisaged.

We shall assume a single pithead price per coalfield and type of coal which is independent of the kind of consumer and the use to which the coal will be put. The first hypothesis is then as follows : this price represents the production costs of the marginal pit, in other words the supply curve is identical with the cost curve given in Chapter 6 and the level of equilibrium corresponds to the intersection of this curve and the demand curve whose form has been explained above : a quantity q can be sold at a pit head price p. This hypothesis will constitute the basis of our specimen calculations.

There is also a second hypothesis whereby each coalfield always sells at a single price equal to average production costs.



Ignoring for the time being the actual methods adopted in such a process, we can see straightaway that it would lead to higher sales q_1 and a lower selling price p_1.

We can also envisage a differential pithead price structure for a given quality of coal whereby each consumer pays the same price as for imported coal; the saleable output would then be even higher than in the previous cases. In the long term, however, the adoption of such methods by the seller would lead to the industry being chased out of coalmining areas and at the same time attract oil refineries into them; this would operate against the sought-after aim of increasing coal outlets.

In the calculations which follow we shall mainly concern ourselves with the first hypothesis but also give results for the second.

E — *Privileged outlets*

A substantial proportion of coal output, varying according to the field involved, is supplied direct by pits for certain purposes without going through the market. Particular examples are deliveries to pithead coking plants, pithead sintering plants, pithead power stations and employees, as well as collieries' own consumption. In 1960 these supplies represented about 45% of the marketed total.

The conditions under which these supplies compete with imported energy are obviously special ones. Collieries will always tend to use their own output rather than feed their coking plants or power stations with imported coal, even if the latter is cheaper. This trend will be particularly noticeable in coking plants running on Community coal where a changeover to imported coal would entail substantial modifications. In the long term this practice would be limited by the need to ensure the financial stability of the : collieries-plus-coking-plants-plus-power-stations complex.

In order to deal fully with the question of competitiveness between Community coal and imported energy it would be necessary to examine the possible selling prices of gas, coke and electricity, i.e. to study competitiveness between pithead and blast furnace coking plants, between pithead coking plants and the gas industry and between pithead power stations and public power stations. This is out of the question, at least for the moment. We shall therefore proceed in two stages :

(i) we shall first of all examine competitiveness between various forms of energy irrespective of legal ties between pits and users, which is the obvious approach to adopt in a long-term view;

(ii) we shall see to what extent these ties can affect the above results during the period covered by the forecast.

Section 2 — Detailed examination of a specimen calculation

In order to illustrate the application of the calculating methods explained above, we shall now show the detailed stages involved in a specimen calculation for the year 1970. [1]

A — *Coal-coal competition*

We have already seen that at consumer level there is no difference between Community coal and imported coal when

$e\ (p_i + D + t_i) = c_m - S + t_m$

If $e = 1$, this equation can be written $c_m = p_i + D + S + t_i - t_m$.

The calculation is based on the hypothesis that $p_i + D + S$ is \$15.00 for American steam coal and \$17.00 for American coking coal. For steam coal, for example, this figure of \$15.00 can be interpreted as a c.i.f. price of \$13.00 plus assistance [(customs duty plus subsidy) of \$2.00 or as a c.i.f. price of \$14.00 plus assistance] amounting to \$1.00 or again as a c.i.f. price of \$15.00 and no assistance. The calculation can proceed in the same way whatever the interpretation. [2]) To make the calculation more explicit, we shall assume that we

[1]) This section can be omitted by readers who are only interested in the results, which are to be found in Chapter 15.

[2]) Subject to minor differences due to the fact that e differs slightly from 1.

have adopted the interpretation of a c.i.f. price of $13.00 and a subsidy of $2.00 (and for coking coal a c.i.f. price of $15.00 plus a subsidy of $2.00), but no conclusion should be drawn from this example because it is designed solely to illustrate the method of procedure.

We shall take coking coal, steam coal and anthracite in that order.

(a) Coking coal

1970 requirements amount to 92 million metric tons distributed regionally as shown in Table 45 above.

With a price c.i.f. Rotterdam (not discharged) of $15.00, Table 47 gives the "delivered" price in the different consumption areas (column 3) and, allowing for quality differences, the competitive pithead price for various Community coalfields (column 6) and finally the maximum cost including the subsidy (column 7).

We can then see what the supply pattern would be for each iron and steel production area.

Table 47 — Marketing Conditions for Community Coking Coal assuming a c.i.f. Imported Coal Price of $15.00 and a Community Coal Subsidy of $2.00 ($m.t.)

Iron and Steel production aera	Port of entry	c.i.f. coal price	Community coal equivalent delivered price for Community Coal $e(p_i+t_i)$	Coalfield	Pithead equivalent price $e(p_i+t_i)-t_m$	Pithead maximum cost $e(p_i+t_i)-t_m+S$
1	2	3	4	5	6	7
North						
Rhine-Westphalia	Rotterdam	16.90	16.20	Ruhr	15.90	17.90
Lower Saxony	Bremen	17.90	17.20	Ruhr	14.20	16.20
Schleswig-Holstein	Hamburg	16.00	15.30	Ruhr	11.30	13.30
Saar	Rotterdam	18.80	18.00	Saar	13.20	15.20
France-East	Rotterdam	18.60	17.20	Saar	15.80	17.80
			17.80	Lorraine	14.30	16.30
France-North	Dunkirk	17.20	15.80	Nord-		
(non-coastel)				Pas-de-Calais	15.10	17.10
North Coast	Dunkirk	15.90	14.60	Nord-		
Belgium-interior	Antwerp	16.80	15.10	Pas-de-Calais	13.00	15.00
(Liège)			16.10	Campine	13.90	15.90
Coast		15.80	14.20	Ruhr	14.00	16.00
Italy	Genoa	16.40	15.70	Campine	12.30	14.30
Luxembourg	Rotterdam	18.80	18.00	Ruhr	10.70	12.70
Netherlands	Rotterdam	16.00	14.90	Ruhr	14.00	16.00
				Dutch		
				Limburg	13.60	15.60

Germany. — Ruhr coal is competitive in all consumption areas in Germany except on the coast.

For Saar iron and steel plants we can envisage mixed supplies, the majority being from the Saar (3 million metric tons), supplemented by Ruhr coal (2 million metric tons).

Belgium. — In 1970 the Campine basin will be able to supply the 8.5 million metric tons of coking coal required by the inland iron and steel industry.

For iron and steel plants on the coast, however, the Campine is not competitive with imported coal.

France. — For supplies to iron and steel plants in Lorraine, locational advantages offer substantial protection against imported coal, but there is a possibility of outlets being shared between Lorraine, the Saar and the Ruhr in view of comparative costs and the technical need to obtain supplementary coal from the Ruhr. The calculations give us a figure of 6 million metric tons from Lorraine, 4 million metric tons from the Saar and 6 million metric tons from the Ruhr.

A strict calculation would show that the Nord and Pas-de-Calais coalfield could dispose of only 3.5 million metric tons to pithead coking plants, whereas the capacity of the latter is some 6 million metric tons. Nevertheless the advantage of obtaining supplies from the local coalfield (easy availability and coke-ovens specially built for this type of coal) suggest that in fact 5.5 million metric tons could be sold.

All the coastal iron and steel industry's requirements will be covered by imports.

Italy. — There are no possibilities of supplies from European coalfields (they would require a pithead price of less than $11.00).

Luxembourg. — In view of transport costs (with the Moselle canal) and quality differences, the Ruhr can supply the entire requirements of the Luxembourg iron and steel industry.

Netherlands. — Limburg coking coal can cover the country's entire requirements.

Community. — The above results are summarised in Table 48. Community coalfields will supply 74 million metric tons and imports 18 million metric tons.

Two conclusions can be drawn from this :

(i) Community coal can supply all the pithead coking plants expected to be in operation in 1966 (Table 46);

(ii) imported coal will only be used in Italy and for the coastal iron and steel industry.

Table 48 — Coking Coal Supplies for the Community Iron and Steel Industry in 1970 hypothesis : import price + duty + subsidy = $17.00) ('000,000m.t.)

Country	Ruhr	Saar	Campine[1])	Nord and Pas-de-Calais	Lorraine	Dutch Limburg	Community	Imports	Total
Germany (Fed. Rep.)	32	3	—	—	—	—	35	3	38
Belgium	—	—	8.5	—	—	—	8.5	2	10.5
France	6	4	—	5.5	6	—	21.5	4	25.5
Italy	—	—	—	—	—	—	—	9	9
Luxembourg	6	—	—	—	—	—	6	—	6
Netherlands	—	—	—	—	—	3	3	—	3
Community	44	7	8.5	5.5	6	3	74	18	92

1) Under this calculation the S. Belgian coalfield markets no coking coal.

These figures assume that there will be a considerable shift towards the coast in pig iron production. Such a pattern is obviously uncertain and it is interesting to see the results of calculating on the basis of the other hypothesis, whereby coastal plants are less numerous. The differences concern Germany, Belgium and France.

In Germany we can envisage a reduction in the import figure by about 1 million metric tons in favour of the Ruhr; in Belgium the difference would be 0.5 million tons in favour of the Campine. In France the difference would be 1 million metric tons in favour of either the Nord and Pas-de-Calais or Ruhr coalfields. The overall difference would be about 3 million metric tons.

Finally it must be noted that these disposals figures are based on the implicit assumption that the associated output of graded coal and coke for consumers outside the iron and steel industry would be sold at least at cost price and that coking coal would no longer have to support the burden represented by the selling price of graded coal. Later on, when dealing with steam fuel, we shall see whether this assumption is justified.

(b) Steam coal

As regards steam coal, competition exists between Community coal, imported coal and fuel oil.

As explained above, we shall first of all work on the basis of there being only two competing products, Community and imported coal. If the c.i.f. cost per calorie of imported coal and fuel oil is the same inland the use of fuel oil is at least as advantageous as imported coal and often more so. The calculation will thus overestimate the potential outlets for Community coal.

At a later stage we shall attempt an approximate estimate of the market which would in fact have to be abandoned to fuel oil.

The basic specimen calculation which we are now investigating represents an import price of $13.00 [1]) for American coal and a subsidy of $2.00 per metric ton for Community coal.

Table 49 gives the cost of imported coal carriage paid to point of consumption and the corresponding pithead cost, corrected for differences in quality. It will be noticed that the maximum pithead cost is always for outlets situated in the same region as the pit; this factor will govern the procedure adopted in the calculations.

First of all we shall examine outlets near the pit. Table 44 has given us a possible regional breakdown of solid, liquid and gaseous fuel requirements for 1970. From the previous chapter we can determine the ceiling in the solid fuel market. The second stage is to deduce the following inevitable or quasi-inevitable items :

(i) brown coal (and briquettes);

(ii) small coke (equal to 1/10th of coking coal);

(iii) anthracite (see (c) below);

(iv) graded coal associated with consumption of Community coking coal (1/3rd of coking coal).

It is the remainder of the market which has to be investigated for competitiveness with imported coal.

We are then faced with three possibilities :

(i) the coalfield's steam coal is completely uncompetitive with imported coal;

(ii) the coalfield's steam coal is only competitive with imported coal in a portion of the market;

(iii) the coalfield's steam coal is competitive with imported coal throughout the market.

In the first two cases the analysis is at an end. In the case of the third we must see whether the output of the coalfields can be marketed in other regions; the procedure for this fresh analysis is then identical with that set forth above.

The systematic application of this method to all coalfields enables us to estimate the outlets in industry and the domestic sector (excluding anthracite) on the one hand and at power stations on the other.

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[1]) This price applies to fines; for graded coal we must allow between $ 0.50 and $ 1.00 extra.

Table 49 — Marketing Conditions for Community Steam Coal (hypothesis: import price c. i. f. ARA port + duty + subsidy = $ 15.00)

Consumption region	Representative centre	Port of entry	Additional cost[1]) to consumer	Delivered price of imported coal p_i+t_i	Equivalent delivered price for Community coal	Transport charges from pit $-t_m$	Pithead price $e\ (p_i+t_i) -t_m$	Coalfield	Pithead maximum cost $e\ (p_i+t_i) -t_m+S$
1	2	3	4	5	6	7	8	9	10
Germany (F. R.)									
Schleswig-Holstein	Hamburg	Hamburg	1.00	14.00	13.00	4.00	9.00	Ruhr	11.00
Lower Saxony	Hannover	Bremen	2.90	15.90	14.80	3.00	11.80	Ruhr	13.80
North Rhine-Westphalia	Duisburg-Essen	Rotterdam	1.90	14.90	13.00	0-0.50	13.30-13.80	Ruhr	15.30-15.80
Hessen	Frankfurt	Rotterdam	2.30	15.30	14.20	3.10	11.10	Ruhr	13.10
Rhineland-Palatinate	Coblenz		2.10	15.10	14.00	2.80	11.20	Saar	13.20
						3.80	11.00	Ruhr	13.00
Baden-Württemberg	Stuttgart	Rotterdam	2.90	15.90	14.80	3.20	11.20	Ruhr	13.20
	Mannheim	Rotterdam	2.50	15.50	14.40	3.40	11.00	Saar	13.00
Bavaria	Nuremberg	Rotterdam	3.70	16.70	15.50	3.70	11.80	Ruhr	13.80
France	Paris								
Paris		Le Havre	3.00	16.00	14.80	4.00	10.80	Ruhr	12.80
					14.50	2.90	11.60	Nord-P.-d.-C.	13.60
Paris Basin	Rouen	Le Havre	1.90	14.90	13.50	3.00	10.50	Nord-P.-d.-C.	12.50
North	Lille	Dunkirk	2.20	15.20	13.80	0.50-1.00	12.80-13.30	Nord-P.-d.-C.	14.80-15.30
East	Thionville	Antwerp-Rotterdam	3.60	16.60	13.90	1.40	12.50	Lorraine	14.50
					15.40	3.50	11.90	Ruhr	13.90
					14.40	1.50	12.90	Saar	14.90
	Strasbourg	Antwerp-Rotterdam	3.20	16.20	15.00	3.20	11.80	Ruhr	13.80
					13.60	2.20	11.40	Lorraine	13.40
					14.00	2.60	11.40	Saar	13.40
Belgium	Brussels	Antwerp	2.00	15.00	13.30	1.80	11.50	Campine	13.50
	Liège	Antwerp	1.80	14.80	13.10	1.20	11.90	Campine	13.90
	South		2.10	15.10	13.40	1.90	11.50	S. Belgium	13.50
Netherlands	West Region	Rotterdam	0.80-1.30	13.80-14.30	11.70-12.20	6.30	10.40-10.90	Limburg	12.40-12.90
	Limburg		1.70	14.70	12.50	—	12.50	Limburg	14.50

1) This item includes the port differential as against ARA c.i.f. price, deduction of 2% in lieu of weighing, discharging costs and inland freight charges, including unloading charges at consumer's end.

As regards the latter, we must lastly compare the coal disposals figure with the probable requirements of pithead power stations on the basis of the anticipated 1965 capacities of the latter (see Table 50). The method of calculation employed, including the concentration of demand at a single point in each region, means that we cannot take precise account of the advantage to pithead stations of being in the immediate vicinity of their source of supply. The figures for certain outlets should thus be raised slightly, so that all pithead stations will run on Community coal.

Table 50 — Pithead Power Stations

	1960 coal consumption ('000,000 m. t.)	Actual capacity, beginning of 1961 ('000,000 kW)	Estimated capacity, beginning of 1966 ('000,000 kW)
Ruhr	7.3	3.5	5.2
Aachen	0.2	0.1	0.3
Lower Saxony	0.2	0.1	0.2
Saar	0.8	0.5	0.8
Campine	0.4	0.4	0.4
S. Belgium	1.2	0.8	0.9
Nord/Pas-de-Calais	3.2	1.3	1.3
Lorraine	1.7	0.7	0.7
Centre/Midi	1.1	0.6	0.5
Italy		0.1	0.3
Dutch Limburg	0.9	0.4	0.5
Total	17.0	8.5	11.6

Cost curves are not available for Lower Saxony, the French Centre/Midi or Italy. On the basis of available information and comparisons between these fields and those already studied we have assumed that 1970 market will be about 5 million metric tons (1960 production was 13.5 million metric tons).

We thus arrive at the final figures for all Community coalfields as shown in Table 51.

Table 51 — Steam Coal Outlets from Community Coalfields in 1970 under a Specimen Calculation (hypothesis : import price + duty + subsidy = $15.00m.t.) ('000,000 m. t.)

Industry and domestic sector	24
Power stations	45
Total steam coal	69

(c) Anthracite

Output in 1960 was 19 million metric tons. This is a quality product with a high market value and competition with oil products will be particularly marked. In the absence of a detailed analysis we can assume that future figures will be as shown in Table 52, which shows a slightly falling output trend.

Table 52 — Anthracite Marketing Estimates ('000,000m.t.)

	1960 output	Marketing estimates 1965	1970	1975
Ruhr	4.4	4	4	4
Aachen	2.1	2	2	2
Lower Saxony	0.2	0.2	0.2	—
S. Belgium	5.9	5.5	5	4
Nord/Pas-de-Calais	1.1	1	1	1
Centre/Midi	1.7	1.5	1	1
Netherlands	3.4	3	3	.3
Total	18.8	17.2	16.2	15

(d) Hard coal as a whole

The figures obtained in the preceding sections are summarised in Table 53 to give the possible market for Community coal in 1970 under the specimen calculation studied.

Table 53 — Possible Market for Community Coal in 1970 in Competition with Imported Coal under a Specimen Calculation (hypothesis : imported coal price + duty + subsidy : coking fines f = \$17.00, steam coal v = \$15.00). ('000,000m.t.)

Coking coal	74
Graded coal for industry and domestic sector	24
Anthracite	16
Power stations	45
Total Supplied	159
Collieries' own consumption	5
Total disposals	164

B — *The effect of fuel oil competition on Community coal*

If the c.i.f. price per calorie is the same for fuel oil and imported coal, competition from fuel oil may restrict the market for Community coal for two reasons.

Firstly, transport charges differ for coal and oil products, sometimes considerably. This gap will increase as time passes, since the number of inland refineries obtaining their crude supplies by pipeline will rise. In 1970 liquid oil products are expected to represent between 220 and 340 million metric tons hard-coal equivalent, i.e. 150—230 million metric tons of oil products. It is possible that there will then be between 25 and 40 refineries in operation; this means at least one refinery in each of our consumption regions (with the exception of one or two regions of very low consumption, for instance the Massif Central in France) obtaining its crude by pipeline at a transport cost of $0.20—0.30 per metric ton per 100 kilometres.

Coal transport is much more expensive, with the difference in cost rising the further inland we go. The difference per metric ton of hard-coal equivalent may be estimated as follows :

Consumption region	Port of entry	Transport charge difference per m. t. H.C.E. available
North Rhine-Westphalia	Rotterdam	$ 1.00
Eastern France	Antwerp	$ 2.00

In addition, as already noted in the previous chapter, fuel oil may offer certain specific advantages over coal, varying considerably according to the use involved.

Fuel oil competition will effect graded coal, anthracite and power station steam coal. A detailed calculation of the effect of fuel oil competition would entail the possession of accurate information which is not at present available, but we can gain some idea by looking at the share of solid fuel in meeting the demand represented by the market figures calculated above. The lower this share, the less the effect of fuel oil consumption.

Except for the Ruhr coalfield, the percentages in industry and the domestic sector are fairly low. This suggests that competition from fuel oil will not appreciably encroach on the market envisaged for graded coal and small coke. In the Ruhr, on the other hand, the percentage is high and without risking an exact figure we can say that the coal market would probably be reduced by several million tons.

The same type of calculation can be made for power stations. Here again the Ruhr presents the major problem. If the c.i.f. price per calorie is the same for fuel oil and coal, we can estimate a difference of $0.70—1.00 in favour of fuel oil in the Ruhr. Competition from fuel oil may be capable of reducing the power station market for Ruhr coal by 4—5 million metric tons.

C — *Overall results of the specimen calculation undertaken*

It remains to be seen how competition operates between fuel oil and imported coal. If the c.i.f. price per calorie is the same, fuel oil will supplant imported coal with most inland consumers owing to its lower transport cost per calorie and its specific advantages for certain uses. We can thus assume that the coal market (Community + imported coal) will roughly achieve the minimum level forecast in the previous chapter.

We can now work out the suggested primary energy breakdown according to major sectors of consumption, as shown in Table 54. In more overall terms, total demand would be met as follows :

	Community output	Imports	Total
Hard coal	164	70— 80	234—244
Brown coal	32	—	32
Oil	20	312—294	332—314
Natural gas	33	7— 15	40— 48
Hydro power and nuclear energy	60	2	62
Total	309	391	700

The Community output would thus cover 44% of demand.

The same type of calculation can be applied using other values of v and f corresponding to the sum of the c.i.f. import price, duty (if any) and subsidy (if any) per metric ton of marginal Community coal for steam coal and coking fines respectively. It can also be utilised either — as above — on the assumption that each coalfield sells at a single price per grade equivalent to the production costs of the marginal pit, or else on the assumption that sales take place at average coalfield cost. The following chapter gives the result of various alternatives for both hypotheses.

Table 54 — Suggested Primary Energy Supply Breakdown in 1970 ('000,000 m. t. H. C. E.)

for v = $ 15.00
f = $ 17.00

	Hard coal: Community	Hard coal: Imported	Brown coal	Oil	Natural gas	Manufactured gas	Blast furnace gas	Hydro thermal and geo-power	Nuclear electricity	Total
I. Energy producers converters and distributors										
a) Own consumption and conversion and transmission losses	12		2	24	1	7	5			51
b) Manufactured gas equivalent in terms of primary energy	19	5		3		—27				—
c) Total (a+b)	31	5	2	27	1	—20	5	—		51
II. Iron and steel industry										
a) Gross consumption	48	13	—	12	8	6	14			101
b) Blast furnace gas production							—24			—24
c) Net consumption of sector (a+b)	48	13	—	12	8	6	—10			77
III. Other Industries			4	75-65	22-28	6	—			125
IV. Transport	40	32-37		99						102
V. Domestic Sector			3	64-61	7-9	8				133
VI. Power Stations	45	20-25	23	55-50	2	—	5	54	8	212
VII. Total primary energy requirements Ic+IIc+III+IV +V+VI)	164	70-80	32	332-314	40-48	—	—	54	8	700

N.B. The maximum and minimum figures given in the body of the table do not add up to the totals given in the bottom row as some of the items involved overlap.

Chapter 15

The position in the Community in 1970

Section 1 — Community coal disposals according to various specimen calculations

The method described in the preceding chapter has been applied to various specimen calculations differing according to the import price + duty + subsidy total. Calculations have been made for four values for each main product, namely \$13.00, 15.00, 16.00 and 18.00 per metric ton hard-coal equivalent for steam coal and \$15.00, 17.00, 18.00 and 20.00 for coking coal.

We have also allowed for both selling alternatives in each coalfield, namely marginal cost or average cost. In the former case there is a single selling price per coalfield for each grade of coal equivalent to the production costs of the marginal pit supplying that grade; in the latter there is a restriction imposed by the need for the coalfield as a whole to balance its costs. This means that profits from high-productivity pits are used to offset losses from low-productivity pits in order to balance the total revenue and expenditure of the coalfield in question. The latter method obviously presupposes a more highly developed organisation in the coalfields involved. It has only been possible to make this calculation for the types of coal and coalfields for which cost curves are available. For anthracite in general and for steam coal from the Lower Saxony and Centre/Midi fields the quantities given are those adopted in the marginal cost calculation.

We have thus examined eight alternatives, whose results are shown in Tables 55 (sale at marginal cost) and 56 (sale at average cost). The results for alternatives A are not given in the tables and call for special comment. The mechanical application of the calculation methods described above results in very low outlet figures of the order of 105 million metric tons for Community coalfields as a whole. At this output level, which differs considerably from the present one, the market would have to be very highly concentrated geographically and in this case our analytical fiction of concentrating a region's consumption at its centre would no longer be a sufficiently refined instrument, especially since it cannot allow for the advantages to pithead power stations and coking plants of being in the immediate vicinity of their source of supply. This makes a correction necessary, thus entailing a very detailed examination of each coalfield. Provisionally it can be estimated that all the pithead coking plants and power stations expected to be operating in 1966 will, in the light of the investigation into investment expenditure, still be running in 1970 and will be supplied exclusively with Community coal. This means that we can raise the figure by about 20 million metric tons, thus giving us a market of some 125 million metric tons with sales at marginal cost and 135 million metric tons with sales at average cost (a little more than half of this relates to coking coal).

The outlet figures for the various alternatives mean that output must be about 3% higher in order to meet collieries' own consumption.

Selling at average instead of marginal cost increases the market for Community coal. Thus under alternative C the Ruhr could reach South German markets and the Nord and Pas-de-Calais could meet the entire demand from the north of France with the exception of the coastal regions.

It should be emphasised that the results given in Tables 55 and 56 are based on full costs, including depreciation and financial charges, i.e. on the assumption that the production capacities achieved by 1970 will be maintained. Calculating on the basis of regression costs for marginal pits, disposal levels in 1970 would be higher (although output would have to drop in subsequent years); this point will be dealt with in greater detail in Section 4 below.

We would repeat that the level of the parameters v and f is capable of several interpretations, since a given value of v or f may reflect different values of the two terms c.i.f. import price and Community coal aid. v = $16.00 may thus have the following alternative interpretations :

c.i.f. price	13	14	15	16
aid	3	2	1	0

and the aid may be either in the form of duty or subsidy or a combination of the two.

The advantage of this parametric presentation is to give the reader results which are valid for various estimates of the c.i.f. price.

It now remains to ask what seems the most likely c.i.f. price level for 1970. On the basis of the details given in Part Three, we can suggest $13.00—13.50 for American steam coal c.i.f. ARA port and approximately $15.50 for coking fines. The c.i.f. fuel oil price will be $18.00—19.00, so that the cost per metric ton hard-coal equivalent would be for the same as coal.

On the basis of the foregoing calculations the volume of Community coal which is competitive with imported energy in the absence of duty or subsidy, on the basis of selling at coalfield marginal cost would be about 125 million metric tons, i.e. a little over half the present output.

Assistance (via duty or subsidy) amounting to $2.00 would enable outlets to be increased by 40 million metric tons; $4.00—5.00 would give an increase of 100 million metric tons.

These tables and figures relate to 1970. Similar calculations could be made for 1965 and 1975, but the results are not given for the following reasons.

Table 55 — Possible Market for Community Coal in 1970 under Various Alternatives on Full Basis (marginal cost sales)

I. Each variant is defined by the differing values of the parameters v and f, representing, for imported steam coal and coking fines respectively, the c.i.f. import price plus duty (if any) and subsidy (if any) per metric ton of marginal Community coal (v and f in $ m. t. H. C. E.) ('000,000 m. t.)

Alternative	Coking	Steam-raising	Anthracite	Total sales to consumers	Collieries' own consumption	Total market
A. v = 13 f = 15 For record only — see text.						
B. v = 15 f = 17	74	69	16	159	5	164
C. v = 16 f = 18	75	85	16	176	5	181
D. v = 18 f = 20	77	119	16	212	6	218

N.B. These figures are based on full costs. With regression costs they work out appreciably higher, especially in cases A and B (see Section 4, page 168).

Table 56 — Possible Market for Community Coal in 1970 under Various Alternatives (average cost sales)

I. Each variant is defined by the differing values of the parameters v and f, representing, for imported steam coal and coking fines respectively, the c.i.f. import price plus duty (if any) and subsidy (if any) per metric ton of marginal Community coal (v and f in $ m. t. H. C. E.) ('000,000 m. t.)

Alternative	Coking	Steam-raising	Anthracite	Total sales to consumers	Collieries' own consumption	Total market
A. v = 13 f = 15 For record only — see text.						
B. v = 15 f = 17	74	81	16	171	5	176
C. v = 16 f = 18	76	117	16	209	6	215
D. v = 18 f = 20	78	126	16	220	7	227

N.B. These figures are based on full costs. With contraction costs they work out appreciably higher, especially in cases A and B (see Section 4, page 168).

For 1965 we can assume that the factors of inertia referred to earlier will still be in evidence, so that the amounts of Community coal likely to find a market will in practice be appreciably larger than those arrived at by calculating strictly along the lines described.

For 1975 this line of calculation has about the same validity as 1970. In the interests of brevity it is not proposed to give the results in full detail, but in outline they are as follows. As compared with 1970, two factors will be operating in opposite directions by 1975 :

(i) the upward trend in the costs of Community coal as against a comparative stability in the prices of imported products will result in the price-indifference lines *(lignes d'équiprix)* — along which the consumer pays the same price for indigenous as for imported coal — shifting closer to production centres;

(ii) as a result of the all-round rise in demand the requirements of consumers close to the pits will tend to increase.

The calculation shows that between 1970 and 1975 these two factors will approximately balance each other out; the shrinkage in the actual area of each coalfield's market will be offset by more concentrated consumption of energy within that area, so that the marketable tonnages will be much the same in both years under each alternative.

Section 2 — The Community's overall energy position

On the basis of the foregoing it is possible to work out a rough picture of the Community's overall energy position in 1970.

Table 58 gives figures based on parity of c.i.f. price per calorie for various imported products. In this case inland requirements not covered by Community primary output will be met by oil products rather than imported coal, whose transport costs are much higher. Coal, both Community and imported, would then cover about one third of the demand and oil nearly half.

The estimated coal level would seem to represent a minimum not likely to be substantially affected if the c.i.f price per metric ton hard-coal equivalent of oil products is a little less than that of imported coal. If, on the other hand, it is higher — a possibility which cannot be entirely ruled out (see Chapters 9 and 17) — coal imports might be some tens of millions of metric tons higher, so that coal and oil products would then meet an equivalent share of the demand (about 40% each).

Community output would thus cover between 40% and 50% of internal demand by 1970 as against 73% in 1960 (Table 57).

Table 57 — Energy Supply Pattern of the Community in 1960

A — In millions of metric tons hard-coal equivalent

	Community output	Net imports[1]	Total[2]
Hard coal	235	13	248
Brown coal	29	4	33
Oil	17	106	123
Natural Gas	14	—	14
Hydro Power	41	2	43
Nuclear Energy	—	—	—
Total	336	125	461

B — In percentages

	Community output	Net imports	Total
Hard coal	51	3	54
Brown coal	6	1	7
Oil	4	23	27
Natural Gas	3	—	3
Hydro Power	9	—	9
Nuclear Energy	—	—	—
Total	73	27	100

1) And stock fluctuations.
2) Excluding bunkers.

Table 58 — Energy Supply Pattern of the Community in 1970

A — In millions of metric tons hard-coal equivalent

	Community output	Imports	Total[1])
Hard coal	125-225	110-30	235-255
Brown coal	32	—	32
Oil	20	310-286	330-306
Natural Gas	33	8-12	41-45
Hydro Power	52	2	54
Nuclear Energy	8	—	8
Total	270-370	430-330	700

B — In percentages

	Community output	Imports	Total
Hard coal	18-32	15-4	33-36
Brown coal	5	—	5
Oil	3	45-42	48-45
Natural Gas	5	1	6
Hydro Power	7	—	7
Nuclear Energy	1	—	1
Total	39-53	61-47	100

N.B. These figures assume parity of c.i.f. prices per metric ton hard-coal equivalent as between imported coal and fuel oil.

Table 59 — Energy Supply Pattern of the Community in 1975

A — In millions of metric tons hard-coal equivalent

	Community output	Imports	Total[1])
Hard coal	125-200	100-40	225-240
Brown coal	34	—	34
Oil	20	420-371	440-391
Natural Gas	44-56	20-26	64-82
Hydro Power	58	2	60
Nuclear Energy	24-40	—	24-40
Total	305-408	542-439	847

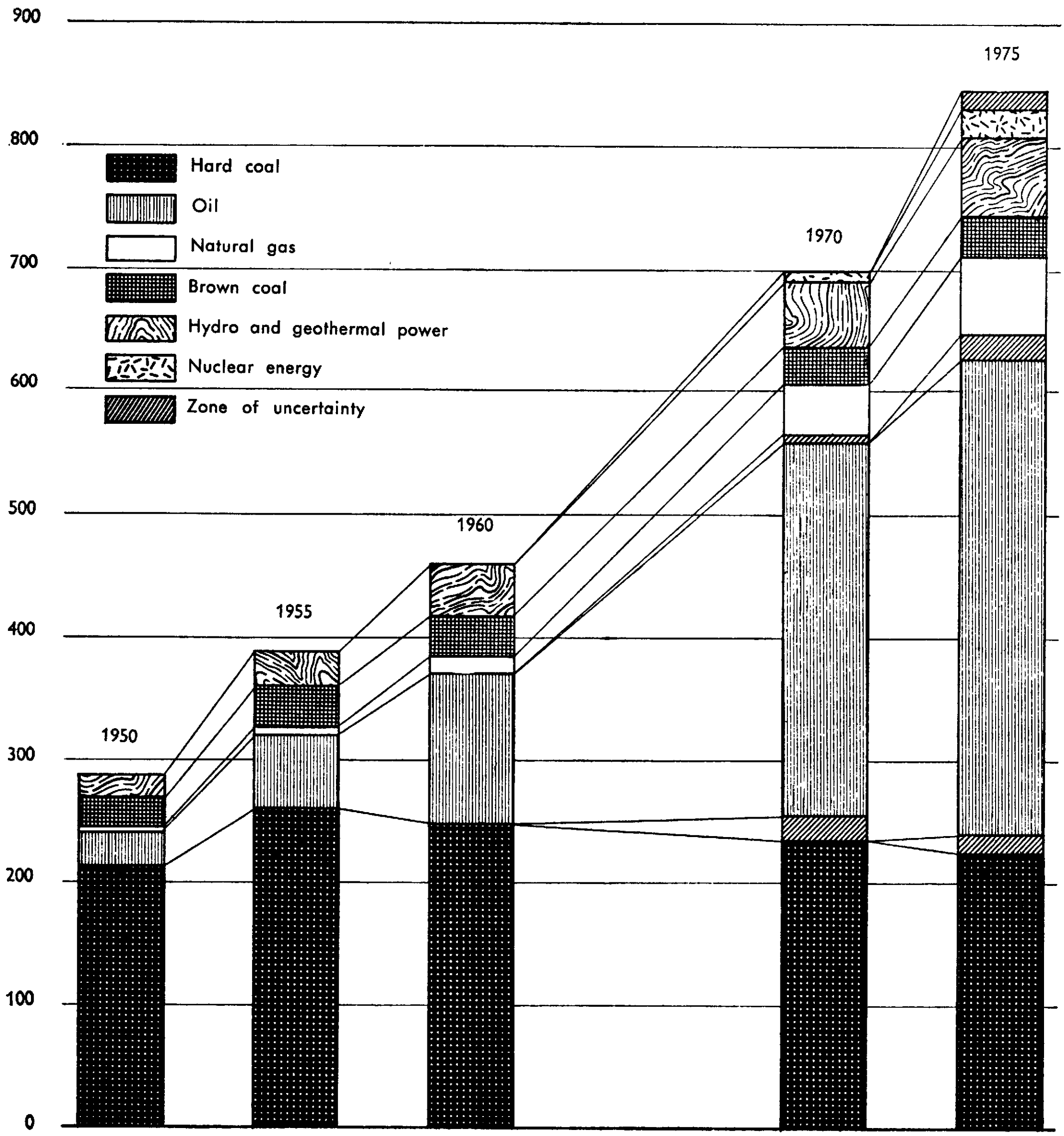
B — In percentages

	Community output	Imports	Total
Hard coal	15-23	11-5	26-28
Brown coal	4	—	4
Oil	2	50-44	52-46
Natural Gas	5-7	3	8-10
Hydro Power	7	—	7
Nuclear Energy	3-5	—	3-5
Total	36-48	64-52	100

1) Excluding bunkers.

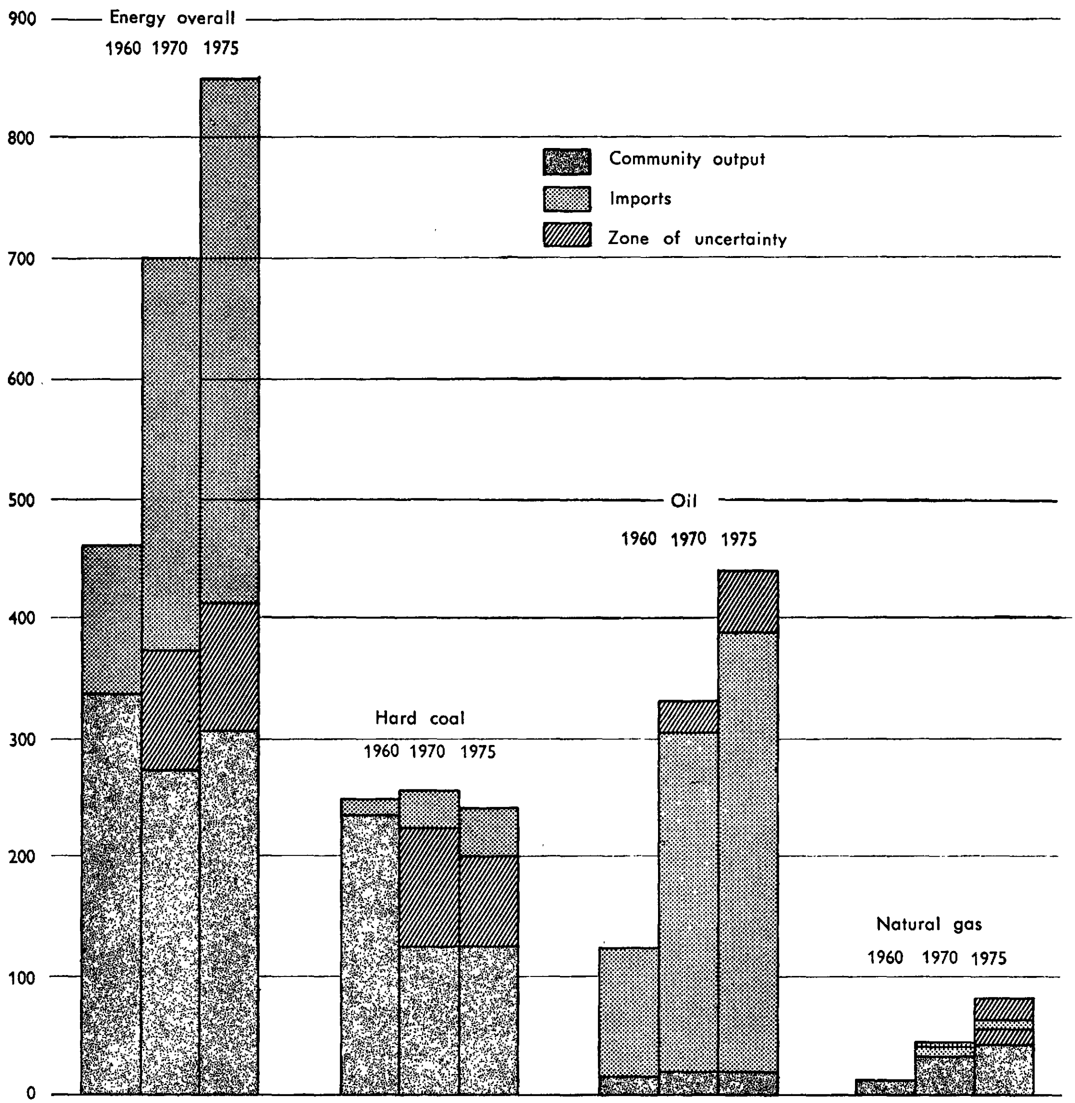
Graph VII

Changes in the Energy Supply Pattern of the Community, 1950 – 1975
(in millions of metric tons hard-coal equivalent)



Graph VIII

Coverage of Community Requirements from Indigenous and Imported Sources, 1960, 1970 and 1975 (in millions of metric tons hard-coal equivalent)



N. B.: The zones of uncertainty for the different products are to some extent interdependent, so that the zone indicated under „overall" does not simply represent the aggregate.

Section 3 — Accuracy of results

No illusions can be entertained about the mass of figures given above, which should be regarded as merely approximate, owing to the numerous factors of uncertainty involved in the various stages of the calculation. The main implications of this will now be dealt with.

A — *Cost curves*

We have already noted that the hypotheses adopted, particularly as regards wage trends, probably result in somewhat low costs, so that outlets tend to be overestimated.

A parametric presentation of the alternatives selected has been adopted in the preceding sections. This reveals straightaway the effect of an alteration in cost curves arising from different miner's wage or productivity trends.

Furthermore, as stipulated in Chapter 6, the cost curves for Community coal maintain the present ratio between social security charges and wages for the period under review. They therefore imply that measures will be taken to prevent this ratio deteriorating in the event of contraction. The fact remains that the present ratio may nevertheless include certain abnormal items which can only be estimated with great difficulty. Initial analyses suggest that these charges should not exceed \$1.00 per metric ton under the most unfavourable circumstances. If subsequent investigations confirm this figure, the following tables indicating the level of competitiveness must be read as though the point of equilibrium corresponded to a c.i.f. price or aid level of \$1.00 less.

B — *Regional energy requirements*

Uncertainty exists as to overall requirements and regional breakdown. It is clear that the homothetic growth hypothesis adopted above is inaccurate, because the regional policies of various countries aim at levelling out differences in living standards between one region and another. Nevertheless a detailed examination of the anticipated outlets for Community coal in each region shows that in most cases these outlets would remain substantially the same if a different regional development hypothesis were adopted, seeing that they only represent a fraction of the energy requirements of each region. Only in the Ruhr might there be appreciable differences; here outlets need correcting in the same direction as demand, but it is likely that regional policy will tend to provide regions such as Bavaria with a higher growth rate than the national average, so that the trend in the Ruhr would be slightly slower than that of the rest of the country. The conclusion is that the hypothesis of homethetic development tends to increase outlets for the Ruhr coalfield.

C — *Transport charges*

These constitute one of the major links in the calculation. Community coal outlets will clearly depend to a certain extent on transport policy. Although it is impossible to estimate the effect exactly, it is already noticeable that a general increase in transport charges tends to expand Community coal outlets, since by 1970 the indigenous product will be carried over shorter distances than competing imported products. An attempt will be made to estimate the effect of this at a later stage.

D — *Overall results*

Despite the difficulty of giving an accurate estimate of the degree of uncertainty affecting the above figures, it seems likely that the market is overestimated rather than the contrary for each alternative, although this is only valid if the productivity trend assumed for the collieries is correct; with a different trend the market could vary.

Section 4 — The influence of timing on the above results

The tables showing the possible market for Community coal under various aid alternatives in the previous sections are intended to represent various specific points in time in order to show the competitive position of a pit which is assumed to be maintaining its production capacity over a long period.

To use these tables to advantage, we must be very careful to bear in mind that production levels at different dates are interdependent :

(i) firstly, we cannot envisage substantial fluctuations either upwards or downwards over a period of time, because this would mean capacity being under-employed at some time and the number of miners in employment fluctuating to an extent which is unthinkable;

(ii) secondly, coal can be mined at pits which it is intended to close down at a later date, in which case the pit's production costs drop considerably. Further reference will be made to this point.

A — *Regression costs*

Under normal circumstances a colliery acts so as to enable its production capacity to be maintained several years later, e.g. by preparing to work a lower level. If this preparatory work is done away with a substantial saving results. In addition a decision to close the pit enables depreciation charges to be discounted on equipment no longer requiring renewal.

The competitive position of a pit at a given moment therefore depends on its future production prospects. Three cases can be envisaged :

(i) permanent maintenance of production capacity;

(ii) pit kept open, but with the prospect of closing in a few years;

(iii) immediate closure.

To study the first possibility we must work on the basis of full costs as calculated in Chapter 6, which is what we have done previously.

In the other two cases we must use "regression costs", [1]) which are derived from full costs by deducting certain items relating to preparatory work and depreciation. At a given pit these items increase as closure draws nearer, but they can vary very heavily from one pit to another according to geological conditions and the degree of modernisation of the pit.

Financial charges require careful treatment when calculating regression costs, owing to certain legal considerations. Past financial charges have to be distinguished from new ones. Economically the closing of a pit makes no difference to past financial charges, i.e. the charges will continue to apply whether the pit remains open or not, so that they should be excluded when calculating the production costs of a pit kept open temporarily.

Legally several situations are possible : if the pit belongs to an undertaking continuing in business, the latter must continue to pay the charges, whereas if the pit is the undertaking's sole business the closing-down of the former will entail that of the latter and the undertaking's creditors will lose their capital.

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[1]) So-called because they relate to pits whose output will contract fairly quickly.

A conflict may thus arise between the economic and legal aspects. If the undertaking remains in business, closing down one pit may raise the book cost of other products (particularly the output of other pits), without there being any corresponding increase in economic cost, which means that pits which would be economically competitive are rendered un-competitive. If the undertaking is a single pit, the burden of past financial charges may force it to close, although on the basis of partial costs it would be economic to continue operations for some years.

The case of fresh financial charges is obviously quite different and much more simple : if carrying on mining means creating fresh charges, these must be included in the "regression costs".

For all these reasons, "regression costs" differ from full costs by an amount which varies considerably from one pit to another. Purely by way of guidance, calculations in respect of certain pits seem to indicate a difference of between $1.00 and 3.00. Likewise the lifetime of such a pit varies greatly according to its condition at the time when it is decided to close it down; the period involved may be between roughly three and ten years.

B — *Working out production prospects*

Strictly speaking the proper method is to work backwards from a date for which one has postulated the desired long-term production level and by when one assumes that reorganisation will have been completed. The following is an example :

Table 60 — Hypothetical Trends in Marketable Production of Community Coal ('000,000 m. t.)

Hypothesis		Marketable production				
		1960	1965	1970	1975	1980
1	Aid $ 2.00 from 1963 onwards Production steady after 1975	230	215	195	150	150
2	Aid $ 3.00 from 1963 to 1970 $ 2.00 after 1970 Production steady after 1975	230	225	205	150	150
3	Aid $ 2.00 from 1963 Production steady after 1980	230	215	195	165	150
4	Aid $ 3.00 from 1963 to 1970 $ 2.00 after 1970 Production steady after 1980	230	225	205	170	150

Assuming that we decide on a capacity of 150 million metric tons after 1975, necessitating aid amounting to \$2.00 per marginal metric ton in 1975, production in the previous years would be 150 million metric tons plus the output of the pits due to close before 1975. Thus for 1970, with \$2.00 aid, 160 million metric tons can be marketed on a full cost basis plus approximately 30—40 million metric tons on a regression costs basis. Corresponding figures for 1965 would be 160 and 50—55. If we assume an aid level of \$2.00 throughout the period and steady production after 1975, we obtain the trend shown for hypothesis 1 (see Table 60). With a different level of aid between now and 1970 the trend will differ, as ist will if the date when production assumes a steady level is put forward. Three further examples are given in the table.

A variety of trends are therefore possible according to the hypothesis adopted as to the trend in the level of aid and the completion date for reorganisation.

Part Five

The Major Problems Involved in the Long-Term Energy Balance

The previous chapter shows the Community's possible energy supply structure — assuming free consumer choice automatically directed towards the cheapest supplier — for alternative Community coal output levels and varying degree of aid from the authorities.

The degree of aid required to raise the production level of marketable coal not only results in a burden on the economy but also has other effects, for instance on the average price of energy at consumer level. These problems will be dealt with in Chapter 16.

The supply patterns arrived at in Chapter 15 show the increasing importance of imports, not only in volume but also in the share of demand covered. It is thus necessary to examine the outlook for long-term security and stability of supply (see Chapter 17).

Increasing reliance on imports may also influence the balance of payments position, which is briefly discussed in Chapter 18, Section 2.

Although the intention is not to deal with manpower questions in detail until the General Objectives for Coal are actually prepared, a brief review will be given in Chapter 18, Section 1, of labour force trends and the problems they raise.

Lastly, we shall see that cyclical fluctuations, to which not all energy producers are equally sensitive, are capable of constituting an obstacle to the steady trend in the energy position (Chapter 18, Section 3).

Chapter 16

Forms and cost of assistance for Community coal

The aim of this chapter is to describe the means and cost of providing assistance for Community coal to raise sales above a level which would be strictly competitive. [1])

Firstly we must remember that there are *two selling systems* for any given coalfield : either the price equals the costs of the marginal pit with the highest production costs (less any subsidy) or else the average costs of the coalfield (again less any subsidy) arrived at by compensation between efficient and inefficient pits. [2]) (We have seen in Chapter 15, Section 1, that the amount of aid required to ensure the marketing of a given quantity of Community coal is lower in the second case than in the first.) Whatever method is actually employed, we shall assume that there is a *single pithead price* for any given grade at all mines in the coalfield concerned.

There are several possible ways of achieving the objective of reducing the difference to the consumer between the price of Community coal and that of imported energy :

(i) by imposing a duty, thus making imported energy more expensive;

(ii) by subsidising production, thus making Community coal cheaper. The subsidy can either be payable at a flat rate for all the pits in a given coalfield (or possibly in all coalfields), equalling the difference between the selling price and the costs of the marginal pit (i.e. the highest-cost pit in production) or else it can be differentiated pit by pit according to production costs so as to represent the difference between the selling price for the coalfield and the production costs of the particular pit concerned;

(iii) by subsidising consumption so that consumers will pay the same for Community coal as for imported fuels.

Two factors require consideration :

(i) the cost to the economy as a whole;

(ii) the apportionment of benefits and disadvantages amongst those concerned according to the method of aid proposed.

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[1]) The account which follows is deliberately simplified, but even so sufficient complications remain to show the reader how complex the problem is and how far-reaching are the repercussions which aid may have throughout the economy.

[2]) Present practice probably lies somewhere between these two extremes, since some undertakings possess both efficient and inefficient pits whose costs can to a certain extent be balanced out.

These two factors must be carefully distinguished, since paying a subsidy does not automatically constitute a burden on the economy if its only effect is to transfer from certain economic agents to other agents without any additional call on production factors. On the other hand any measure which raises the volume of production factors required to ensure overall energy supplies does constitute a burden on the economy even if no direct subsidy is paid. We shall see below how these two notions compare with each other on a quantitative basis.

To calculate all the effects involved accurately is extremely difficult and entails having a detailed knowledge of cost and demand curves (and thus of consumer location) and assessing the side-effects on the economy as a whole. This precludes our offering a complete set of figures here, but in order to render the following exposition of the main effects more intelligible, since they vary according to the type of aid adopted and the method used to fix coal prices, we shall give rounded figures for raising Community coal disposals from the marginal-cost-sale level [1]) they would achieve without aid (about 125 million metric tons) to a level of about 180 million metric tons (corresponding to aid per marginal metric ton of about $3.00 for marginal cost sales and about $2.00 for average cost sales). The results are summarised in Table 61. Although this example is backed up by figures it in no way affects the final choice of a production level lying between the competitive nucleus and the present output.

Section 1 — The cost to the economy of supporting Community coal production

Whatever the system of aid adopted, the basic cost to the economy as a whole is the result of producing at, say, $14.00 per metric ton (delivered price to the consumer) a product which could be imported and paid for by exported goods manufactured at a cost of, say, $13.00 per metric ton. The cost to the economy would then be $1.00 per protected or subsidised metric ton.

Thus, as regards coal production, subsidisation and protection place the same burden on the economy inasmuch as they serve to keep plant, manpower and capital artificially tied up in the collieries that could be used to better advantage elsewhere. The cost to the economy of marketing 180 million metric tons instead of 125 would work at about $120 million a year.

[1]) Assuming a c. i. f. imported product price of $ 13.00 per metric ton hard-coal equivalent.

From this gross cost should be deducted any costs incurred as a result of unorganised regression in production and injudicious redevelopment. These latter costs, however, tend to cancel one another out after a period of years.

In addition the cost to the economy increase in the case of tariff protection, which puts up the price of imported energy and may enable other energy producers to increase their output and market products which would not be competitive with unpenalised imported energy. Additional hydroelectric plants can be built, for instance. Here we have a second example of the cost to the economy of its energy supplies being increased, but this item is not estimated here in terms of figures because it is well below the level of the main item.

Section 2 — The effect of different types of assistance

Besides placing a heavier burden on the economy, a policy of assistance for Community coal will have a number of other effects varying according to the type of arrangement adopted. These will now be discussed (see Table 61).

A — *The effect of tariff protection*

Tariff protection sends up the price of imported energy and hence the level of pithead prices at which Community coal can be marketed. This means that the price of other Community energy then benefiting from the same protection as Community coal may also rise.

(a) When the selling price of coal is fixed at marginal cost level, the following effects may be noted :

(i) the cost to the economy of its energy supplies rises (see above (production of expensive coal at a cost of $120 million and a possible rise in output of other Community energy producers above the economically reasonable level);

(ii) a rise in the price of imported energy ($1,120 million);

(iii) the provision of intra-marginal rent owing to the increased selling price of Community energy. First of all there is intra-marginal rent for all pits whose production costs are below that of the marginal pit ($130 million). Secondly, there is possible intra-marginal rent for other Community energy producers who can raise their selling price by the amount of the duty (amount x, between $0 and $440 million).

The increased price to the energy consumer is the sum of the above effects (increased cost of energy to the economy, rise in price of imported energy and provision of intra-marginal rent))and may thus amount to $1,370 + x million (i.e. 15—20% of total cost of supply).

This increase in price to the consumer might partially be prevented by using all or some of the revenue from the import duty to bring down energy prices by a general subsidy in respect of all fuels, which leaves their competitive position *vis-à-vis* one another unchanged. Assuming this possibility is exploited to the full, the net amount of the increase is $1,370 + x — 1,120 = 250 + x million. This more or less wipes out the rise in the price of imported energy and leaves us merely with the greater burden on the economy as a whole and the provision of intra-marginal rent ($120 + 130 + x million, i.e. 3—8%).

It will be seen that the more important of these two factors is the provision of intra-marginal rent, in particular to other energy producers.

(b) With coal sold at average coalfield cost, we are faced with a new situation. Selling at average cost means that the efficient pits subsidies the inefficient ones; at coalfield level the transition from marginal cost to average cost sales thus eliminates the intra-marginal rent of the better pits ($80 million) and at the same time increases the marketable output. In addition the other effects mentioned above continue to operate, but to a different extent. Although the cost to the economy is the same ($120 million), the increase in import prices is nevertheless lower ($750 million), as is the intra-marginal rent, since the level of protection can be lower in order to ensure the same volume of coal sales ($2.00 instead of $3.00).

B — *The effect of subsidising coal producers*

The aim of the subsidy is to reduce the price of Community coal so as to enable it to find fresh markets.

As stated above, there are three possibilities :

(i) flat-rate subsidy for all pits in the coalfield and marginal cost sales;

(ii) flat-rate subsidy and average cost sales;

(iii) differential subsidy depending on the production costs of each pit and marginal cost sales.

In the case of average cost sales, the pits are balanced out and the only possibility is then the flat-rate subsidy for all pits in the coalfield.

(a) Flat-rate subsidy and marginal cost sales

The subsidy is the amount necessary to make the marginal pit competitive ($3.00 in the calculated example). The main effects are as follows :

(i) an increase in the cost to the economy of its energy supplies (see above) owing to the production of expensive coal ($120 million);

(ii) the provision of intra-marginal rent for pits whose production costs are lower than those of the marginal pit (the reduced income of these pits owing to the lower price of coal is more than offset by payment of the subsidy ($130 million);

(iii) the provision of a consumer surplus for coal purchasers, who benefit from the reduced selling price of Community coal ($290 million).

The subsidy required is the sum of the above three amounts, namely $540 million.

The effect on the price the consumer pays for his energy depends on the way in which tax is collected to produce the subsidy. If it is levied on the remainder of the economy, we have the apparent paradox of a slight drop in price owing to the lower selling price of Community coal (—3.1%). If it is levied solely on energy, however, the price to the consumer rises, thus balancing out the additional cost to the economy as a whole and the intra-marginal rent enjoyed by certain pits (+2.8%).

(b) Flat-rate subsidy and average cost sales

At $2.00 the subsidy is less than in the preceding case (marginal cost sales) because the more efficient pits to a certain extent subsidise the less efficient ones. The cost to the economy is the same ($120 million), as is the consumer surplus ($290 million). At this point, however, we have a repetition of the phenomenon referred to above in connection with tariff protection, namely a reduction in the producers' intra-marginal rent owing to the transition from marginal cost to average cost sales ($80 million). The total amount of the subsidy is the algebraical sum of the above three items (120 + 290 — 80 = $330 million). Here again the effect on the average price the consumer pays for his energy depends on the way in which the subsidy is financed. If it is levied entirely on energy, the increase in average cost is about 0.5%.

(c) Differentiated subsidy and marginal cost sales

The subsidy varies from pit to pit according to production costs and is limited to what is strictly necessary to make each pit competitive.

The effects are then as follows :

(i) increased cost to the economy of its energy supplies (\$120 million);

(ii) the provision of a consumer surplus for certain purchasers (as above) (\$290 million);

(iii) owing to the fall in the price of coal, the elimination of all or part of the intra-marginal rent previously enjoyed by some producers owing to the difference between their production costs and the coal-field selling price (unlike the case of the flat-rate subsidy, this effect is no longer counteracted by the subsidy payment) (—\$70 million).

The subsidy must cover both the cost to the Community and the difference between the above-mentioned consumer surplus and eliminated intra-marginal rent (120 + 290 — 70 = \$340 million). Here again the effect on the price of energy depends on the way in which the subsidy is financed. [1]

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[1]) A further means of increasing Community coal outlets is to combine subsidies to selected pits with subsidies to selected consumers so that the latter pay the same price for Community as for imported energy. This procedure enables either type of subsidy to be concentrated on and a wide range of effects to be obtained; in addition a certain amount of latitude exists in selecting the consumers to be subsidised (for instance subsidies can be restricted to thermal power stations or extended to other major consumers such as the iron and steel industry, cement works, particular types of chemical factories, etc.). Owing to the wide range of alternatives, we have decided not to work out any figures because they would be only of limited value.

Table 61 — Example Illustrating Effects of Various Types of Aid for Community Coal (1970) (rounded figures in millions of dollars)

	Selling system	Aid ($/m. t.)	Community production ('000,000 m.t. H.C.E.)		Imports ('000,000 m. t. H.C.E.)	Total consumption ('000,000 m. t. H.C.E.)
Reference calculation	Marginal cost	—	125	146	429	700
Hypothesis A	Marginal cost	3	181	146	373	700
Hypothesis B	Average cost	2	176	146	378	700
		Customs duty		Flat-rate tariff		Differentiated tariff
		A	B	A	B	A
1. Increased cost to the Community		120	120	120	120	120
2. Increased price of other sources of energy						
a) imported energy		1,120	750	—	—	—
b) other Community energy		(for record only) x	y	—	—	—
3. Intra-marginal rent for coal producers		130	—80	130	—80	—70
4. Intra-marginal rent for other energy producers		x	y			
5. Coal consumer surplus						
6. Amount of subsidy (=1+3+5)		—	—	290	290	290
7. Revenue from duty (=2a)		1,120	750	540	330	340
8. Change in total energy expenditure of consumer (+ rise — fall)						
a) Financial machinery confined to energy (1+2+3—7)		250+x	40+y	+250	+40	+50
b) Financial machinery operating outside energy[1]) (1+2+3—6)		1,370+x	790+y	—290	—290	—290
a) As percentage of cost of energy to the economy as a whole		3 to 8%	1 to 3%	+2.8%	+0.5%	+0.6%
b) Do.		15 to 20%	9 to 11%	—3.1%	—3.1%	—3.1%

1) Revenue from duty distributed to or subsidies financed out of remainder of economy.
A. Marginal cost sales.
B. Average cost sales.

Section 3 — Effects compared

Bearing in mind that the foregoing details (summarised in Table 61) relate to the main and most likely effects and do not exhaust all the complex aspects of aid for Community coal, we can now compare the various forms of assistance.

Firstly we must remember that the cost to the economy as a whole of raising coal production is the same whatever the form of aid adopted, whereas tariff protection runs the risk of encouraging the anti-economic output of energy in the Community other than coal.

Secondly, a number of criteria can be adopted in comparing the different methods available — degree of selectivity, workability, effects on colliery rationalisation. Finally, the combination of different systems can be envisaged.

(a) *In order of increasing selectivity* we have tariff protection, flat-rate subsidies to producers, differentiated subsidies to producers and differentiated subsidies to producers and consumers.

The customs duty is intended to aid overall sales of marginal output and cannot therefore be varied to fill the price gap between imported energy and Community coal in separate regions.

The provision of intra-marginal rent in favour not only of efficient mines but also of all other forms of energy, including competing sources, thus stimulating an anti-economic rise in other forms of Community output, is the most expensive solution to the consumer. This is because in order to affect the production of some tens of millions of tons of coal it is necessary to operate on the price of 300—400 million tons of imported products.

Subsidy systems are aimed at producing the desired effect directly. The most costly method is to pay a flat-rate subsidy and allow the coalfields to sell at marginal cost. Subsidy differentiation obviously enables the total volume of subsidy to be reduced, but selling at marginal cost reduces it even further because the efficient pits subsidise the less efficient ones. This procedure seems specially suitable where the aim is to maintain a given level of production in a specified coalfield considered as a separate unit.

Lastly, the solution which reduces the volume of subsidy to the absolute minimum by equating it with the additional cost to the economy of producing non-competitive coal is to pay differentiated subsidies to specific producers and consumers and maintain the pithead price at equilibrium level without aid.

(b) *In order of workability* the classification is roughly the opposite. Tariff protection and flat-rate subsidies are the easiest to operate.

The payment of differentiated subsidies to producers entails a knowledge of the relative position of each pit.

The difficulty is even greater where subsidies are paid to specific consumers, because although the producer is already known, not all the consumers yet exist — they will only appear as new factories are built.

(c) *Effect on colliery rationalisation.* — The drawback of the differentiated subsidy procedure, if strictly applied, is that it reduces the incentive to cut costs, because to do so would mean a reduction in the subsidy. If differentiated subsidies are not to have the effect of impairing rationalisation, the market organisation must be such as to supplement and reinforce it by enabling control to be exerted over the relation of the subsidies to the implementation of reorganisation programmes.

In more concrete terms, if subsidies are to stand in the correct relation to rationalisation programmes, it is necessary that administrative arrangements should to some extent be centralised, e.g. in the form of nationalised collieries, co-operative rationalisation schemes, selling agencies etc.

(d) *Combination of various forms of aid.* — It may be possible to even out the advantages and disadvantages inherent in various forms of aid by adopting different systems simultaneously.

As an example, steps could be taken to ensure the balanced operation, in book-keeping terms, of financial machinery aimed at enabling a given volume of Community coal to be sold by using a revenue-producing duty system and subsidization simultaneously.

The advantages of combining two systems in this way are as follows :

(i) at a given sales level the subsidy is less than under a pure subsidy system and also tariff protection is very much lower than with a pure duty system (in the case of the volume of sales quoted above, with a flat-rate subsidy and average cost sales, the duty required would be about \$0.60 and the subsidy \$1.40);

(ii) the ratio between the volumes of imported energy and Community coal output would be such that a modest rate of duty would finance a fairly high rate of subsidy;

(iii) because the trend in the energy position will only accentuate the relative share of imported energy (at least until nuclear energy can play a decisive role), maintaining tariff protection at a constant level should enable a constant level of coal disposals to be ensured even if the competitiveness of Community coal *vis-à-vis* imported energy continues to deteriorate; if, on the other hand, it settles down at a steady level, it might be possible to reduce the rate of duty.

Chapter 17

Security of supply

The preceding chapters have shown that the share of imports in meeting the Community's requirements, currently running at about one third, will tend to increase and after about ten years will exceed 50%.

These supplies from abroad are subject to an element of risk either as regards the quantities available or as regards price stability, but often on account of both at once. The importance of energy to the smooth running of the economy is such that steps must be taken to mitigate the harmful effects of these risks. This chapter will first of all describe the nature and extent of the risks and then outline various possible remedies.

Section 1 — Risks

It is difficult to make any forecasts as to what might happen in the event of a general war, since far-reaching disturbances of every kind would affect the operation of the economy, even to the extent of cutting off energy supplies. Not only external supplies but also Community energy production might be affected.

We shall therefore confine our attention to the risks involved in a partial conflict, either political, military or economic. [1]) Repercussions may be of two kinds, either affecting the volume it is possible to import or else leading to rises in product prices.

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[1]) We shall ignore the influence of cyclical fluctuations, which will be dealt with in Chapter 18.

A — *Quantitative repercussions. The share of imports in meeting demand*

In 1970 Community energy production will lie between the following two extremes :

(i) the minimum is expected to be about 275 million tons hard-coal equivalent, 125 million of this figure being coal; this level of coal production would roughly correspond to the competitive figure, assuming that the price of imported energy was situated at the bottom of the ranges forecast in Part Three;

(ii) the maximum is expected to be about 375 million tons, with coal production maintained at the 1962 level (about 225 million tons).

Imports will thus cover between 47% and 61% of requirements. The corresponding figures for 1975 would be slightly higher, showing the continued tendency of the relative share of requirements covered by imports to increase after 1970. Not until after 1980 will the expansion of nuclear energy enable this trend to be reversed.

The foregoing very approximate figures conceal deep-seated differences in the position occupied by imports in meeting demand for various uses; they must therefore be supplemented by a somewhat more detailed view (see Tables 62 and 63).

(i) Motor fuel requirements for road transport, inland waterway navigation and a part of railway transport, covering more than half the goods traffic and three quarters of the passenger traffic, will be met almost entirely by oil products, and thus by imports.

(ii) Two thirds of the specific requirements of the iron and steel industry will be covered by Community products if coal production is brought down to a competitive level; this percentage could amount to about 80—85% with Community coal assisted to the extent of $2.00—3.00 per marginal metric ton, but is scarcely likely to rise any higher owing to the geographical location of certain iron and steel plants unless aid considerably exceeds $5.00. The remainder of the demand will be met from the U.S.A.

(iii) 41% of electricity requirements will be covered by hydroelectric and nuclear production and by power stations running on brown coal. Community hard coal will provide an additional 15—35% of the demand, according to the production level, so that 24—44% remains to be covered by imports.

(iv) The remaining requirements, mainly fuel, are expected to amount to 300 million metric tons hard-coal equivalent in 1970. Internal production will supply about 85—125 million metric tons hard-coal equivalent, so that imports will have to meet between 57% and 70% of the demand (about 45% of the requirements being met by oil products).

Table 62 — Coverage of Requirements from Indigenous and Imported Sources ('000,000 m. t. H. C. E. & %)

	1970				1975			
	A	B	C1 %	C2 %	A	B	C1 %	C2 %
Motor fuel	95	5	95	95	126	6	95	95
Iron & steel industry (specific requirements of coking coal)	92	61-78	15	34	98	61-80	18	38
Electricity production	212	120-160	25	43	282	140-190	34	50
Other requirements	301	84-127	58	72	341	98-132	61	71
Total	700	270-370	47	61	847	305-408	51	64

A — Total requirements in millions of metric tons hard-coal equivalent.
B — Requirements covered by Community production in millions of metric tons hard-coal equivalent.
C1 — Share of requirements covered by low % import limit.
C2 — Share of requirements covered by high % import limit.

Table 63 — Electricity Generation (% of total production)

		1960	1965	1970	1975
Hydroelectric and geothermal		36	27	23	18
Brown coal, blast furnace gas		16	15	14	12
Nuclear		—	1	4	7-12
Sub-Total		52	43	41	37-42
Thermal from Community coal	A (Production 125 million metric tons)	38		15	10
	B (Production 160 million metric tons)			25	17
	C (Production 220 million metric tons)			35	25
Production from Community energy	A	90		56	47-52
	B			66	54-59
	C			76	62-67
Thermal from imported products	A	10		44	53-48
	B			34	46-41
	C			24	38-33
Grand total (A or B or C)		100		100	

A strict rationing system for requirements of lesser importance might prevent heavy cuts in supplies for a short while — a few weeks at the most — causing serious economic difficulties, but prolonged scarcity would jeopardise the chances of maintaining the rate of growth. Precise calculations on this point are both tricky and open to uncertainty. [1])

B — *Price aspect*

The main risk of higher prices concerns crude oil, whose price structure includes royalties and taxes paid to producer country governments (see Chapter 9). We must not overlook the danger that these countries may well bring pressure to bear in the future to secure a larger share of the proceeds. The risk of this increases as supplies become concentrated in a few countries all situated in the same part of the world.

These price trends mainly depend on political factors whose prediction is a matter of great uncertainty, although a comparison of supply and demand prospects provides certain economic pointers.

In the present state of technology, refined oil products such as motor fuel, lubricants and some petrochemicals raw materials cannot be replaced by other products. Fuel, on the other hand, competes with other products, and one region's oil competes with another's.

With present royalties *and* the American government's policy of preserving the ratio between external purchases and domestic consumption maintained, the approximate crude oil supply and demand position for 1970 can be outlined as follows : [2])

(i) a deficit in North America (U.S.A. and Canada) and a surplus in Central and South America, giving a slight deficit trend for the western hemisphere as a whole;

(ii) a very large deficit in Western Europe, which will have to import 95% of its requirements;

(iii) a big surplus in Africa and Asia (mainly Middle East);

(iv) net shipments from Eastern countries.

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[1]) The report of the Energy Commission of the fourth French plan provides the tentative estimate that in 1975 oil products will meet about 45% of the French demand (a slightly lower figure than the forecast for the Community given above). Oil product supplies could be cut by 15% without noticeably checking economic expansion.

[2]) For details as to the way in which this pattern is made up, see Annex 11 to full Community-language edition.

(a) Competition between oil and other products

If the price of oil rises appreciably by comparison with our earlier forecasts, this form of energy will lose some of its outlets owing to competition from other products :

(i) American coal, not only on the U.S.A. market but also in Europe and many other countries. It should be borne in mind that fuel oil can only be replaced by coal on an instantaneous basis if the apparatus involved is of the dual-firing type; if not, a considerable amount of time and money will need to be spent In addition coal production elasticity in the U.S.A. is not unlimited and a large-scale increase in outlets exceeding some tens of millions of metric tons would lead to a rise in prices;

(ii) European coal : once the approximate production level consistent with a particular energy policy is laid down, the short-term possibility of increasing production is very slight (at the most 10—20 million metric tons);

(iii) natural gas : supplies to Europe could be increased either by intensifying the rate of extraction in European fields or by increasing the amount of Sahara gas transported to Europe; by 1970, allowing a lapse of a year or two for the former and three to four years for the latter, additional resources of 20—25 million metric tons hard-coal equivalent could be counted on;

(iv) nuclear energy : by 1970 the extra production potential in the Community would be a few million metric tons hard-coal equivalent at the most, with a much higher figure possible by 1980 (see Chapter 12).

(b) Competition between oil from various sources

It was pointed out in Chapter 9 that Middle East reserves are at such a level that production could be substantially increased very quickly, even when the production levels envisaged for 1970 are reached.

Relatively few new reserves have been discovered in the U.S.A. in recent years and it seems that the 1970 development and extraction forecasts for this country are barely likely to be reached, let alone exceeded.

In Venezuela the annual extraction rate is around 6% of the reserves, which is a fairly high figure. To increase production over and above the level forecast for the period from now until 1970 would entail a very large amount of prospection in view of the slackening-off during the past two years. It is unlikely that output can be increased above some sixty million metric tons.

In North Africa the 1965 production estimates cannot be very much exceeded, but intensified prospection would enable a fresh advance of 30—40 metric million tons to be recorded.

The quantities available for export outside the Eastern countries could probably be substantially exceeded.

Lastly, there are the regions at present producing little or no oil (South America, Central Africa etc.). Scarely anything is known of their production potential, although there is no doubt that the period between commencing prospection and extracting several tens of millions of metric tons would be lengthy, possibly ten to twelve years.

To sum up, the amount of crude oil capable of being replaced by other products by 1970 represents a moderate fraction of world requirements.

Potential competition among major oil-producing areas is also a significant factor, although only to a limited extent if seen from the 1970 standpoint. The further ahead we look the more it is likely to increase, but only if prospection programmes are initiated in various parts of the world a good ten years ahead.

The risk of oil product prices rising above the level forecast in Chapter 9 ($17.00—19.00 per metric ton of fuel oil) should therefore not be underestimated. This is less likely to happen if prospecting in general is carried on actively, and if the Community in particular takes the steps outlined in Section 2 below.

Section 2 — Means of improving security

Not only the long-term risk of a rise in imported oil prices but also the danger of supplies being accidentally cut off forces oil-consuming countries to see to it that alternative sources of supply are permanently available to enable them to quickly offset the blocking of certain import channels and resist price rises in imported products.

Without going into details as to how security can be improved — a subject which must be left for a separate document — we propose to briefly discuss the economic aspects of three major types of measures.

A — *Improvement in Community production*

Chapter 15 dealt in detail with the production costs of the most expensive Community coal tonnages.

With other conventional forms of energy, the possibility of exceeding the production figures forecast in this report is fairly limited :

(i) with hydro power, the possibility is less than some 20 TWh (equal to 8 million metric tons hard-coal equivalent);

(ii) with brown coal, the figure of 95 million metric tons forecast for the Rhineland can certainly be exceeded, probably up to a level of 110—120 million metric tons. The additional quantity is thus 5—7 million metric tons hard-coal equivalent. It should be noted that this additional brown coal would compete directly with Ruhr coal in thermal power stations;

(iii) with natural gas and oil, the element of uncertainty is much greater, not only as to the quantities whose discovery may be hoped for but also as to the cost of these discoveries. Nevertheless it looks as though by 1970 the additional quantity will not exceed 20—30 million metric tons hard-coal equivalent owing to the time involved in prospection and development (including, in the case of natural gas, the provision of transportation and distribution facilities).

With nuclear energy, on the other hand, *a priori* a fairly wide margin can now be envisaged, although not until 1975 and onwards. By 1970 the excess over the figure of 20 TWh suggested earlier will be 6—8 TWh at the most, i.e. 3 million metric tons hard-coal equivalent. By 1975, on the other hand, a production level 60 TWh (25 million metric tons hard-coal equivalent) higher than that envisaged may well be possible, with an increasing degree of scope for improvement in later years. Chapter 12 showed that the outlook for nuclear fuel supplies is very sound, which means that nuclear energy can play a major long-term part in improving the Community's security of energy supplies.

B — *Stockbuilding*

Stockbuilding within the Community itself is a helpful means of coping with any momentary stoppage or shrinkage of supplies from particular sources, and also affords a breathing-space for taking other steps to counter difficulties over tonnages and/or prices, but its effects are obviously only temporary. [1])

Stockbuilding costs are the sum of three items : depreciation and financial charges on installations, financial charges on stored products and deterioration, if any, during storage. Naturally they depend on the length of time for which the product is stored.

The E.E.C. Commission has undertaken a survey as part of the activities of the Working Party of Oil Experts in order to pinpoint various economic factors involved in stockbuilding, particularly costs. The next step will be to decide, firstly, what risks have to be guarded against and the likelihood of their occurring and, secondly, how they are to be met, so as to calculate what level of reserve stocks is necessary to avoid supplies being cut off and to mitigate the danger of a rise in prices.

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[1]) This does not refer to buffer stocks, which are dealt with in Chapter 18.

C — *Diversification of sources of supply*

A policy of diversifying sources of supply is not a new idea in itself; the oil companies themselves carry on prospecting in various parts of the world, where the discovery of valuable new oil deposits seems possible.

Owing to the hazardous nature of prospecting, we can never know beforehand what quantities of oil are likely to be discovered, nor their cost, which explains the highly fluctuating profitability of the deposits at present worked. Companies naturally prefer to prospect in regions where there is a likelihood of discovering low-cost oilfields. This is particularly true of the Middle East as regards supplies to Europe, all the more so as an important factor in security of supplies lies in the reserve potential at present located in America. The policy followed by the United States Government has entailed the provision of a production capacity reserve of over one hundred million tons which, although limited in time, is quickly available, and this indirectly contributes to the security of European consumers.

The results of prospecting operations in the U.S.A. in the last ten years and the outlook as to demand suggest that this reserve will steadily contract both absolutely and, still more, proportionately.

To be sure of adequate security reserves commensurate with future requirements, it will be necessary to push ahead very actively with prospecting and development operations.

European consumer countries must thus adopt a policy on supply which encourages this diversification of sources. Various steps are open to them, ranging from trading policy measures to the provision of incentives to prospect for oil either in the Community itself or in other more suitable areas. One of the objectives of Community oil policy must therefore be to devise and introduce arrangements for improving security of supply and preventing unjustified increases in oil prices.

Chapter 18

Other economic features of the 1970 energy position

Although not attempting to outline all the economic aspects of the 1970 energy position, this chapter will review four especially important points: the trend in the labour force in the coal industry, the effect of imports on the balance of payments, the sensitivity of the energy position to cyclical fluctuations and the trend between now and 1970.

Section 1 — The trend in the labour force in the coal industry

The aim of this section is not to deal with labour problems in the Community's coalmining industry, which will be studied in great detail when the General Objectives for Coal are drawn up, but simply to recall certain fundamental figures in the present situation and to provide approximate estimates of the future trend in the light of the main hypotheses and results contained in the earlier parts of this report. A final task will be to describe the nature of the major problems likely to arise.

Table 64 — Labour employed in Community Coalmines ('000 workers at end of year).

	1955	1958	1961
Underground workers	649	637	488
Surface workers	253	239	188
Ancillary plants	53	55	53
Administrative personnel (underground and surface)	98	104	96
Total	1,053	1,035	825
Total excluding ancillary workers	1,000	980	772

At the end of 1961 Community coalmines employed 825,000 persons. The fall in numbers has been very sharp since 1958 : 25% in three years, i.e. about 8% per annum. This is mainly due to a steep rise in productivity owing to stationary markets.

As regards the future two basic factors require consideration. Firstly, coal will be competing with forms of energy whose prices, after settling down to the long-term level below which they stand at the moment, will remain fairly stable or will only increase slowly. Community coal will then only be able to maintain its competitive position by increasing productivity sufficiently to offset wage rises. The immediate result will be that even at this constant production level it will be necessary for the labour force to shrink fairly sharply at an average rate of about 3.5—5% per annum. Thus even assuming that in 1975 the production level will be the same as to-day (and also assuming the same level of employment in ancillary industries), the total labour force cannot exceed 500,000 (as against 825,000 at the end of 1961).

The preceding chapters (particularly Chapter 15) have nevertheless shown that even with an increase of about 70% in underground output between 1960 and 1975 the competitive level for coal production would only slightly exceed half the present output, in which case the labour force would have to drop to about 280,000 (ancillary workers included).

The above two figures are based on maximum and minimum hypotheses; the actual figure would lie somewhere between the two. Thus with a Community output of about 160—170 million metric tons the 1975 labour force would be between 350,000 and 400,000.

The transition from the present level to this figure would entail reducing the labour force at an average rate of some 6% per annum, which is a very high figure.

The reduction over the last three years has of course been very steep (8% per annum) and the main difficulty now is to find labour. Nevertheless contractions in the labour force as severe as those mentioned above are likely to raise three serious types of problem :

(i) the human problem of occupationally re-training a large number of workers;

(ii) regional problems which may given rise to acute difficulties at some pits if the necessary steps to foster the development of new industries are not taken in time;

(iii) problems within the coalmines themselves arising from the unfavourable trend in the age structure, in that it is mainly young workers who leave the mines and rapid reductions in labour forces make it difficult to recruit apprentices. This means that the general age level rises, which may lead to serious difficulties in filling certain jobs and cause the output trend to react unfavourably.

However difficult they may be, these problems can be solved provided that all the necessary steps are taken sufficiently in advance, particularly as regards occupational re-training and regional development.

Section 2 — Energy imports and the balance of payments

In view of the anticipated heavy increase in the proportion of energy requirements covered by imports, we must ask ourselves whether such a trend is not likely to upset the equilibrium in the balance-of-payments position.

A comprehensive answer to this question can only be given on the basis of a detailed analysis of Community import and export prospects for the next ten to fifteen years. At the present time the economic outlook for 1970 (see Part One) only provides indications as to the *next* external trade position, which must, moreover, be regarded as an aim rather than a forecast. The following remarks will thus be limited to giving approximations and qualitative judgements.

In 1960 the Community's total imports from the rest of the world were $19,400 million, with net energy imports accounting for $1,300 million and thus representing 7% of the total (obviously the figures vary considerably from one country to another — Italy 16%, France 13% and Germany 4.5%).

In the future the Community's energy requirements will increase less rapidly than the gross national product (4.1% per annum as against 4.6% between 1960 and 1970), but energy imports are likely to increase considerably more sharply (between 10% and 12%). As regards the total volume of external trade with the rest of the world, arguments can be put forward to support both a quicker and a slower growth than in the gross national product; a reasonable course in the light of our present knowledge is to assume an identical growth rate for both.

On this basis the Community's total imports from the rest of the world would amount to $31,000 million in 1970 and $39,000 million in 1975. It seems reasonable to assume that imported energy will be carried by Community-flag vessels; the average cost of imported energy in foreign currency would then be $9.00—10.00 per metric ton hard-coal equivalent and the total cost would be between $3,500 and 4,500 million in 1970 and between $4,600 and 5,600 million in 1975. To sum up, energy imports would represent between 11 and 14.5% of total imports in 1970 and between 12 and 14% in 1975.

Although much higher than the present percentages, these figures are still modest and, as regards the Community, slightly below the present rates for France and Italy.

Insofar as there is a risk of imports being concentrated in a small part of the world, difficulties may arise in paying for them with exports. This calls for two remarks :

(i) firstly, the f.o.b. cost of crude oil includes prospection and extraction expenditure, a substantial portion of which is for purchases of equipment in Europe and for salaries of European technicians; part of the imports are therefore automatically covered by exports;

(ii) secondly, exporting countries will obviously want to use their foreign currency; it is highly likely that they will not use it all on purchases within the Community, and the other countries in which they spend their foreign currency will themselves then be in possession of foreign currency which they will try to spend; either directly or by multi-lateral trading there is a tendency for Community exports to enable imports to be covered. True, the more roundabout the process, the greater the risks of temporary malfunctioning; this does not, however, apply to energy only. We must also remember that the balance of payments equilibrium necessitates correct rates of exchange. This point was touched on at the beginning of Part Three, where provisionally the conclusion was reached that the hypothesis of maintaining present exchange rates was acceptable subject to additional analyses.

The portion of energy imports capable of being modified by the energy policy represents some 100 million metric tons hard-coal equivalent, a fairly high figure in absolute terms ($1,000 million in 1970), although it only represents 3% of the total imports from the rest of the world, i.e. less than one year's growth under steady expansion conditions. Marginal currencies are, of course, always the most difficult to acquire, but the question of saving foreign currency must be viewed as an overall problem by reference to the comparative competitiveness of all export industries, and the discussion in Part Four enables us to measure the real cost of the foreign currency saved by raising Community output. If we propose to avoid importing one metric ton hard-coal equivalent which would cost $13.00 by producing one metric ton H.C.E. costing the equivalent of $17.00—18.00 in Community currencies, we must investigate the saving in foreign currency to see whether it is really beneficial and whether the production factors — capital and labour — required to provide this metric ton H.C.E. would not be utilised to better advantage in producing exportable items to offset the additional imports of energy.

Section 3 — The effect of cyclical fluctuations

All the remarks contained in the foregoing chapters are based on the concept of steady trends (either expansion or contraction) in supply channels, substitution processes, market apportionment etc. The figures for 1970 must be looked at far more as landmarks in a general trend than as specific values for a privileged year.

Economic development, however, does not exhibit such a steady trend. Even though the implementation of policies designed to counteract cyclical fluctuations may limit the latters' extent, it cannot entirely eliminate them. We must now see whether these fluctuations are capable of upsetting the harmonious pattern of the trend and the state of equilibrium forecast for 1970.

A — *Cyclical fluctuations affect different energy products in different ways* owing not only to disparities in cost sensitivity and to inequalities in the financial standing enjoyed by different undertakings but also to the existence of more than one energy product.

(a) Disparities in cost sensitivity

Owing to the large share of labour costs in overall coal production costs and to the need for a stable labour force — not only from the worker's point of view but also from that of the employer, who would find it very difficult to recruit labour during a boom after having laid it off when there was a slump — the cost per ton extracted is extremely inflexible and even tends to rise during slumps. The result is that for reasons of solvency colliery undertakings cannot really lower their prices when markets contract.

Oil product costs, on the other hand, include a substantial amount of depreciation, which on a temporary basis can be deferred to a later period. In addition prospection accounts for a large proportion of the annual expenditure and can be slowed down from time to time. As a result it is much easier to vary oil product prices over a period of time.

With imported products, a substantial part of the c.i.f. price (20—35% under average business conditions) consists of the freight rate, which is especially sensitive to cyclical fluctuations and is likely to collapse during a slump, thus entailing a possible reduction of 10—15% in the c.i.f. price of imported energy products.

(b) Inequalities in financial standing

Community collieries are organised on a national basis and all their activities are therefore influenced by the economic situation in the country concerned, even if they have financial links with customer undertakings.

The major oil companies, on the other hand, are international concerns and can thus make balancing adjustments which allow prices to be temporarily reduced in a given market which is particularly affected by slump conditions.

(c) Existence of more than one energy product

In some cases the existence of a number of energy products enables temporary price reductions on one product to be offset by income on another product when different markets do not react in the same way to a change in economic conditions.

In this respect the oil industry is more flexible than the collieries. One of its products — motor fuel — is not subject to competition from any other industry, whereas all colliery products face competition either from fuel oil and imported coal for steam-raising or else from the latter only for coking purposes.

B — Because of the disparity in sensitivity and varying degree of capacity to ride out economic fluctuations examined above, *cyclical fluctuations could upset economic trends considered desirable from a long-term point of view.*

This will especially apply where the market is divided between coal and oil on the one hand and between Community and imported products on the other. To be more specific, marketing difficulties arising from economic fluctuations and aggravated by temporarily fiercer competition may reduce some collieries to such an awkward financial position that they are forced to close, despite the fact that long-term prospects require them to remain in business. In addition the policy of diversifying sources of supply for oil could be hempered if prospection programmes have to be slowed down in particular areas.

C — The last difficulty is that cyclical fluctuations prevent demand from developing regularly. At this point we must ask to what extent such irregularity can be contained by stockbuilding or production measures, and in the latter case what steps should have priority (this raises the question of dual-fired equipment).

Section 4 — Special problems between now and 1970

The energy positions forecast for 1970 and beyond have been calculated on the basis of probable 1970 prices and the probable trend around 1970, but — as pointed out earlier, particularly in Chapters 7 and 9 — the current prices of imported coal and oil products are below the level anticipated in the future. The gap varies from product to product — over $1.00 per metric ton hard-coal equivalent for American coal and considerably more for fuel oil. In all probability this situation will persist for several years yet.

The result is that the play of forces expected to produce the state of equilibrium outlined by about 1970 might, in the years between now and then, give rise to two unpleasant consequences : firstly pits might be closed down in too great a number or too quickly, and secondly the policy of diversifying crude oil supply sources might be hampered. Both these consequences would be very serious : the first because closing down a pit is usually an irreversible step and the second because a thorough-going geographical diversification of crude origins can only be achieved by sustained effort over a number of years. Temporary measures will thus need to be worked out and put into force to supplement the long-term energy policy.

Conclusions

Each margin of error and source of uncertainty has been carefully noted, and as far as possible evaluated, at the various stages of these studies. Many of the figures arrived at must be regarded as approximations rather than as definite values.

This circumspection is essential in a study involving highly complex and in many cases chancy factors. Far from weakening the conclusions, however, it gives added weight to some of the findings, in the light of which it is now possible to isolate the problems on which energy policy must be primarily concentrated, and to gauge the effects of the measures which that policy might comprise.

(1) Given the rapid growth forecast for the Community economy (4.6% per annum in G.N.P.), total energy requirements may be expected to increase by about 4% per annum, from 460 million tons hard-coal equivalent in 1960 to 700 million in 1970 and almost 850 million in 1975.

(2) By 1970 barely one-third of the requirements will be met by coal. The share of Community coal, therefore, will shrink, even if the present volume of production is maintained, from 45% today to 33% in 1970 and 27% in 1975.

(3) Even with Community production of other energy sources expanding, more and more of the requirements will have to be covered by imports, mainly of crude oil. These imports will increase in amount (hence the need to secure a supply potential of an adequate scale), and also in proportion to requirements as a whole, from one-third today to over half in 1970 : this will make the question of security and stability of supply (tonnages and prices) even more important.

(4))The competitive capacity of Community collieries is much diminished even today, with the prices of the rival products, imported coal and fuel oil, at their present level.

Admittedly they can be said to be competing under disadvantageous conditions, owing in part, very definitely, to the disparate rules of competition in the respective markets, and also doubtless to the industry's own costs of regression. Moreover, some of the ultra-low prices quoted in the last few years for imported fuels may be regarded as exceptional.

Nevertheless, even should these inequalities be corrected and should more normal market conditions return, with a certain hardening of the prices of the imported products there seems no prospect of a long-term improvement in the competitive position of Community coal, since even on the assumption of a rapid rise (70% over 15 years) in underground O.M.S. the expected movement of wages is bound to drive up costs.

Given the divergent trend in the c.i.f. prices of imported fuels and the production costs of Community coal, notwithstanding the increase in energy requirements, the tonnage of Community coal which will be competitive without assistance of any kind will amount to not much more than half present production.

This calculation — a rough but reasonable estimate — could be discounted only

(i) if it were possible to scrap the already optimistic hypothesis as to the productivity trend in favour of one assuming revolutionary innovations in coal-winning techniques;

(ii) if the Community were to adopt no policy at all concerning oil prospecting and supply, and thereby leave oil prices wide open to the long-term political risks.

(5) In view, then, of all that is involved — the security factors, the social and regional considerations, and the hazards inherent in a market comprising such uncertain political elements — it is felt to be right and proper that the collieries should be given assistance in order to enable them to produce and sell more coal than they could do competitively in strictly economic terms.

Without wishing to anticipate the conclusions on energy policy, an economic analysis of this report thus raises three main problems :

(a) Measures must be worked out to enable the volume of coal production considered desirable in the Community to be marketed. These measures must be capable of stimulating rationalisation in Community coalmines. In the light of the foregoing remarks, they should aim at retaining the essential nucleus of Community coal production.

(b) An imported energy supply policy must be formulated, particularly for crude oil. The principle of lowest-cost Community supplies must be looked at from a fairly long-term point of view and conditions aimed at which will prevent prices rising artificially whilst relying mainly on production regions where technical costs are lowest.

(c) A study must be made of the most suitable rate for expanding nuclear installations. In fifteen to twenty years' time the atom will be the source of energy which will improve the Community's security of energy supplies. On the basis of the information available, there is every reason to believe that large-scale nuclear power stations will be competitive from 1970 onwards in meeting the base of the load curve. Owing to its novelty, however, the nuclear industry raises a large number of problems for many suppliers, especially in the mechanical engineering, chemicals and civil engineering industries. Rapid expansion in the provision of industrial power reactors may thus meet with bottlenecks, especially as regards trained personnel, if the rate of development is not adequately anticipated. A decision to accelerate the rate of expansion will not show full results until several years have elapsed. This means that the outlook considered desirable between now and 1975 must be decided on without further delay.

A solution to any one of these problems leaves a certain amount of latitude in dealing with the others. It should nevertheless be realised that the growing share of imports in the Community's energy supplies (which places the Community in a very different position from that occupied by other major economic units) makes it necessary to keep the market wide open to products from all sources so as to reduce the cost of supplies as much as possible; and the necessary corollary to this approach is then to adopt a common energy policy which safeguards security of supplies, without which the aim of low-cost supplies cannot be achieved.

Publications Departments of the European Communities
3365/5/64/1