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ENERGY IN EUROPE

ENERGY FOR A NEW CENTURY: THE EUROPEAN PERSPECTIVE

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Commission of the European Communities □ Directorate-General for Energy

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ENERGY FOR A NEW CENTURY: THE EUROPEAN PERSPECTIVE

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Foreword

"The energy future of the European Community will rely on the development of an energy policy that emphasises a free internal market, encourages technological advance and supports sustainable economic growth with concern for the environment."

This was the framework that emerged from two days of discussions at "Energy for a New Century - The European Perspective", a two-day conference organised by the European Commission in Brussels, 3-4 May, 1990.

I am grateful to the distinguished speakers and guests for making available their experience and for the informative debate on these important energy issues.

Clearly we share a common concern with our global partners in looking at how best energy can contribute to economic growth and prosperity and how we can better manage the environmental consequences of energy production and use through the improved application of technology.

This special edition of "Energy in Europe" provides the opportunity of sharing with a wider audience:

- the report of the "Groupe des Sages" who at our request identified those issues and areas of energy policy in need of greatest attention;

- the energy analysis "Major Themes in Energy Revisited"; and

- the conference proceedings.

The results of the conference form an invaluable input to the Commission's programme for energy policy.

Antonio Cardoso e Cunha
Member of the Commision

Introduction

In 1987 the Directorate-General for energy began the process of establishing the conditions for integrating energy in the framework of the Single European Market. The following year, the Council of Ministers approved the Commission's programme for the Internal Energy Market, fixing the priorities for its achievement. Today there is consensus (among Member States and industry) that a new and more common approach to energy is urgently required.

In parallel to this and placing the Internal Market in a wider context, we have been examining the factors which could influence the Community's energy future. Among the many influences at work on both the demand for and supply of energy, a number were identified as "Major Themes" which can determine the direction of future policy. These reflect the important political, economic, industrial, environmental and energy developments at the world level. The Community's energy objectives for 1995 alone are not sufficient to drive the Community's energy economy towards a new integrated single market. Other actions are necessary commensurate with the challenges of these global issues.

We believe that a comprehensive and well-structured debate on world and Community energy perspectives for a new century was essential. This debate began with the publication in September 1989 of the interim report "Major Themes in Energy".

The report sought to facilitate a dialogue between often opposing interests. The extensive exchange of views which followed its publication was essential to deepen and expand the analysis. The final version, "Major Themes in Energy - Revisited", incorporates comments and suggestions received.

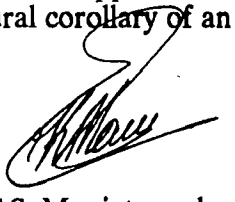
I am grateful to Kevin Leydon who directed this project and to all the members of his team who drafted both reports and ensured the coordination of an extensive exchange of views.

We had the good fortune and the honour to receive the criticism and suggestions of six eminent personalities who accepted our invitation to form a "Groupe des Sages" to comment on the "Major Themes in Energy". Their report together with the "Major Themes in Energy - Revisited" report will be the cornerstone of the continuation of our work.

I am therefore grateful to Professor Umberto Colombo, Dr. Martin Gallego, Dr. Heinz Horn, the Rt. Hon. David Howell, Professor Jacques Lesourne and to Mr. Peter Winsemius for their valuable cooperation.

Commissioner Antonio Cardoso e Cunha initiated the discussion when addressing the World Energy Conference last September in Montreal. His comments and his ideas, together with his dynamic endorsement of this initiative added political value and a stimulus to the efforts of my colleagues. I am grateful to the Commissioner for his guidance and support.

Following the conference "Energy for a new century: The European Perspective" the first stage of this work has been accomplished. The major and challenging task of redefining the future direction of the Community's energy policy begins. The Directorate-General for Energy is committed to this most important second stage. We believe firmly that a common approach to European energy policy is of capital importance for our economy and a natural corollary of an Integrated European Market.



C.S. Maniatopoulos
Director-General

Energy for a new century :

The European Perspective

Report of the "Groupe des Sages"

Prof. U. Colombo

Dr. M. Gallego

Dr. H. Horn

The Rt. Hon. D. Howell MP

Prof. J. Lesourne

Dr. P. Winsemius

In a wide ranging and comprehensive review such as is presented in this report, not every member of the group would necessarily share all the statements and opinions expressed. The conference provided the occasion to develop and expand on the important issues raised.

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Foreword

"Can we continue to develop the world's energy supplies, on a secure and economic basis, sufficient to maintain economic growth whilst at the same time ensuring that the global environment is protected and indeed improved ?"

Commissioner Cardoso e Cunha,
Montreal, September 1989.

The question is straightforward. Finding the answer is one of mankind's most complex and vital tasks. It has assumed a new sense of urgency for the European Community because of the dramatic changes which now face us.

These changes include the completion of the internal European market, the unprecedented developments within the countries of Eastern Europe and increasing concern for the environment, in particular global warming. The significance of these changes should not be underestimated. They will influence major decisions in all sectors over the next decade and beyond.

For the energy sector, in particular, the challenges are immense. This was lucidly illustrated in the report "Major Themes in Energy" produced by the Commission's Directorate-General for Energy (DG XVII) and first presented at the World Energy Conference at Montreal in September 1989. In that study alternative future scenarios were presented as a means of stimulating discussion on the major themes and challenges facing the energy sector.

In this report, we take a step forward. At the request of the Commission, we have attempted to draw out the key messages from the "Major Themes" report. In particular, we have sought to identify those issues and areas of energy policy in need of greatest attention.

The first part of our report focuses on the scenarios developed by DG XVII. We present our understanding of the key features of each of the scenarios and also provide some general comments on aspects of the scenarios which could be further developed. In the second and third parts, we consider the main challenges which now face us. These challenges derive not only from the "Major Themes" report but also incorporate our own views of more recent developments, particularly with regard to Eastern Europe. In the final part, we present some concluding remarks on the way forward.

Our report provides no easy answers, because there are none. But we will have succeeded in our task if this document provokes thought, discussion and debate both at the Conference and within our society in general.

Introduction

A decade has passed since the last energy crisis. However, energy issues are moving to the top of the political agenda once again. We believe that energy will be a priority issue in the 1990s because of its importance for economic development and because of increasing environmental concerns associated with its production and consumption. Even if resource scarcity is of less concern than in the past, the possibility of another major price shock cannot be ignored.

We are, therefore, more than ever convinced that an energy policy is required. But, there are no easy solutions. An energy policy which encompasses all of the key objectives (strong economic growth, a clean environment, moderately priced and secure energy supplies) may not be readily compatible with current trends and values. An effective strategy to achieve sustainable development should recognize two fundamentals :

1) The linkage between economic growth and energy demand needs to be reduced;

2) Acceptable trade-offs have to be made, on an international scale, between energy and other concerns, particularly the environment.

The first step must be to establish a consensus on the nature and magnitude of the problems to be faced. This will require a dialogue amongst the key players : energy companies, consumers, policy makers and other leading opinion formers. Only in this way, can conflicting objectives be recognized and resolved.

In our view, an important initiative in this direction was taken when the Commission's Directorate-General for Energy (DG XVII) published its report "Major Themes in Energy" at the 1989 World Energy Conference.

Prospects : The "Major Themes" Report

In this first part of our report we focus on the scenarios developed by DG XVII.

There are at least three areas of novelty for which the "Major Themes" report should be commended :

1) The key role of energy demand policies is highlighted;

2) Recognition is given to the importance of environmental concerns in shaping energy policy;

3) The importance of technology in helping to improve energy efficiency and

4) Power generation and, especially, transport are identified as the critical sectors where solutions need to be focused.

An important strength of the "Major Themes" report is the systematic use of models. The three scenarios hightlighted in the Report do not pretend to be predictive, but the use of models has ensured the self-
consistency of the assumptions used in the three cases. The following is our understanding of the key features of each scenario, together with our general comments on their findings and on how they could be further developed.

Scenario 1

DG XVII's Scenario 1 could best be described as a "business as usual" scenario. It does take account of the move towards integration of the European market, but no other major new policy initiatives are incorporated. Furthermore, the key scenario parameters, such as economic growth and oil prices, take values which broadly represent the "conventional wisdom" currently prevailing in the energy world. Although some of the assumptions could be debated, our judgement is that the resulting changes are unlikely to be sufficiently large to modify the general conclusions.

Scenario 1 points to some potential problem areas, such as the growing need for upgrading facilities in the oil refining industry. On the whole, however, the conclusions seem to be reassuring from the energy point of view.

In particular, saving major political upheavals, there is little reason under these assumptions to expect a new oil price shock or supply shortages. Although European dependency on oil and energy imports remains high, it does not reach unmanageable levels. No physical constraints on the availability of resources are anticipated until at least 2010.

The concept of security will, in our view, continue to apply mainly to oil imports. Coal should present few problems due to the variety and nature of the suppliers to the world market. Some difficulties associated with gas imports could possibly arise if production capacity and transportation infrastructure do not keep pace with demand.

Pollutants associated with acid rain (sulphur dioxide (SO2) and oxides of nitrogen (NOx)) are expected to be under control as a consequence of Community legislation. SO2 emissions would fall drastically after 2000, mainly in the power sector. NOx emissions would decline more slowly as reductions per unit of output, particularly in the power and transport sectors, were offset by increased economic activity. Vigilance would certainly be needed to ensure that the planned reductions were achieved in practice.

However, there could still be environmental problems. Carbon dioxide (CO2) emissions would increase (from 2700 million tonnes (Mt) in 1987 to 3400 Mt by 2010) in Scenario 1. The Toronto agreement, which proposed a 20 percent reduction by 2005, would not be achieved.

Scenario 2

History has demonstrated that the "conventional wisdom" is rarely correct. Usually unforeseen changes take place. Although such events cannot be predicted, the sensitivity to changes in key assumptions can be examined to test the robustness of a scenario.

Such an exercice has been carried out in constructing Scenario 2. Economic growth in the EC was increased from 2.7 percent per annum to 3.5 percent per annum between 1990 and 2000, reflecting the impact of a more favourable international situation, combined with greater benefits derived from the completion of the internal market in Europe.

This Scenario demonstrates that higher economic growth, without appropriate energy policy measures, will lead to increasing tensions.

In international energy markets, the possibility of new price shocks and tight supplies would become more likely. Polluting emissions would also be higher than Scenario 1 as a result of rapidly growing energy demand. The consequences of these problems in the longer term are significant. The higher rate of economic growth is judged to be unsustainable.

Although variations in this analysis are possible, we believe that Scenario 2 clearly demonstrates, within a consistent framework, that unless effective energy policy measures are taken, the benefits of higher economic growth may be difficult to maintain.

Scenario 3

In designing Scenario 3, the aim was to reconcile the competing objectives of sustaining high economic growth (with resources available at acceptable price levels) and protecting the environment.

This could be achieved principally by a rapid increase in energy efficiency after the turn of the century accompanied by a significant increase in nuclear power and gas-fired units substituting part of coal-fired plants.

The technologies required to produce this large efficiency improvement are already available to-day and it would clearly be economically justified to promote their use. Indeed, a rapid penetration of technology would be consistent with and would itself promote higher economic growth.

One important criticism of Scenario 3 could be the projected rapid increase in nuclear energy supply, from 180 Mtoe in 1995 to 340 Mtoe by 2010. This would appear to be very high given the climate of opinion which exists currently in most European countries. Conversely, the European indigenous coal industry experiences a rapid decline from 150 Mtoe in 1995 to 60 Mtoe in 2010. This would have major economic and social implications for the regions concerned, which could justify further analysis.There is no doubt that the technological potential exists for Scenario 3 to be a plausible representation of the future. However, this poses the fundamental question : how in practice can such a rapid uptake of technology be achieved ?

But, technological developments alone cannot be sufficient to satisfy the objectives. It is important to recognize that energy efficiency is not synonymous with energy conservation. Consumer behaviour however would likely absorb some of the efficiency gains in the form of increased services or comfort levels. Also, improvements in overall energy efficiency tend to be accompanied by an increase in the penetration of electricity.

It is therefore necessary to bring about important structural changes in the behaviour of consumers and society in general. For example, in the critical transport sector a significant intermodal shift is required from road to rail for both passengers and freight. Such deep structural changes may require very large investments, the return on which is only achieved over the longer term. This could have a modifying effect on the level of sustained economic growth in Scenario 3.

The Scenario 3 approach implies a strong political will. In fact, the solutions outlined in "Major Themes" are mostly normative and, in many situations, normative approaches may be very difficult to implement. For example, how can such large shifts in passenger traffic from road to rail be achieved ? The feasibility of Scenario 3 needs to be further explored. In particular, it will be necessary to examine ways in which such a policy could be implemented.

Furthermore, the policy solutions need not only be normative ones. It would be important to consider other approaches, such as fiscal instruments. For example, incentive-disincentive mechanisms based on revenue- neutral taxation changes are one class of approach now attracting increasing interest. Such mechanisms which make use of market signals could usefully complement regulations and standards as ways of promoting greater efficiency and technological change. Clearly there are important issues requiring an overall and European approach.

General comments

Overall, the scenarios usefully demonstrate how higher economic growth could result in energy related tensions emerging. They also show how it might be possible to avoid these tensions and satisfy the objectives of sustainable economic growth, moderately priced and secure energy supplies, and a clean environment.

There are three aspects of the scenarios which could be further developed :

All three scenarios are "smooth scenarios". It would be useful to incorporate some shocks or unexpected events, such as :

.a nuclear moratorium which could follow a major reactor accident;
.an oil price shock due to unexpected political developments in the Middle East;
.recent events in Eastern Europe are a good example of unexpected "discontinuties", as is the uncertain situation in Soviet energy exports

Whatever their probability, such events could have a large impact on both the European and indeed world energy scene.

The scenarios form a consistent framework to 2010. Policy makers need to recognize the importance of the development of energy futures beyond this time horizon. This is particularly relevant with respect to the availibility of energy resources and environmental concerns.

We recommend that these aspects be further explored in variants on scenario three and possibly with the expansion of the analysis to incorporate a new scenario 4 based on a combination of low economic growth and strong decrease in energy demand plus increased energy prices to consumers.

There is little explicit discussion of changing structures and systems within the Community in the scenarios.

How will the gas and electricity grids in Europe evolve ?
How will utilities change ?
Which new players will enter the market ?
Will companies need to operate on a European scale to be competitive ?

These questions are important to address, given progress towards the internal market.

The evolving political structures in Europe, the internal market, Eastern Europe and environmental concerns require consistent policies and strategies for 2010. These raise key challenges for both the Community and indeed the world.

Challenges : The Emerging Issues

In this second part to our report we consider the main challenges which now face us. This analysis derives not only from the "Major Themes" report but also incorporates our views of more recent developments, particularly with regard to Eastern Europe.

There are major historic changes influencing the Community both within its territory and in its external relations which present unique challenges to European political structures.

Because energy plays an important role in our economic and social life and in our geopolitical relations, this historic process requires a positive contribution from this sector. The elements of an energy policy will need to be defined in a Community framework. The genesis of such a policy is emerging. Its constituents will include the internal energy market, environment, development in Eastern Europe, technological progress and geopolitical relationships.

Internal Energy Market

Steps are underway to complete the internal energy market. Current progress in this area focusses on increasing competition leading to lower costs and prices; greater integration and hence optimisation of energy networks, pricing and investment transparency. But to what extent energy network optimisation through integration opposes the partial liberalisation and market desintegration, which accompanies the "common carrier approach ?"

These specific actions are completed by proposals for public procurement, freeing capital movements, tax and technical harmonisation and with energy objectives such as conservation, resource sharing and diversification of fuel sources.

Completion of the internal energy market is likely to lead to a greater cohesion in the planning of gas and electricity supplies, and greater integration of electricity and gas grids. If such achievements are realised, a reappraisal of the existing structures and operations of gas and electricity utilities will be needed.

The developement of the internal energy market provides the opportunity to reinforce cohesion between different regions of the Community. Decreasing inter-regional differences will be especially important for peripheral countries. And progress on the integration of energy infrastructures and the encouragement of investments in new, and refurbished, facilities will need to be encouraged within the internal market framework.

The realisation of an internal energy market introduces a new reality in the construction of a community energy policy.

Environment

Concerns are growing as public awareness of environmental problems increase. Energy production, transport, transformation and use are important contributors to polluting emissions. These impact on landscape, waste disposal (nuclear and non-nuclear), water and atmospheric pollution.

Examples of such impacts are : sea and coastal areas being polluted by mismanagement of oil production and transport facilities; the damage to forests due in general to acid rain deposition; effects on landscape and natural fauna from big hydropower projects; the whole debate around nuclear waste disposal. In summary, the fear of all these impacts associated with those resulting from major accidents and risks inherent to the energy sector have led public opinion to resist major new projects in the area of energy production and transformation.

But as environmental concerns grow generally, we are likely to see regional differences, both globally and within the Community, raising conflicts of interest among States as regards the responses advocated and adopted. To put it simply, the wealthier a country, the greater is likely to be its willingness to devote significant resources to environmental improvement.

Community-wide measures aimed at reducing SO2 and NOx emissions (acid rain related) have already been adopted. However, we have not yet seen the full implementation of currently available technologies to reduce these emissions. The question is to what extent and at what cost the Community will pursue improvements in this area.

As regards nuclear waste disposal, which is a very long term issue, the question is if we have already availability and control of a sound technology. The answer is essential in terms of public assurance.

For the global warming issue, there is still no scientific consensus on both the magnitude and implications of the problem. However, if action is required, Community policy is only a small part of the answer with a very limited effect if consistent policies are not adopted in all other regions of the world. The energy sector is not the only contributor to this phenomenon. CO2 emissions are responsible for only about 55 % of total "greenhouse" gases, and part of these gases do not result from energy sector activities.

Scenario 3 describes an attempt to reduce air polluting emissions particularly CO2. However, CO2 reductions at the end of the period may prove to be insufficient if there is consensus that the worst expectations regarding global warming are confirmed.

Eastern Europe

The extraordinary changes currently underway in Eastern Europe and the USSR will have a profound impact on the European Community. It is to early to understand the full consequences of these changes - they are still unfolding but pending a full analysis some preliminary observations seem appropriate.

Higher economic growth and a different social structure will likely lead to robust energy demand growth, at least in the short to medium term. This results from the fact that these countries currently have a very high energy intensity. However, as the economics evolve new, more efficient energy technologies will be introduced, possibly combined with structural changes.
Due to the possible surge in Soviet and other Eastern European energy demand, we could see a reduction of energy trade among all these countries and specially of Soviet energy exports. This could not only lead to a tightening of world energy markets, but in particular to pressure on the European Community to participate in the supply to some of its Eastern European partners. The electricity supply sector is one where this pressure could arise.

In the nuclear sector, real concerns have been voiced about the safety of some power stations in Eastern Europe. Given the widescale implications of a reactor accident similar to that of Chernobyl, the Community should make every effort to ensure that safety standards are improved rapidly.

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Developing countries

Problems surrounding world supply and use of energy are strongly affected by developing countries. The growth in energy demand in the Third World, particularly in the high population LDC's in Asia and Latin America, will have a major impact on the future world energy and environment situation. These countries are currently facing a real energy crisis due to rapid population growth, an urgent need to increase per capita energy consumption to improve living standards, and a move from non-commercial to commercially traded fuels. Payment for their growing energy needs is particularly difficult for those countries with major debt problems.

The need now is for effective energy planning and transfer of "know how" and technologies, aimed both at improving the efficiency with which energy is used in the Third World and developing local energy sources. For those countries with low-cost energy supplies, economic profitability may induce a transfer from the developed to developing countries. On the environmental side, care would need to be exercised to ensure that problems were not simply transferred from one, wealthy, region to another, poorer, region.

Energy technology

Not all of the energy questions now facing the Community have technological answers. But it is to be expected that the implementation and dissemination of new technologies will continue to be important and may yet serve to reduce significantly our present concerns regarding the environment and energy security. Indeed, it would be difficult to extrapolate Scenario 3 beyond 2010 without assuming the introduction of new and innovative technologies.

Renewables, inherently safe reactors, fusion, hydrogen and superconductivity may all play an important role in the more distant future, even though their future contribution to the world energy market is difficult to assess. However, if the potentially major benefits of such technologies are to be exploited in the long term, a strong commitment to research and development is necessary.

Energy Security

The specifics of energy security of particular fuels are discussed elsewhere in this report. There are some general considerations which are appropriate. The balance in the contribution of indigenous production and imports is changing with imports expected to increase in importance in Community supply. This applies equally to oil, coal, gas and uranium. Consequently the availibility of these supplies at secure and moderate prices remains an important consideration for the Community.

As mentioned earlier, developments in Eastern Europe and in the Soviet Union could have important consequences on the overall energy situation.

The interaction between consuming and producing regions of the world will increase. An illustration is provided by the pressures now building up for the use of natural gas for power generation. In the European context this new demand will be met by increased imports.

Similarly the increased demand in OECD oil requirements (largely due to increased transportation), will add to already growing demand for supplies from the oil producing regions. Changes in the supply structure and investment programmes of these countries will effect their capacity to respond to these demands.

Coal, which is largely consumed in place of origin, will grow in importance as a world energy commodity.

The analysis in the three scenarios usefuly provides an indication of possible Community requirements. Such trends emphasizes the need to develope the external dimension of the Community energy policy.

Energy security will remain a major concern. The issues mentioned reflect the interaction, between global developments and changes in the Community with the implementation of the internal market and environmental policies.

Challenges : Energy Sources

So far in part two we have looked at the broad challenges facing the energy sector. We continue this review by concentrating on the energy sources.

Oil

The future of OPEC is critical to developments in the oil market. Arguments for greater cohesion between OPEC members may be made but the opposite could also be true. As reserves become increasingly concentrated within a few Middle Eastern OPEC members, the difficulties affecting political relationships in the region will become of even greater importance. In our view, the Community should promote economic and industrial cooperation with Gulf oil-producing countries.

In the longer term, sustained investment in new production capacity in the key producing countries will be necessary to maintain stability in the oil market. Such investment may be funded internally or, indeed supplemented by Western investment.

Similarly because production in non OPEC countries is important in maintaining stability in the international oil market it is necessary to continue and indeed increase investment in both areas under current development and in those areas where exploration is currently less intensive.

Recently US imports have been increasing which may in the medium term put pressure on the call on world markets and in particular on OPEC export requirements.

Coal

European coal production has been declining for many years. Pressures on the industry will persist in the future as production from low-cost regions outside Europe results in a highly coal-to-coal competitive market.

Furthermore, most of the coal imports into the Community are from suppliers no less reliable than European industry.

If the European coal industry is to decline, careful planning of the process should be undertaken. In particular, new industrial and infrastructure investments in those Community regions affected by reduced production should actively be thought.

Given that, over the next twenty years, nuclear's contribution to European electricity supply will be less than many analysts were predicting five or ten years ago, and that oil and gas-fired units are not likely to make up for the loss in nuclear capacity, coal burning will likely have to continue growing. In this case and if European coal production falls, coal imports are also likely to grow. And yet coal represents at the world level one of the largest energy reserves.

Concerns in some quarters are raised that by reducing indigenous coal production, the Communities security position is weakened. Others argue that indigenous production per se does not contribute for energy security.Coal will remain an important fuel in power generation. In an era of growing environmental concern further R & D developments can improve the efficiency and the cleanliness with which coal is used.

Gas

A greater use of gas in the Community is now envisaged, particularly in the power sector. Gas offers environmental advantages over coal (virtually no SO2 and lower CO2 emissions) that make it particularly attractive for use in densely populated areas.

Efficiency of use is high in combined cycle generating plant (even higher in cogeneration schemes) and the technology is well suited to the construction of relatively smaller, modular units. This, combined with low capital costs per unit of installed capacity, means that combined cycle gas fired power stations are likely to feature prominently in the more competitive energy scene associated with the internal market. The financial risks associated with such stations will be lower and the threat of overcapacity, always present when very large stations are built, will be reduced.

As the contributions from gas supplies from Member States fall, we will see greater dependence on supplies from Norway, USSR, Algeria and possibly even West Africa and the Middle East. It seems therefore convenient to consider the development of gas pipelines to all those producing areas, within the framework of industrial cooperation between the Community and those countries. Gas reserves outside the Community are very large but care will be needed to ensure that the greater gas import dependency which now seems almost inevitable does not lead to a new energy security threat.

As gas use expands and in the context of the internal energy market, we will likely see the construction of new and the increasing of existing transportation/ distribution infrastructures. The need for investment is not negligeable and careful allocation of Community resources is necessary within the framework of cohesion policies.

Nuclear

The part played by nuclear energy differs widely accross Member States. France and Belgium produce some 70 % of electricity from this source - some Member States have refused this source as an option. Currently there is declining consensus at both the political and public opinion levels about nuclear's role in the future.

The difficulties associated with the construction of new nuclear capacity are not only due to environmental concerns. There is a growing mis-match emerging between the financial requirements of utilities, which need the flexibility of short lead times and low unit capital costs, and the financial realities and risk concentration of nuclear power. The challenge for nuclear engineers is to develop nuclear technologies more in line with these changing needs.

This raises questions on the evolution of existing nuclear power units, and the type of new nuclear technologies likely to emerge. However, none of these are likely to have a major role unless they can be made both financially attractive and overcome the widespread opposition to nuclear power which still exists in most countries of the Community.

The problem of the safe disposal of nuclear wastes remains an area of concern. In addition, reactor decommissioning, which will become of increasing importance within the Community over the next twenty years, will also contribute substantially to the problem of waste disposal.

Renewables

Renewable energy has been the basis of man's earliest fuels. Today we are, through technology, seeking to make these sources more efficient. Indeed hydro was the initial source of electricity generation in many states. Currently this accounts for some 12 % of total Community electricity and with further developments in traditional and new small hydro schemes this percentage share is likely to be maintained.

The contribution of other renewable sources (solar, wind, bio-mass, etc.) in the Community as a whole is small, although regionally we may see contributions as high as 10 % of total primary energy needs. In fact, in many cases the economics of renewable technologies compete favourably with fossil fuel options. They appear particularly attractive in remote areas where the energy infrastructure is weak or in areas endowed with particular natural resources.

For a number of reasons - domestic supplies, environmental concerns, regional development - renewable energy sources are likely to be required to play an increasing role in the long term. However, because there is a need to reduce unit costs to make renewable technologies more competitive, they will only fulfill their role if a major research and development commitment is made. In fact, there are good prospects of R & D leading to the breakthroughs necessary to commercialise particular technologies, for instance in the field of photovoltaics.

Electricity

The demand for electricity will continue to grow through the 1990's. Indeed even in the 3rd Scenario, which presumes substantial energy savings and lower overall consumption (even for transportation), the growth rates for electricity remain positive into the new century.

The interaction between electricity and economic growth is important. Many of the economic sectors - commercial and tertiary - are increasing in importance. The "new industries" linked to new technology and information are fuelled essentially by electricity and these are the sectors we are turning towards for economic growth.

This growth in demand has implications for both investments in new generating capacity and for how use our networks more efficiently. The investment issue is complicated by the difficult choices in fuel options to produce electricity. Yet there is a clear need for maintaining a balanced and flexible range of supply choices. The present concern with emission levels will require new investments in reducing SO2 and NOx (through technical solutions) and CO2 (through fuel substitution).

Coal will continue to be an important source. Yet this must be matched by the concern with the cleanliness and efficiency with which it is burned. Phasing coal out is not an economic option. Certainly gas has become an attractive fuel and nuclear is a potential replacement. However, given the sheer volumes required and the problems inherent to these two energy sources (see respectivve sectors), it will neither be politically, nor economically feasible to stop using coal for power generation. One direction, therefore, is to concentrate on developing more efficient, cleaner coal-burning technologies.

The volumes of generating investment required and the management of these investments (with suppliers facing strong growth initially but with this level decreasing in the longer term) could, for some Member States, pose considerable difficulties.

The issues currently debated in the application of the internal energy market take on added urgency when set against the longer term electricity outlook. There is an incentive to seek more efficient use of networks and to cooperate in meeting new demands (Eastern European needs may become of growing importance).

Similarly how efficiently consumers use electricity is a growing concern shared by customers who pay the bill, utilities who must build new capacity (with growing environmental resistence) and the public authorities. New ways of tackling the efficient use of electricity are required.

The Way Forward

In this third and final part of our report we present some concluding remarks on the way forward.

DG XVII has initiated an important forum for discussion about the energy agenda for the 1990s when it published the Discussion Report "Major Themes in Energy".

By placing energy in the context of economic growth and environment we see clearly the strategic role energy plays in these two fundamental policy areas. By seeking to understand the role of technology in improving end use and production efficiency we can better appreciate the dynamic effects which are influencing the volumes of energy we need. Finally the geopolitics of energy are recognised by placing the Community analysis in a global context.

Using the comprensive framework provided by DG XVII's analysis we have in this report identified issues which require resolution when progressing towards a Community Energy Policy. Some of these issues are likely to find a broad consensus of support. Greater emphasis on R & D and the penetration of the resulting technology in the market will be generally welcomed by all partners to the debate.

Other choices will remain controversial. Fossil fuel burn will be challenged by those whose preoccupation is with emission levels. Can we count on cleaner coal burning and can we look to improvements in nuclear design, in the way in which waste is dealt with and, in a reduction lead times for new reactors ? To meet current public concern these are questions which must be faced.

Energy imports will grow. This is a reality and one which the external dimension of energy must take account.

For environmental issues the attainment of agreed objectives based on scientific evidence could involve the setting of targets requiring new economic instruments.

We are, therefore, more than ever convinced that an energy policy is required. But, there are no easy solutions. An energy policy which encompasses all of the key objectives (strong economic growth, a clean environment, moderately priced and secure energy supplies) may not be readily compatible with current trends and values. We would stress the need for a combination of policies which is the only way of making reasonable trade offs between equally important and partly incompatible objectives.

Perhaps it is inevitable that much attention is focused on the environment, given its current high profile in scientific, public and political debate. But it is vital that we do not lose sight of our other objectives. Energy security may be perceived currently as a low priority issue, but should remain a major concern and could be undermind if policies based on environmental concerns are pursued with scant regard for growing import dependency. Similarly, the adoption of very high cost environmental control strategies in the short term could have a detrimental impact on economic growth within the Community.

Sustained economic growth is imperative if the Community's wider economic and social objectives are to be achieved. But this does not mean that the environment needs to be sacrificed. Not only can growth be accompanied by improving efficiency of energy use, but the greater wealth created would, in the longer term, enable a more extensive range of environmental improvements to be achieved.

Energy for a new century:

The European Perspective

Major Themes in Energy Revisited

a report prepared by
the Directorate-General for Energy
Commission of the European Communities

Contents

Foreword

The Commission of the European Communities' Directorate-General for Energy has been examining the many factors that could influence the Community's energy future. Of the range of influences at work on both the demand for and supply of energy, a number have been identified as "Major Themes" which will have an important bearing on energy policy in the early 1990s.

A first preview of the long-term study undertaken was published in a discussion paper *"Major Themes in Energy"* in September 1989. Based on the criticism and suggestions received from six eminent personalities who accepted the invitation to form a "Groupe des Sages" to comment on the report, this earlier work has been revised and further extended to take account of their suggestions and those of others which were received in response to the invitation to comment on the earlier report.

Chapter 1

Introduction

Challenges and themes

Over the last twenty years, the world's energy consumers and producers have lived through dramatic changes and faced difficult challenges.

- The cyclical behaviour of economic growth has had a strong influence on energy consumption patterns and producer profits;
- Energy markets have experienced sudden shocks and times of glut providing uncertain price signals as input to consumers' and producers' investment decisions;
- Energy security has moved from near the top of the political agenda in consumer countries to a position of lesser importance as policies have been successfully implemented;
- Environmental concerns have been growing throughout the period and have recently heightened.

Change and uncertainty will continue to persist in the future. Yet decisions still have to be taken. Although risks cannot be avoided, it may be possible to manage them better.

Because energy is so firmly embedded in a rapidly evolving economic, social and political climate, its development will continue to be influenced by external factors. Furthermore, because of its fundamental strategic importance, it can itself affect economic and environmental conditions. Due to the complexity of these relationships and the associated uncertainty, there is a need for a robust policy framework within which the key issues facing us today and in the future may be addressed.

Responses to the *"Major Themes"* report and world events since September 1989 have confirmed that the challenges facing us today are no less severe than those experienced over the last two decades.

The *Major Themes* can be reiterated:

- **Energy and economic growth** - how will the internal market impact on energy use within the Community?

- **Energy and the environment** - can increased demand for energy services be reconciled with a need to improve the quality of the environment?

- **Energy and security** - will increasing import dependency make us once again vulnerable to price shocks and supply disruptions?

Not only are these themes complex within themselves and, furthermore, strongly inter-related, but there is also a new dimension. Developments in eastern Europe have been both dramatic and rapid. Such fundamental political changes could not have been envisaged even in September 1989. The implications of these changes will emerge as the political choices become clearer for the east European countries.

The implications for, and the role of the Community in this process, are also unclear at this stage. However, there is little doubt that the effect on the Community's energy future is likely to be significant. A preliminary assessment is perhaps useful and is presented in Chapter 4. If anything, these latest developments, given the potential implications for growth, the environment and energy security, have reinforced the key issues which emerged from the *"Major Themes"* report.

The "Major Themes" approach and the way forward

Scenarios are tools which enable uncertainty to be structured in a logically coherent fashion so that the complex decisions which face us can be addressed. Given the high degree of uncertainty affecting many of the important parameters in world and European energy markets, there is a need to identify the most vital factors upon which the scenarios should focus.

The scenario focus developed in the *"Major Themes"* report consists of two key elements:

- The impact of economic growth on energy supply and demand patterns, particularly in the context of the internal market;

- The role of Community energy policy in reconciling economic growth objectives with environmental and energy security aims.

The Report of the "Groupe des Sages" to this Conference takes the first important step forward from the *"Major Themes"* report. The Sages' task was to draw out the key messages and to identify those issues and areas of energy policy in need of greatest attention. They also recommended that certain aspects of the scenarios presented in *"Major Themes"* should be further explored.

They focussed on two factors. First, the conventional wisdom as presented in *"Major Themes"* may no longer represent the consensus view. Second, they recognised that the costs associated with meeting strict environmental targets could be very high. In response to these recommendations, Scenarios 2 and 3 have been subject to modifications. At the same time a new scenario has been created to examine another possible future.

Scenarios 1 and 2 are characterised by progressive implementation and development of current thinking:

- Scenario 1 is the original "Conventional Wisdom" view which provides an outlook consistent with consensus thinking;

- Scenario 2 tests the robustness of this view under conditions of higher growth with the economic system "Driving into Tensions".

Scenarios 3 and 4, on the other hand, represent energy futures in which energy policy, coordinated with other key policy areas, plays a vital role in shaping supply and demand patterns within the Community.

- Scenario 3 explores in more detail than in *"Major Themes"* the options available to achieve sustainable high economic growth, a cleaner environment and secure supplies of moderately priced energy;

- Scenario 4 examines the effect of more moderate economic growth combined with higher end user prices but with the same efficiency gains as in Scenario 3.

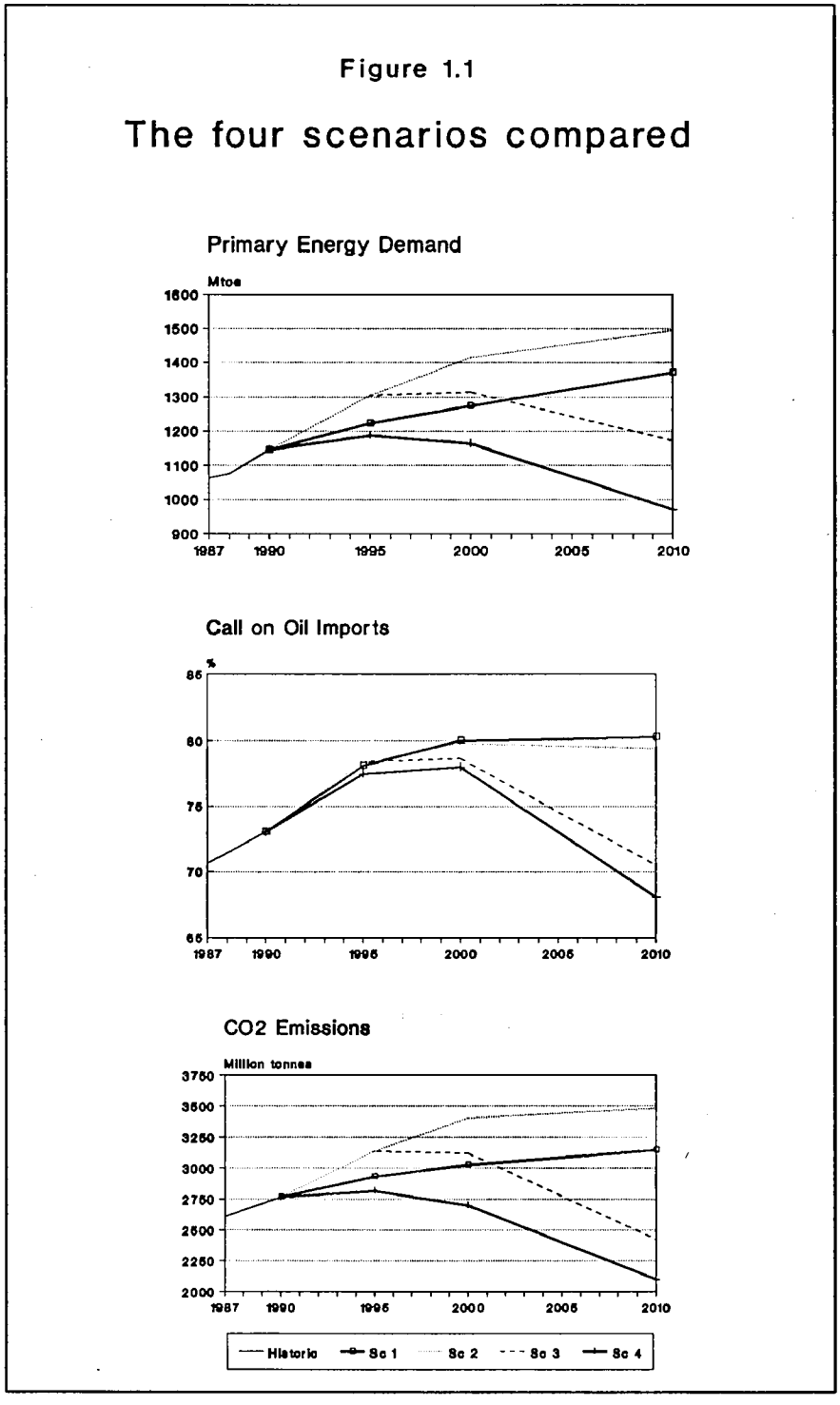
A more detailed description of Scenarios 1 and 2 is presented in Chapter Two, while Scenarios 3 and 4 are explored more thoroughly in Chapter Three.

In Chapter Four, conclusions derived from this analysis are drawn together and placed in the overall framework. Issues within each of the fuel sectors are examined as are issues arising from the major energy themes of sustainable growth, a clean environment and moderately priced and secure energy supplies. Finally, the Community is considered within the changing global situation. Annexes providing supplementary information relating to the four scenarios are included at the end of the report.

Figure 1.1 shows how three key variables, primary energy demand, oil import dependency, and carbon dioxide emissions, evolve in the Community under the four scenarios. Two types of world emerge: "A conventional view" and "A change of policy".

Figure 1.1

The four scenarios compared



This report is not intended to provide "answers". It is hoped that it will provide the focus for further discussion between energy producers, consumers and policy makers. Difficult decisions still have to be faced. However, through better understanding of these very complex interactions with a broad input from all sides, it may be possible to take those decisions with greater confidence.

Chapter 2

A conventional view under stress - Scenarios 1 and 2

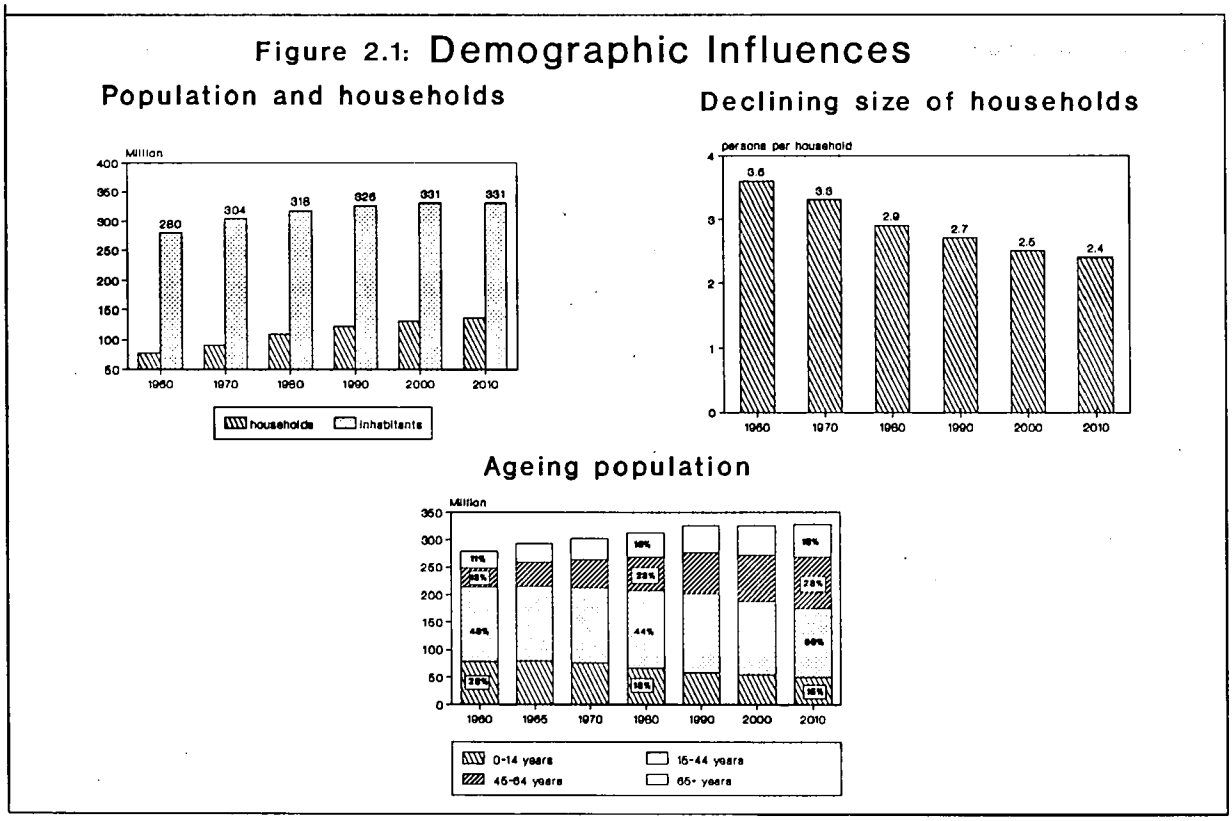
Introduction

The amount of energy required within the Community in the future will be determined by the size, demographic structure, lifestyle and wealth of the population as well as the industrial structure. It will also depend on how efficiently it is produced and converted from one form to another, and how efficiently it is used. All of these factors need to be taken into account in developing energy scenarios.

Demographics

Over the next twenty years a significant increase in the size of the population of the European Community is unlikely. The population will grow by perhaps another 5 million people by the end of the century and thereafter stabilise. However, because of a falling birthrate and increasing life expectancy, the average age of the population will steadily increase. In 2010, as Figure 2.1 shows, nearly half of the population will be more than 45 years old.

Figure 2.1: Demographic Influences



The number of households will increase appreciably and more people will own cars. Both houses and cars could well be larger , on average, than today. The average person will have more money to spend and, probably, more time in which to spend it.

Economic growth

In Scenario 1 the Community economy grows at 2.7 percent p.a. over the period 1990-2010, modest compared to growth during the 1960s but equal to that achieved over the period 1968-88. Creation of the internal market and realisation of its potential benefits occurs gradually, contributing to this steady economic performance. On the world scene, while OECD countries grow at a similar rate as the Community, USSR and other Eastern European countries, after a transition period of slow growth, grow at slightly less than the Community. Developing countries experience the strongest growth at 4 percent p.a. resulting in overall long-term growth for the world averaging 3 percent p.a.

In Scenario 2, the completion of the internal market together with improved world trading conditions results in stronger economic growth in the Community, an average of 3.5 percent p.a. from 1990 to 2000. Overall world growth averages 4 percent p.a. with developing countries experiencing 4.5 percent growth over this period.

Within the Community, energy intensive industries, such as chemicals, steel and building materials, continue to grow during the 1990s. The tertiary sector would also continue to develop, while in the domestic sector higher disposable incomes are achieved.

Beyond 2000, the picture changes. Due to higher energy prices, driven by higher energy demand levels, the economic situation deteriorates with Community and world growth falling to 2.5 and 2.8 percent p.a. respectively. More comprehensive descriptions of the scenarios are presented in the annex.

Energy resources

In the 1970s, "conventional wisdom" suggested imminent depletion of energy resources. Higher energy prices and a desire to increase production where possible stimulated exploration and improvements in production technologies. As a result, in the 1980s a common perception has developed of sufficient resources to cover needs for the foreseeable future. Despite growing energy demand, reserves continue to be replaced and upgraded. In the scenarios, there are no perceived physical constraints on global energy resources in the period to 2010.

International energy markets

Against this background of adequate energy resources, international energy prices are driven by supply and demand fundamentals.

In the case of oil, the increasing concentration of global reserves in the Gulf region will allow OPEC to exercise greater market power over the longer term. In both Scenario 1 and Scenario 2, the call on OPEC oil and OPEC's role in managing the market are key factors.

In both scenarios, non-OPEC supply (including Eastern European net exports) is expected to plateau at around 30 million barrels per day (mbd). Net exports from USSR and other Eastern European countries are projected to decline from their current level of 2 mbd to zero by 2010 as their own energy requirements grow. Hence, in both scenarios, higher world oil demand translates almost directly into additional call on OPEC.

Faster oil demand growth in Scenario 2 during the 1990s due to higher economic growth exerts upward pressure on prices. Oil prices exceed $25 per barrel (in 1987 real terms) in Scenario 2 by 2000, compared to only $20 per barrel in Scenario 1. Oil prices persist in an upward direction, reaching $40 per barrel in Scenario 2 and $30 per barrel in Scenario 1 by 2010.

In both scenarios, the international coal market is highly competitive. Prices are cost driven. In Scenario 1, prices grow slowly to $50 per tonne (in 1987 real terms) by 2000, and to $60 per tonne by 2010. In Scenario 2, due to more rapid growth in demand during the 1990s, prices reach $65 per tonne by 2000. This growth slows thereafter, with prices increasing more modestly to $70 per tonne by 2010.

Historically, natural gas prices in Europe have been strongly linked to oil prices. In both scenarios, this relationship is expected to persist throughout the 1990s with only a slight decoupling in Scenario 2. However, with growing gas use in the power sector, prices increasingly need to reflect the movements in the price of competitive fuels. Consequently, beyond 2000 in both scenarios, gas prices are indexed to coal.

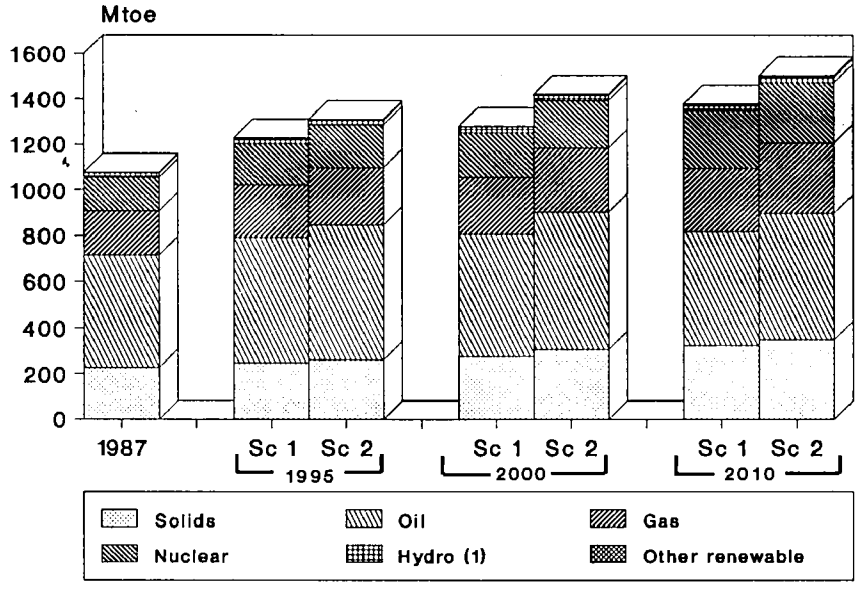
These oil scenarios are discussed in working paper number 12 "The World Oil Market - a scenario approach".

The energy outlook

In Scenario 1, primary energy demand in the Community grows at a rate of 0.9 percent p.a. over the period 1990 to 2010. However, this is the result of two distinct trends: the rate of growth being faster in the 1990s (1.1 percent p.a) but declining in the later period to 0.7 percent p.a.

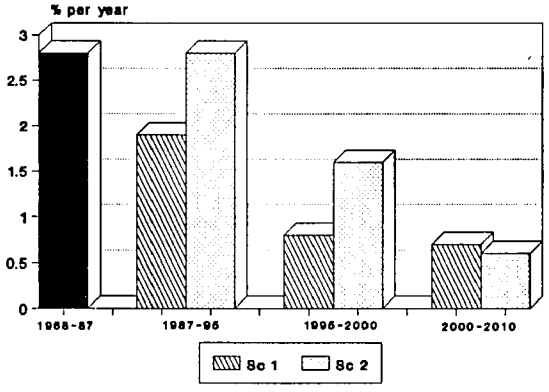
Faster overall growth in primary energy demand is experienced in Scenario 2, at a rate of 1.4 percent p.a. However, the split between the two period is even more accentuated: demand grows by 2.1 percent p.a. in the 1990s, but only 0.6 percent p.a. thereafter.

Figure 2.2 : Primary Energy Demand by Fuel
(Scenarios 1 and 2)



(1) Includes geothermal and net electricity imports.

Average annual growth rates

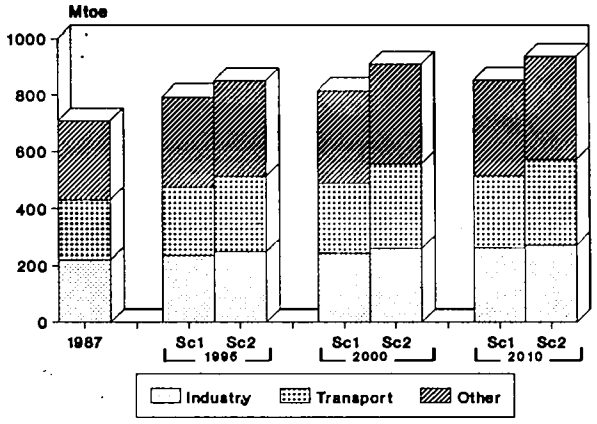


Final energy demand growth (excluding non-energy use) in both scenarios is slower, averaging 0.6 and 1.1 percent p.a. respectively. This reflects changes in economic structures, technical efficiency improvements, and saturation in some markets (e.g. car ownership, household appliances). Final consumption will rise from current levels of around 770 Mtoe to 930 Mtoe in Scenario 1 and 1020 Mtoe in Scenario 2 by 2010. With GDP growing faster than final energy consumption during this period, the ratio between the two, i.e., the "energy intensity", will gradually decline in both scenarios from 0.2 to 0.13 toe per 1000 ECU (at 1985 prices), a decrease of 35 percent.

Scenarios 1 and 2.

Figure 2.3

Final Energy Demand by Sector



Average Annual Growth Rates

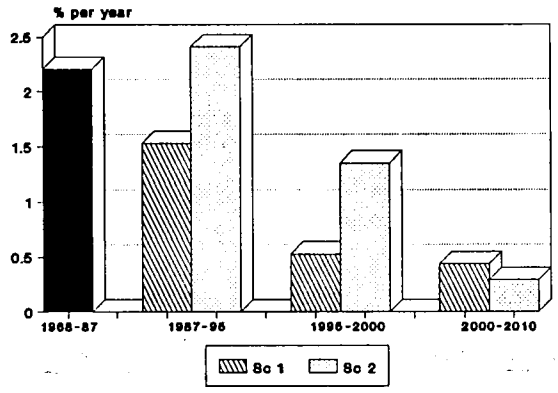


Figure 2.4 : Final Energy Intensity

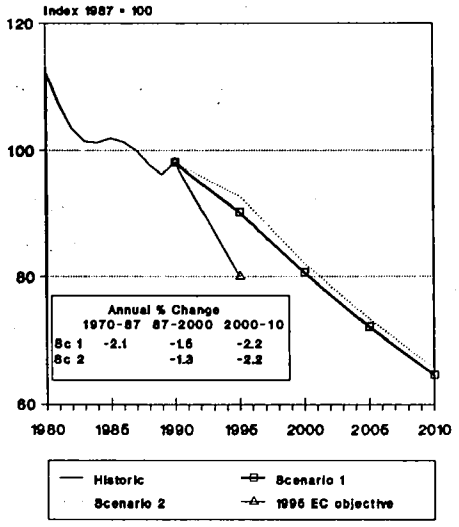


Table 2.1 shows incremental final energy use in both scenarios over the period 1987 to 2010 broken down by fuel and by sector. By sector, transport grows most rapidly in both scenarios, adding 55 Mtoe and 102 Mtoe of incremental demand over 1987 levels. Industrial energy demand growth is more similar between the two scenarios at around 50 Mtoe, while in the domestic sector the range covered is from 46 Mtoe to 74 Mtoe.

Table 2.1: Incremental Final Energy Use 1987-2010.

Scenario 1	Solids	Oil	Gas	Elect.	Heat	Renewab.	Total
Industry	-4	-1	20	26	4		45
Transport		52		3			55
Domestic	-8	-26	32	43	2	3	46
Final Consumption	-12	25	52	72	6	3	146

Scenario 2	Solids	Oil	Gas	Elect.	Heat	Renewab.	Total
Industry	-1	-1	23	30	4		55
Transport		99		3			102
Domestic	-8	-26	48	54	3	3	74
Final Consumption	-9	72	71	87	7	3	231

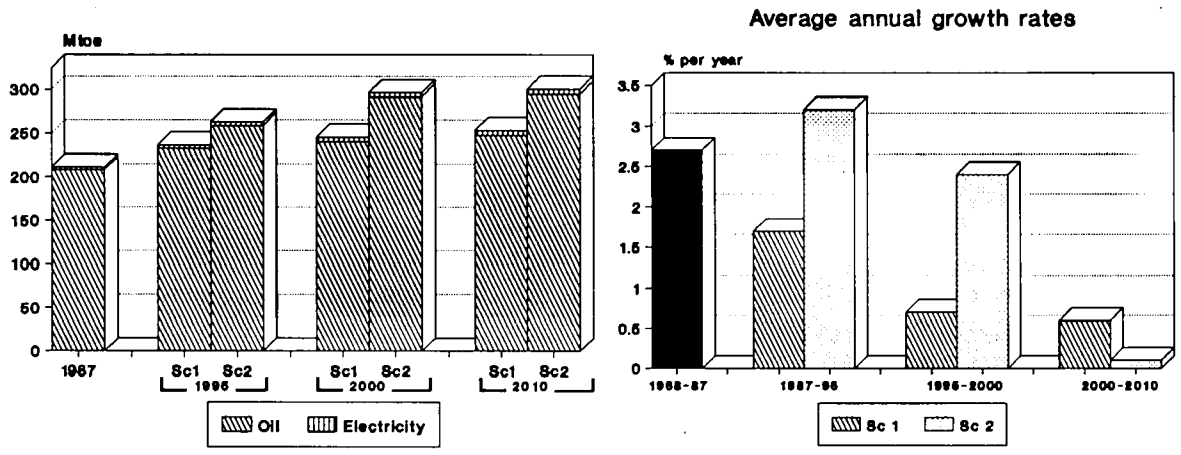
Looking at consumption by fuel type indicates some important changes. In both scenarios, solid fuel loses ground in both industry and domestic/tertiary sectors. Oil is also gradually backed out of the domestic/tertiary sector over the period. Both gas and electricity grow strongly, with electricity growing the faster of the two.

The increase in electricity demand and transport fuels accounts for over 80 percent of the incremental growth in both scenarios. Electricity is replacing mainly solid fuels in the industrial sector, while electricity and gas are replacing solid fuels and oil in the residential and commercial sectors. Oil will continue to dominate the transport sector.

The transport sector

An important effect of greater disposable income in the Community is that more cars will appear on the roads. Because of increased efficiency of new cars, fuel consumption will grow more slowly than the size of the fleet. However, by 2010 over 55 percent of the fuel consumed in the transport sector, over one third of total oil consumption, will be accounted for by private vehicles.

Figure 2.5: Transport Scenarios 1 and 2.



In the road freight sector, higher load factors and technical progress to reduce unit consumption by between 25 and 30 percent will restrain growth in fuel demand.

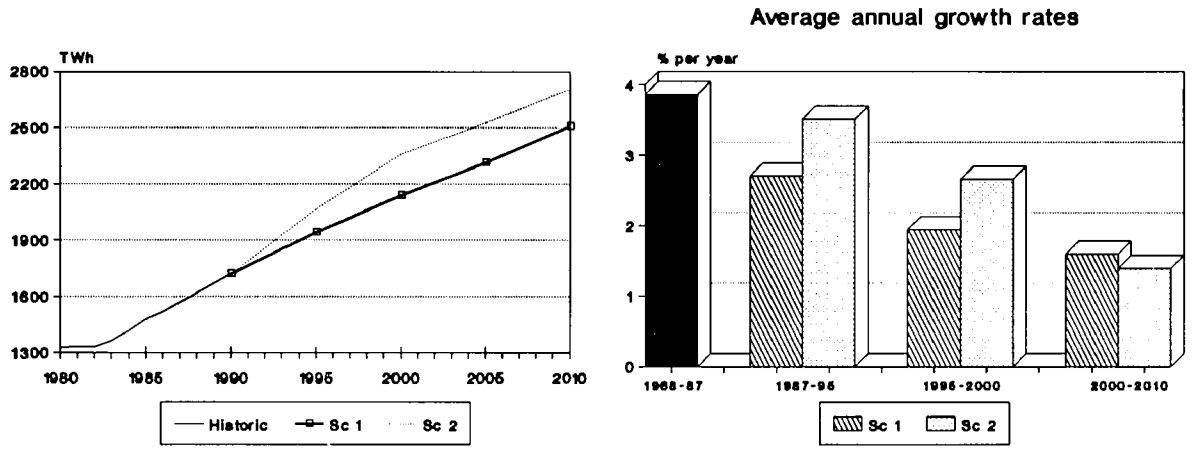
While there could well be a substantial increase in the number of passengers carried by air transport, and in the number of kilometres flown, this is expected to be somewhat offset by jet fuel savings per passenger. Replacement of the existing fleet by higher capacity, more economic aircraft combined with higher occupancy rates, could reduce unit consumption by half over the scenario period.

However, Scenario 2 presents concerns. Oil use in the transport sector increases by 35 percent between 1990 and 2010. With little prospect for substitution, emissions of atmospheric pollutants, particularly of CO_2, will continue to grow. Breaking the link between transport requirements and oil consumption remains one of the great energy challenges.

Electricity generation

During the last 15 years, the demand for electricity has grown faster than that for all other fuels. It has also grown faster than the rate of economic growth, meaning that electricity intensity has increased while other fuel intensities have tended to decrease.

Figure 2.6: Total Electricity Demand Scenarios 1 and 2



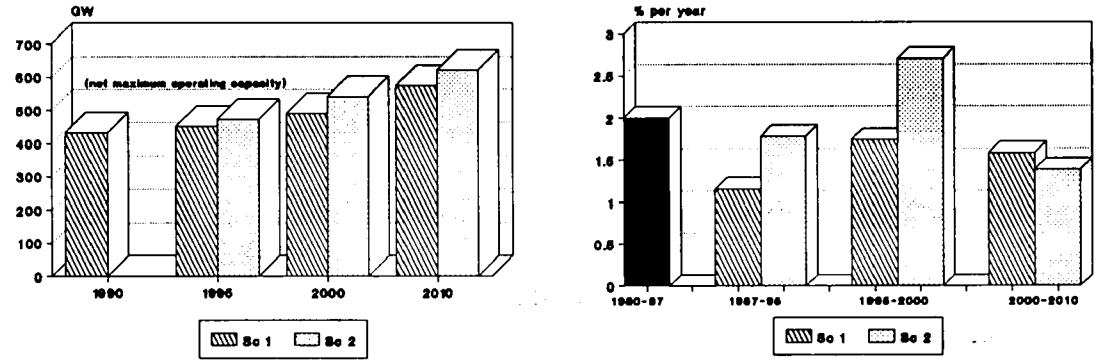
In Scenario 1, the demand for electricity grows at 1.9 percent p.a. over the period to 2010, but again with more rapid growth (2.3 percent p.a.) in the 1990s compared to 1.6 percent p.a. in the following decade. In Scenario 2, overall growth is faster at 2.3 percent p.a. with a similar pattern (3.3 and 1.4 percent p.a. in the two periods). In both scenarios, growth is stronger in the domestic/tertiary sectors than in industry.

However, overall in both scenarios, demand growth is less than GDP growth representing a change in the historical relationship as efficiency improvements begin to outweigh both increasing ownership and substitution effects.

To meet this growth in demand, electricity production will need to increase by 830 TWh and 1080 TWh in the two scenarios between 1990 and 2010. While coal and nuclear will continue to be the major source of inputs of this production (around 85 percent in 2010), oil burn will increase from 36 Mtoe in 1987 to just under 60 Mtoe in 1995, before falling back to around 20 Mtoe in 2010. This increased oil burn over the medium term reflects the reluctance of utilities to invest in new capacity. Gas burn under both scenarios rises from 29 Mtoe to around 50 Mtoe between 1987 and 2010 - an increase considerably below its apparent potential.

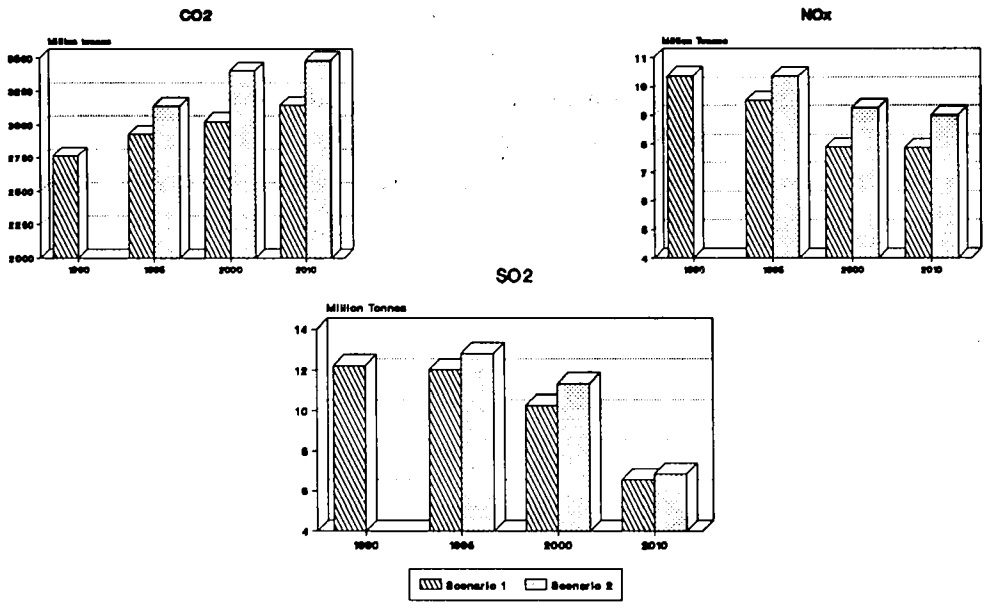
The installed capacities in both scenarios are compared in Figure 2.7. In Scenario 1, capacity needs increase by 142 GW over the period from 1990 to 2010. This growth is met mainly by coal (79 GW), followed by nuclear (45 GW) and then gas (22 GW). In Scenario 2, an additional 188 GW is required. This increment of 46 GW over and above the needs of Scenario 1 is again met predominantly by coal (24 GW) and nuclear (9 GW). The amount of actual new capacity required in both scenarios is, of course, even greater again once retirement of existing plant is taken into account.

Figure 2.7: Electricity Generation Capacities
Scenarios 1 and 2 Average Annual Growth Rates



The environmental consequences differ for each of the three key air pollutants - sulphur dioxide (SO_2), oxides of nitrogen (NOx) and carbon dioxide (CO_2) - in the two scenarios. SO_2 emissions experience a steady reduction as new coal plants equipped with flue gas desulphurisation (FGD) are brought on-line, existing plants are retrofitted, and as gas substitutes for coal. NOx emissions are little changed as the benefits of installing low NOx burners are offset by increasing demand. CO_2 emissions in the power sector increase significantly: in Scenario 1 by over 40 percent and in Scenario 2 by over 55 percent between 1990 and 2010. It is in this last respect where greatest concern may exist, and where the most fundamental of challenges may lie.

Figure 2-8: Air Polluting Emissions
Scenarios 1 and 2



Major themes

Energy and growth

The link between economic growth and energy demand has weakened over time in the industrialised world as a result of economic restructuring and technologically driven efficiency gains. These processes will continue in the future. However, incremental changes in economic activity will still require additional energy; only the amount will be reduced.

In Scenarios 1 and 2, energy demand grows, with industrial and commercial structures changing as a result of the evolving consumption patterns of individuals, households and institutions. Scenario 2, in particular, points towards increasing stresses within energy markets as a result of rapid economic growth.

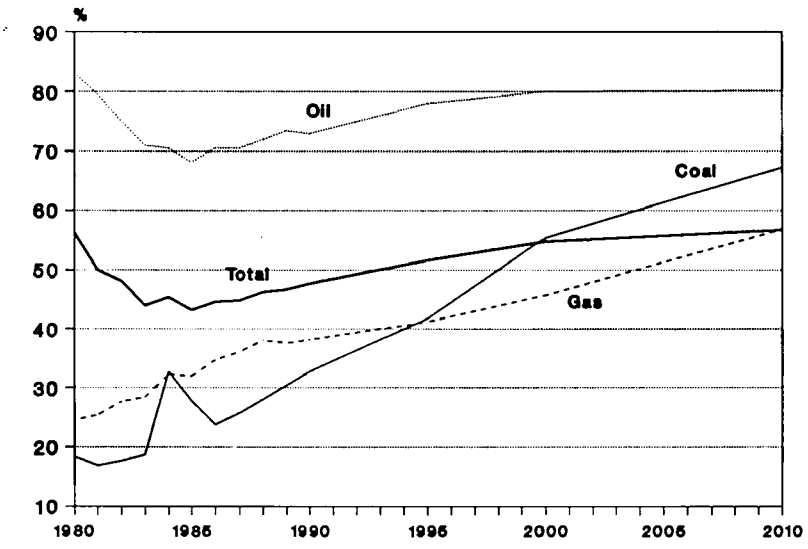
Energy and the environment

Under both scenarios, CO_2 emissions are likely to increase: from 2.8 billion tonnes in 1990 to 3.2 billion tonnes in 2010 in Scenario 1, and to 3.5 billion tonnes by 2010 in Scenario 2. In the latter case, the largest increments take place in the power sector (0.5 billion tonnes) and in the transport sector (0.2 billion tonnes).

Energy security

The Community's dependency on energy imports will continue to rise in both scenarios. Coal imports experience the most dramatic increase from around 30 percent to nearly 70 percent of primary requirements. However, because the market is likely to remain competitive this may represent a lesser concern provided that a diversity of suppliers is maintained. Oil imports will rise from around 70 percent of consumption to 80 percent by 2010. Gas imports rise significantly from 38 percent to just under 60 percent. The call on imports overall for the Community increases from 47 percent in 1990 to 57 percent by 2010 in both scenarios.

Figure 2.9: Call on Imports, a conventional view.



Conclusions

It seems likely that energy demand will continue to grow, driven by economic forces. In Scenario 1, this would appear to be containable. World energy markets remain relatively stable, thus higher European import dependence does not represent a significant threat. On the environment, SO_2 emissions are significantly reduced, while NOx emissions also decline. However, CO_2 emission reductions are not achieved.

It is in Scenario 2 that the real stresses and tensions emerge. World energy prices rise more rapidly, and in the case of oil could be potentially unstable. As a result, higher import dependency becomes a serious concern. Emission levels are also higher, particularly of CO_2, further fuelling the controversy about the polluting nature of energy production and use.

The consequences of these problems are significant. In the longer run, the higher rate of economic growth is judged not to be sustainable. Beyond the end of the century, economic growth in Scenario 2 is slower than in Scenario 1.

Overall, this would seem to demonstrate that there is a need for effective energy policy measures in order that the full benefits of greater economic integration can be realised.

Chapter 3

Reducing the tensions - Scenarios 3 and 4

Introduction

In the previous chapter, a "conventional" approach to energy demand and supply was developed. Presently the outlook for energy demand in the early 1990s seems set on a path closer to that of Scenario 2. We could be "driving into tensions" between the desire for economic growth, a cleaner environment, and secure energy supplies at moderate prices. Scenarios 3 and 4 look at different ways in which these tensions could be reduced.

In Scenario 3, stronger economic growth provides the additional impulse to increase investment which facilitates the penetration of new and more efficient technology into the market place. This dynamic economic process is accompanied by policy initiatives on energy intensity: norms, standards and incentives. In this way, consumers can satisfy their needs in an environmentally conscious manner. Consumer prices in Scenario 3 follow world market trends.

Scenario 4 shares the same assumptions as Scenario 3 concerning improvements in energy intensity. However, tensions are reduced by means of more moderate economic growth (similar to Scenario 1) and by higher end user prices. Further description of the scenario assumptions are in the annex.

The economic and political framework

The internal market and changes in eastern Europe over the medium term could have an important impact on economic growth. This would complement a generally improving world economy. In Scenario 3, world growth averages 4% p.a. between 1990 and 2000, and 3.5% from then to 2010. The average Community GDP is 3.5% p.a. to 2000 and, because this rate could lead to some tensions, there is a slowing down after 2000 to 3% p.a.

In Scenario 3, energy intensive industry continues to grow as in Scenario 2 up to 1995, but stabilises from then until 2010. Other industrial sectors maintain more steady growth throughout the entire period. The tertiary sector expands after 1995 compensating for the slowing down of heavy industry. In the domestic sector, income grows at 3% on average to 2000, declining to 2.5% over the period 2000 to 2010.

From the early nineties onwards, new technological developments, combined with high capital turn-over, lead to greater economic and energy efficiency. Consumer behaviour changes, reflecting decisions to reduce emissions (a wish endorsed across the political spectrum). Consumer behaviour reflects a more energy and environment conscious society.

Given the structure of Scenario 3, with strong economic growth and a clear political consensus, progress is achieved in establishing the internal energy market. With tax harmonisation and greater integration of gas and electricity networks, prices and costs of different fuels tend to converge. After a period of transition, economic growth across Europe would seem to be relatively robust. Consequently, in a healthy economic climate, concern with the level of emissions could lead, in the early 1990s, to much stricter environmental standards.

Energy policy implications

The energy policy implications of the two scenarios are important. The growing tensions reflected in Scenario 2 lead to a renewed focus on energy policy. In scenarios 3 and 4, particular emphasis is given to:

- more efficient use of energy through tighter norms and standards;
- facilitating new technological developments;
- increased diversification of fuel supplies;
- stricter environmental standards.

Furthermore, in Scenario 4 a greater willingness exists to accept the trade-off of more moderate economic growth and higher energy prices. The willingness of consumers to accept such policies reflects a coherence between the desire to maintain growth but with a cleaner environment. The scenario requires this political consensus to enable public authorities to legislate accordingly. As in Scenario 3, close coordination between local, national and community institutions is implied if a coordinated range of policies covering energy, transport, industry and environment are to be implemented.

Scenario 3: Principal results

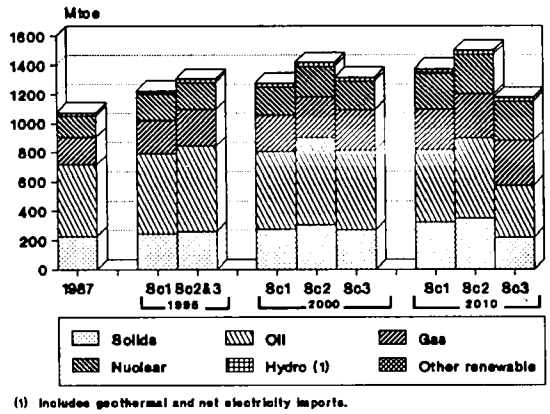
Since the *"Major Themes"* report was published, very useful comments and suggestions from the Groupe des Sages and others have been received. These have guided our review of Scenario 3. In particular, the analysis of the power sector has been developed further. To better illustrate the issues involved four sensitivities are presented showing the impact of different fuel choice options in the electricity sector.

Primary energy demand

The growth path for primary energy demand changes radically over the scenario period. A strong rate of growth of 2.6% p.a. occurs until the mid 1990s after which the new policies to reduce demand begin to take effect. In the latter period, consumption patterns are reversed such that by 2010 the incremental increase over today's demand levels is only 120 Mtoe.

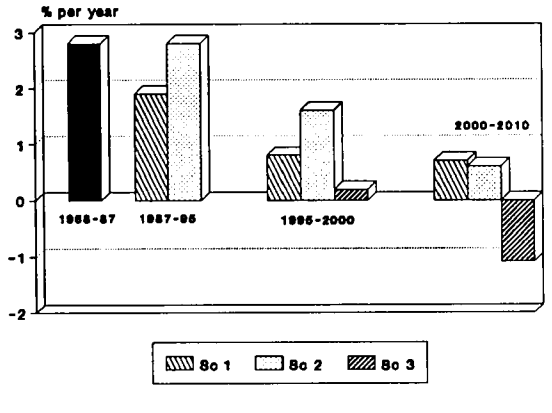
Figure 3.1: Primary Energy Demand by Fuel

Scenarios 1, 2 and 3



(1) Includes geothermal and net electricity imports.

Average Annual Growth Rates



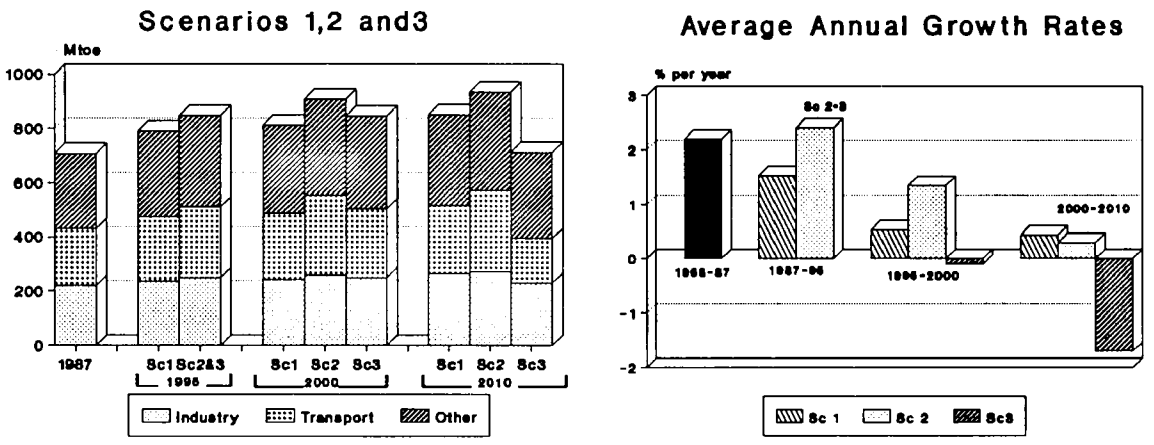
The pattern of fuel use changes with oil's role declining, while the role of gas increases significantly. For power generation major uncertainties exist regarding nuclear and coal while interest in gas and renewables grows.

Changes in primary demand reflect fundamental shifts in how final energy is consumed:

- in transport there is a major shift in demand towards much greater use of public transport;
- in the domestic and tertiary sector a shift away from oil to gas is accompanied by lower demand through efficiency improvements;
- industrial consumption declines due to structural shifts towards lighter industry.

Electricity demand continues to rise particularly in the domestic and tertiary sectors. Over the long term, electricity demand grows at about 1.7% p.a. However, a higher growth rate of 3.5% p.a. is experienced in the initial period to the mid 1990s, followed by a lower rate of less than 1% p.a. in the subsequent period.

Figure 3.2: Final Energy Demand by Sector

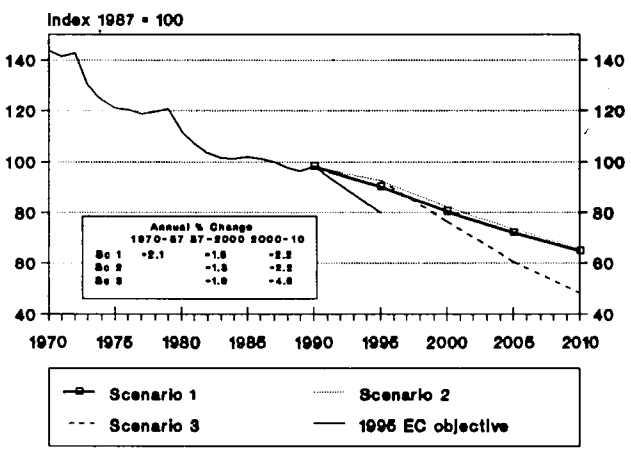


Energy intensity

Energy intensity, an indicator of the impact of structural, behavioural and efficiency changes, is considerably reduced reflecting the changes in final demand. Historically the long-run decline in energy intensity was around 1% p.a. from 1960-1988. Since 1979, intensity has decreased by over 2% p.a. However, since 1985 this has slowed considerably.

The rate of decline in Scenario 3 is 2% p.a. for the period 1990-2000 but doubles to an annual reduction of 4% in the final decade. Many believe such rates are technically possible and politically achievable. Others argue that there is a need for higher prices as examined in Scenario 4, if further decreases in energy intensity are to be achieved.

Figure 3-3: Final Energy Intensity (Scenarios 1,2 and 3)

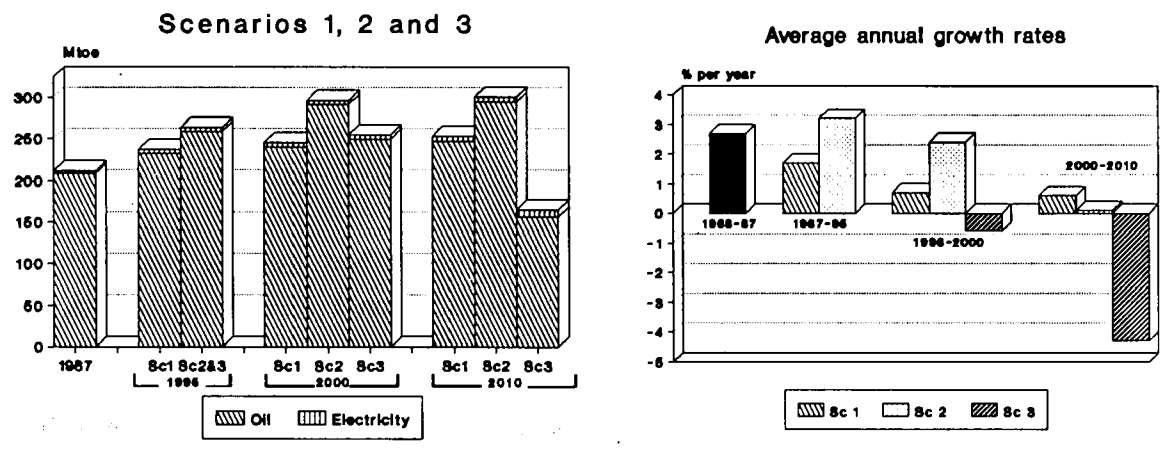


Transport

The transport sector illustrates the policy challenges implied by Scenario 3:

- cooperation of motor manufacturers in designing and marketing vehicles with lower energy consumption;
- refineries upgrading fuel quality;
- city authorities implementing improved traffic management schemes and urbanisation policies;
- development of transport pricing policy;
- significant improvements in public transport.

Figure 3.4: Transport



The key messages are:

- without such policy measures, transport demand will continue to grow. There is no market mechanism (other than congestion) to reconcile the increasing tensions;
- a number of coordinated policy initiatives across different sectors (industry, transport, environment and energy) are required.

This will not happen of its own accord and will require political commitment. Research and development in car design and fuel alternatives (including non-oil options) are required, as well as a re-examination of the role of public transport.

Electricity generation

The electricity sector is growing in importance with demand increasing in the 1990s by between 2-4% p.a. It is a fuel viewed as environmentally benign when it is used - but not when being produced. There is growing controversy about the choice of fuels for generation. Each fuel has potential problems:

- nuclear because of fear of accidents plus waste disposal;
- coal because of polluting emissions;
- renewables because of a lack of scale, and in some cases because of high costs;
- oil because of price volatility and security issues.

Potentially a surge in gas use could occur but this too raises questions about energy security.

To understand the implications of different fuel options on the structure of the electricity supply sector and to highlight other wider implications such as import requirements, and the impact on CO_2 emissions, four power generation sub-scenarios were developed.

These sub-scenarios are defined as follows:

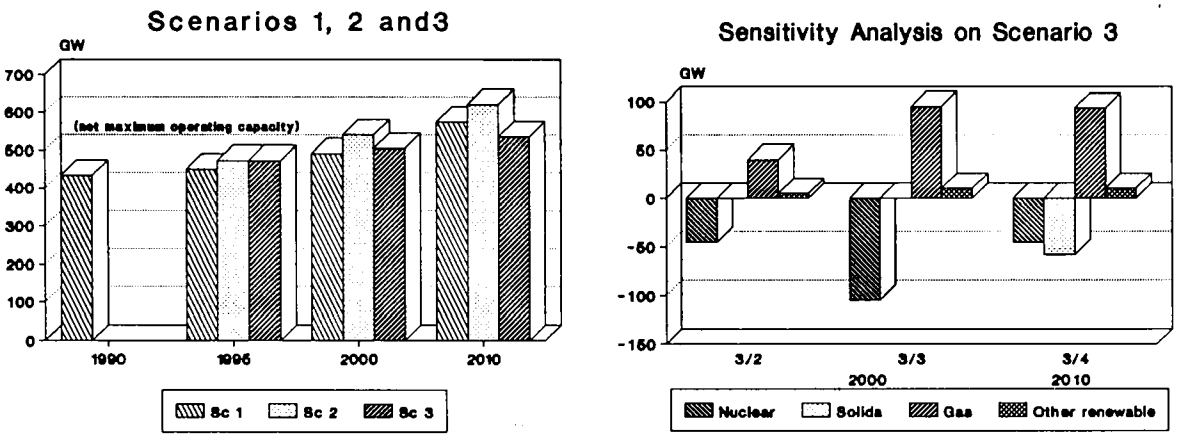
Scenario 3.1	Nuclear is the main fuel used in new power stations;some additional use of solids, gas and renewables(traditional plus some new).
Scenario 3.2	Increase in gas use compensating for nuclear which remains static after 2000; solids and renewables have a supporting role.
Scenario 3.3	Nuclear moratorium; gas used as the swing source.
Scenario 3.4	Reduced role for coal with gas as swing source; some additional nuclear; renewables as in 3.3 .

Additional assumptions for all four sub-scenarios:

. oil capacity is expected to decline after 2000;
. nuclear decommissioning occurs at the end of a technical/economic life of 30 years on average;
. coal remains under pressure because of the cost of removing SO_2 and NO_x and new restrictions on CO_2 emissions;
. between 4 to 10 GW of "non-traditional" renewables become available;
. all new gas fired plants are based on highly efficient combined cycle designs.

These electricity sub-scenarios were chosen to respond to the various arguments presented following the *"Major Themes"* publication. Those who argued that nuclear's role could increase (even if less rapidly than in the original Scenario 3) may expect the supply structure in Scenario 3.1, where 60% of the incremental capacity is met by nuclear. Those who argued for a moratorium (or shock) can see the impact by referring to Scenario 3.3. Reducing coal's role (Scenario 3.4) increases the call on gas to levels similar to a nuclear moratorium - some 120 GW.

Figure 3.5: Electricity Generation Capacities



The resulting additional generating capacities of these different electricity scenarios are shown in Table 3.1. The incremental capacity required is 103 GW, compared to a total capacity currently of about 430 GW.

Table 3.1

The structure of incremental net capacities (in GW) under the four power generation sub-scenarios for 2010

		Increments			
	1990	S3.1	S3.2	S3.3	S3.4
Nuclear	105	60	15	-44	15
Solids	159	22	22	22	-36
Gas	18	28	68	123	121
Renewables	81	16	21	27	27
Others (mostly oil)	70	-23	-23	-23	-23
Total	70	103	103	105	104

Table 3.2

Main findings in 2010 (Mtonnes CO_2)

	CO_2 variations from SC 3.1			
	S3.1	S3.2	S3.3	S3.4
POWER GEN. Solids	395.2	0	0	-149.6
Gas	80.6	+62.6	+147.1	144.6
TOTAL EMISSIONS	2426.2	2488.9	2573.4	2421.3
Variations in % of base case		2.6	6.1	-0.2

CO_2 Emissions: Changes in the fuel choices shown impact little on total CO_2 levels except in the event of a nuclear moratorium where the levels are 6% higher in 2010.

Energy security: there are important consequences for import requirements, particularly for gas. While total net import requirements are lower than those projected in Scenarios 1 and 2 (796 and 856 Mtoe respectively) the call on gas imports rises from a range of 157 to 173 Mtoe (Scenarios 1 and 2) to between 177 to 300 Mtoe depending on the fuel options chosen to meet electricity demand.

Table 3.3

Net import requirements for coal and gas (Mtoe) in 2010

	1987	S3.1	S3.2	S3.3	S3.4
Hard coal	0.6	115.0	115.0	115.0	51.0
Natural gas	71.3	177.3	229.8	300.5	298.5
Total Energy	491.1	562.1	614.6	685.3	619.3

The resulting impact on the Community's gas import requirements is an increase from 56% of total primary demand to between 58% and 70%.

Table 3.4

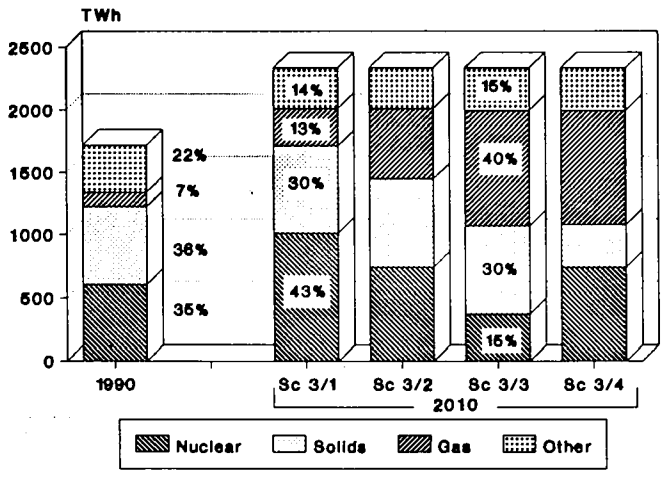
	Call on imports in 2010 (imports as % of total primary demand)				
	1987	S3.1	S3.2	S3.3	S3.4
Hard coal	26.2	52.3	52.3	52.3	32.7
Natural gas	36.0	58.4	64.5	70.4	70.3
Total Energy	46.2	47.7	52.8	59.4	52.5

Key messages from Scenario 3

Power generation

A balance in the fuel mix to generate electricity is required. Over-reliance on a single input reduces the system's resilience and flexibility.

Figure 3.6: Electricity Production by Fuel

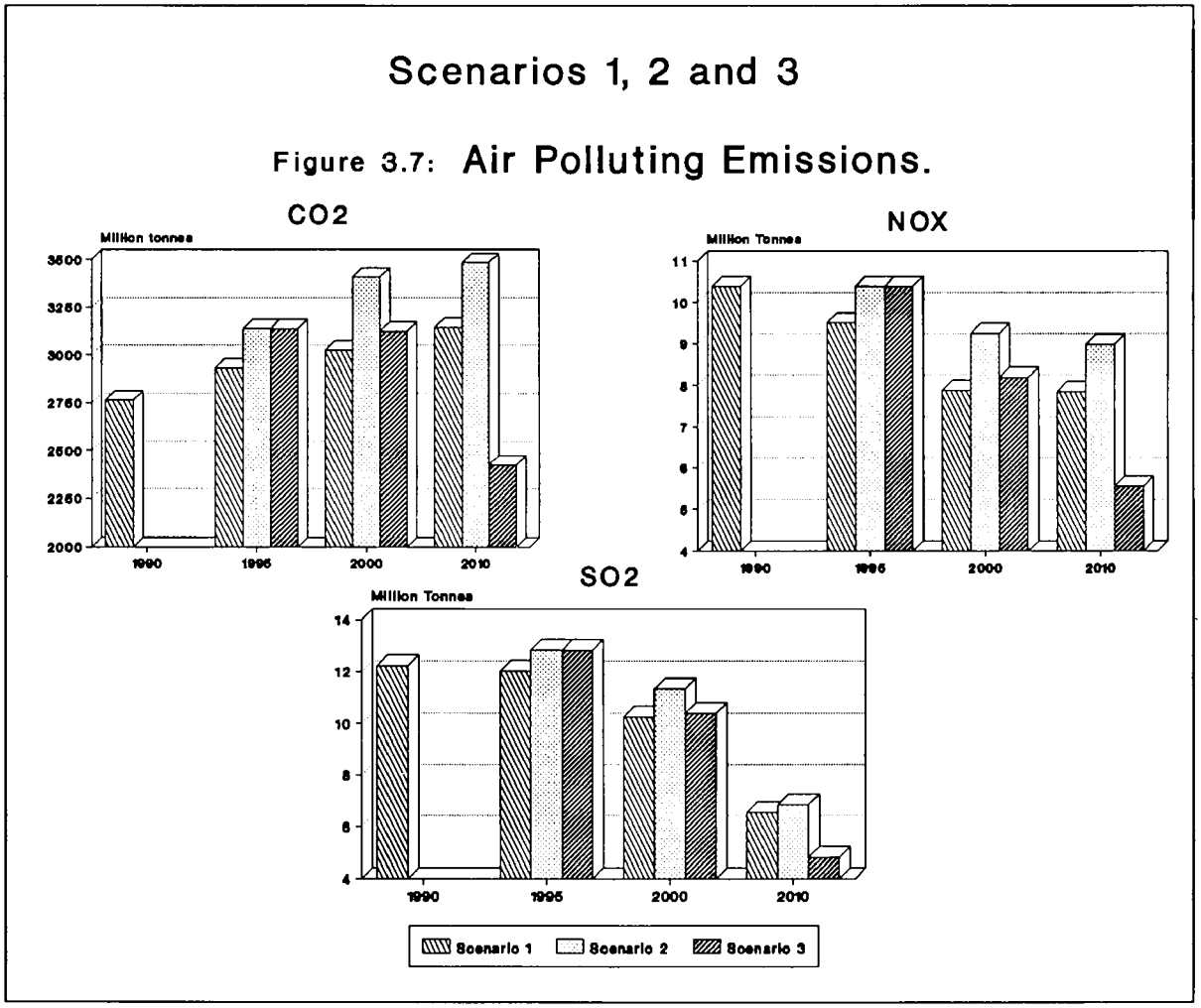


Coal will remain an important input over the period and indeed beyond. The challenge is to improve, through research and development, the cleanliness and efficiency with which it is burnt.

Nuclear faces the challenges of improving both its public acceptability and its financial attractiveness. Reducing or foregoing this option implies increased substitution by either coal or gas

Currently gas is the favoured option. However, the preference for gas could imply a large increase in import requirements beyond that envisaged even one or two years ago. Therefore the policy emphasis must rest on the terms, conditions and security of its long-term supply, as well as on transportation and market structure.

The reduction in electricity demand implied in this scenario requires substantial effort in marketing "electricity efficiency".



The resulting emission levels in 2010 (using sub-scenario 3.1 as a basis) are as follows:

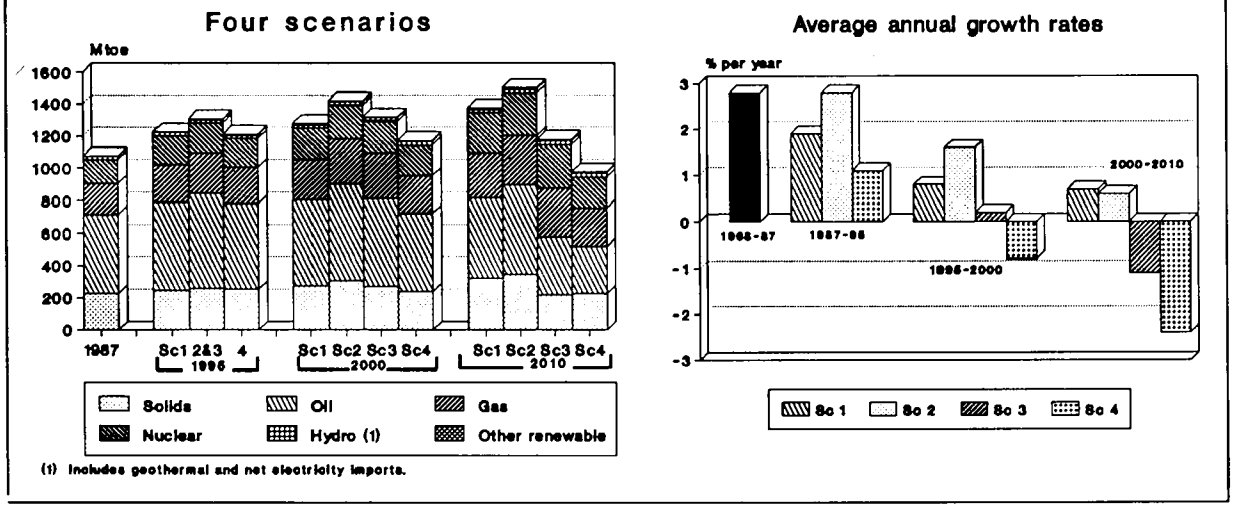
- CO_2 emissions are down some 12% on 1990 levels, but do not achieve the Toronto target (20% reduction on current levels) nor stabilization by 2000;
- NO_x emissions down by 50% with transport contributing 75% and power generation 20% of this reduction.
- SO_2 emissions are down by 60%, with the power generation sector contributing 80% of this reduction;

Scenario 4: Principal results

Scenario 4 is presented as a variant of Scenario 3. This new scenario was prepared in response to comments received from the "Groupe des Sages" and others. Scenario 4 assumes more moderate economic growth, with energy prices to consumers decoupled from world market trends. Price levels are determined by government intervention and, in comparison with Scenario 3, reflect a once-and-for-all increase in coal of 100%, oil of 40% and gas of 30%. In effect, Scenario 4 recognises the need to internalise the costs associated with environmental externalities. The methodology used to calculate the impact of these price levels on demand together with the full definition of Scenario 4 is contained within the annex.

Primary energy demand

Figure 3.8: Demand by Fuel



Despite similar GDP growth rates, growth in primary energy demand in Scenario 4 up to the mid-1990s differs from Scenario 1 by 3% because of higher consumer energy prices. Primary energy demand is 9% lower compared with Scenario 3 because of the combined effect of lower GDP growth and higher consumer prices. From the mid-90s onwards, the growth path of Scenario 4 is similar to that Scenario 3, but shows an earlier reversal from positive to negative annual demand growth rates.

Fuel patterns

While the role of gas and electricity increase significantly in both scenarios, oil declines because of higher prices in Scenario 4. More significantly the scenarios differ in their need for electricity generating capacity. In Scenario 4 total capacity could stabilize beyond 2000, with only 30 GW additional capacity in 2010 over 1990. This can be contrasted with Scenario 3 where 103 GW incremental capacity is required.

Final energy demand

Incremental developments in final energy demand by fuel and sector are summarized in Table 3.5. As with Scenario 3 there is:

- a major intermodal shift in transport demand away from private cars in urban areas;
- significant substitution of solid fuels and oil by gas and electricity in industry and to an even greater extent in the domestic/tertiary sector.

Table 3.5

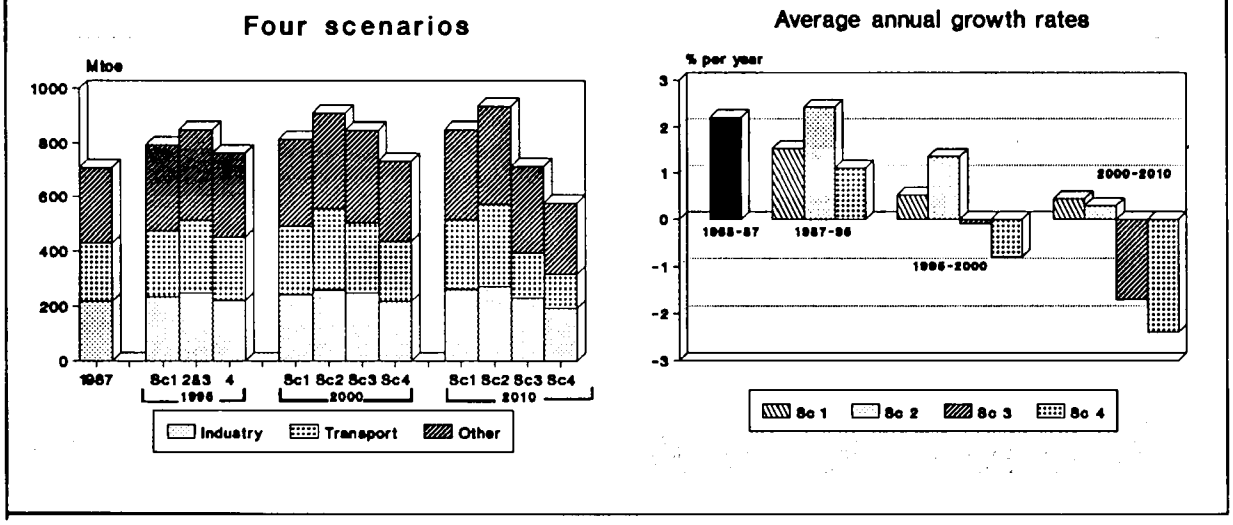
Incremental final energy demand 1987-2010 (Mtoe)

	Industry	Transport	Domestic + Tertiary	Final Energy
Solids	-23		-15	-38
Oil	-19	-79	-52	-150
Gas	+7		+13	+20
Electricity	+7	+5	+18	+30
Heat	+4		+2	+6
Renewables			+5	+5
TOTAL	-24	-74	-29	-127
1987 demandlevel	217	199	289	705

In comparison with Scenario 3, oil demand falls twice as fast while the rate of increase for gas and electricity is halved.

In contrast to all three other scenarios, energy consumption in Scenario 4 decreases in all sectors.

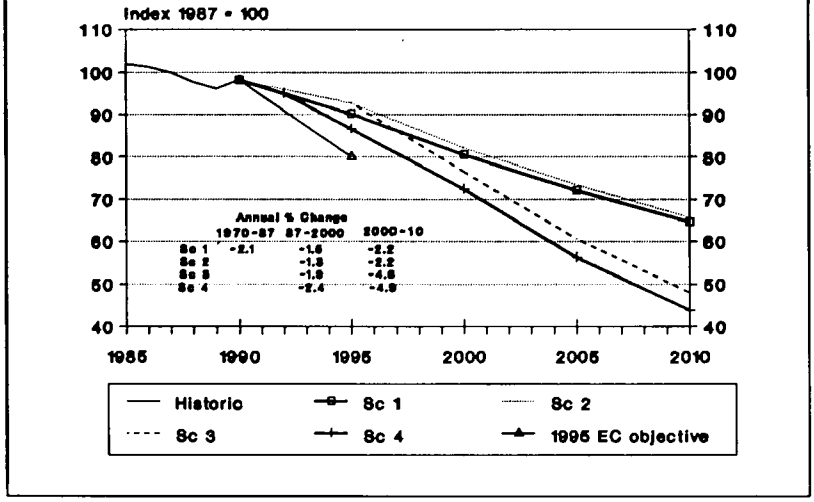
Figure 3.9: Final Energy Demand by Sector



Energy intensity

In Scenario 4, the ratio of final energy demand to GDP falls by 2.4% per year in the 1990s and by almost 5% after 2000 (this compares with 1.9% and 4.6% respectively in Scenario 3). This implies an acceleration in efficiency improvements due to higher prices.

Figure 3.10: Final Energy Intensity

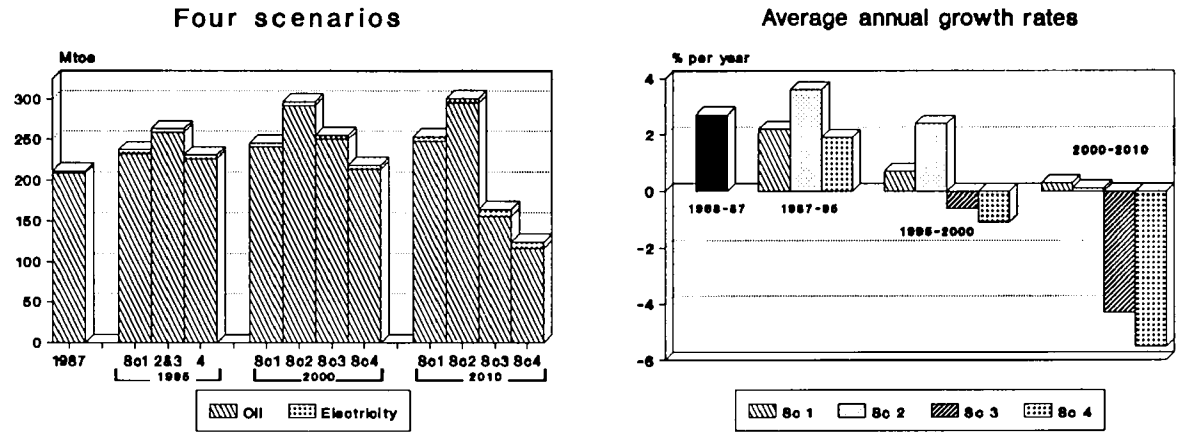


Electricity intensity, which historically has been increasing, declines strongly. By 2010, electricity intensity falls below the level achieved in 1960!

Transport

The trends developed in Scenario 3 are further reinforced, with transportation fuel consumption declining by over 37% from 1987 to 2010 (2% p.a. overall). After 2000, consumption declines by over 5% p.a. in contrast with an increase of 0.3% p.a. in scenario 1.

Figure 3.11: Transport



Electricity generation

In Scenario 4 electricity demand grows on average by 1% p.a. This is almost half of the rate of growth in Scenario 3 and about one third of current growth rate.

Overall investment needs for new, and replacement generating capacity are lower in Scenario 4. Total generating capacity stabilises after 2000.

Table 3.6 compares net capacities in 2000 and 2010 for Scenarios 3 and 4.

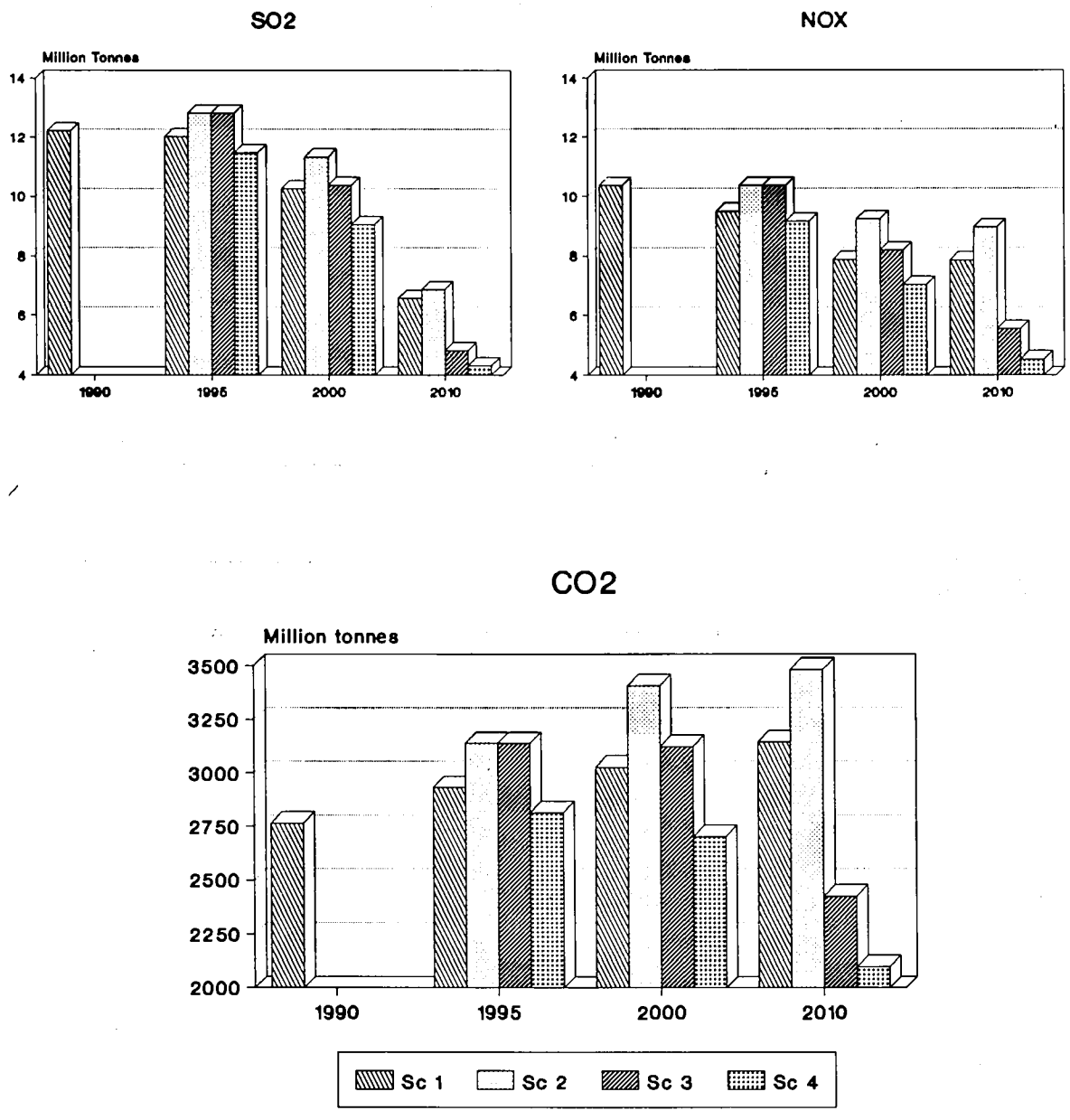
Table 3.6

Structure of electricity generating net capacities (GW)

	1990	2000			2010		
		S3.1	S3.2	S4	S3.1	S3.2	S4
Nuclear	105	120	120	117	166	120	117
Thermal	247	293	290	255	273	313	250
Renewables	81	92	95	91	97	103	95
TOTAL	433	505	505	463	536	536	462

Key messages from Scenario 4

Figure 3.12: Air Polluting Emissions



Reflecting trends in energy demand, emissions of SO_2, NO_X and CO_2 decline further in Scenario 4. By 2010, $S0_2$ and NO_X emissions are 65% and 56% below 1990 levels as compared to 60% and 5O% in Scenario 3;

Overall CO_2 emissions decline by 19% by 2010, compared with 1987 levels, stabilising by around 2000.

In comparison with the other scenarios, Scenario 4 exhibits the lowest energy import dependency.

Figure 3.13: Total Call on Import

Four scenarios

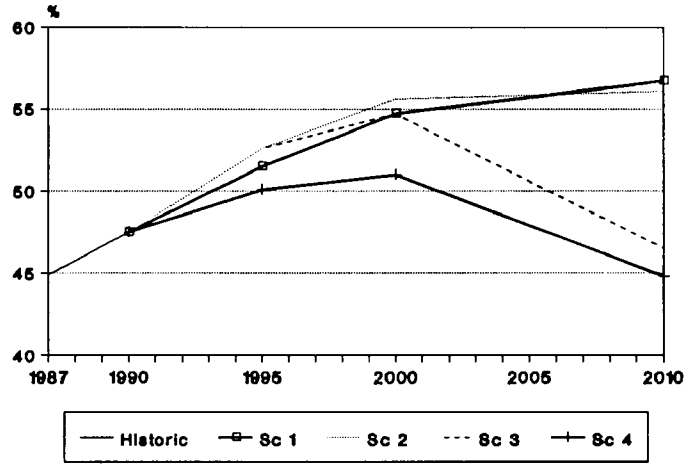


Table 3.7

Share of net imports in total primary demand (%)

	1987	2010		
		Sc3.1	Sc3.2	Sc4
Solids	26	52	52	50
Oil	71	71	71	68
Gas	36	58	65	51
TOTAL ENERGY	46	47	53	45

Conclusions

Scenarios 3 and 4 examined how tensions could be eased by reducing energy consumption. Clearly both scenarios present major changes in current economic behaviour and political preferences. Scenario 3 emphasises the role of technology, more efficient use of energy and willingness to voluntarily change our behavioural patterns. In Scenario 4, higher energy prices act as a stimulus to achieve these effects while at the same time growth is moderated.

Chapter 4

Challenges faced by changing futures

Introduction

Our starting point has been to accept that uncertainty is inherent in energy futures. We cannot predict the future. Perhaps the best that can be expected is: to make the assumptions transparent; try to measure the broad consequences of such assumptions; and to understand the degree of freedom for manoeuvre such directions would provide. On this basis, it may then be possible to develop a broad policy framework within which energy could develop, fostering economic, social and environmental welfare.

Looking back over the last two decades we may wonder if the period 1985-90 was in many ways a transitional one. The 1970's and early 1980's were periods of major changes in the macroeconomic structure, reflecting the stresses and strains in the production process arising from inflation, debt and rising interest rates. This undermined confidence in managing crises as they arose. Simultaneously, the geopolitics of the Middle East were introducing complex and long-lasting influences. This took place against a background of developing debate between the North and South in which the oil issue played a fundamental role. The intellectual climate of the times was essentially pessimistic and Malthusian.

Looking towards the coming decade - how different will this be? Certainly many of the earlier concerns will remain - the debt situation could result in an "energy crisis" for many developing countries. But if the global financial situation has echoes of past problems the geopolitical shape of the world will have altered radically. Superpower tensions have declined but the certainty of continuity supposed when security tensions were highest is replaced by growing uncertainty about the consequences of changing relationships in eastern Europe. There is no reason to believe that we have seen all the changes which are going to happen. Further changes - as fundamental and radical as we have seen in eastern Europe over the past few months - may be expected as the global geopolitics adapt to what has just happened and to what may still happen.

Simultaneously, social and political values are changing. Demographic factors are being influenced by such changes and are, in turn, impacting on how energy is used. The effect of low population growth is expected to be compensated by increases in the number of household units. The social preferences being shown for conservation and environment are more and more reflected in policies and programmes of the mainstream political parties.

How these new socio-political preferences will be accommodated with the desire for continuing improvements in economic welfare is the core of the political debate about energy and environment. The environmental dimension of the debate is not confined only to energy related problems but is widespread across the range of economic and social activity.

The nature of the issues as they affect energy is also multidimensional - siting of plants, urban development and transport-related congestion, waste disposal (both nuclear and non-nuclear), and emissions of SO_2, NOx and CO_2.

The institutional context within which energy policy will be formulated will itself evolve as Community structures adapt and develop in response to change. Yet because of its strategic role, energy thinking must contribute to such changes. The dire energy condition of some eastern European states clearly indicates that if for no other reason than the need to help them, energy will be on the pan-European agenda. But the interaction between different parts of Europe goes well beyond specific needs for cooperation. Energy technology, trade and demand management skills will have a role in designing the future shape and structure of Europe.

Changes in geopolitics at both a global and regional level, in the political value systems and in the evolution of the Community, while outside the realm of energy, will nonetheless influence and perhaps determine the framework within which the energy sector operates.

In this final chapter, we seek to draw together the broad economic messages to facilitate the political debate which needs to take place.

The four scenarios developed identify the range of influences at work which could affect the direction of energy demand and supply over the longer term. Scenario 1 reflects the late 1980s "conventional wisdom" about key variables. Scenario 2, "driving into tensions", tests the robustness of the first scenario and shows that conventional wisdom could underestimate the long-term growth in energy demand with a resulting increase in tensions between the objectives of robust economic growth, a clean environment and secure and moderately priced energy.

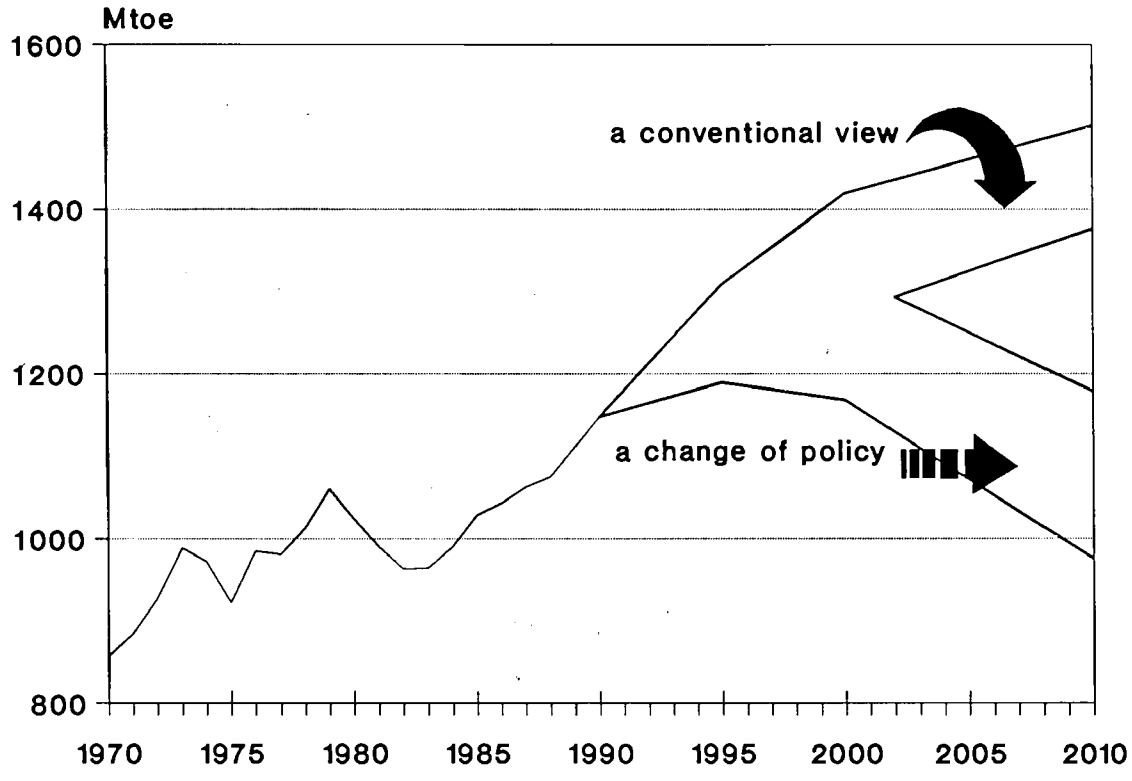
In Scenario 3, stronger economic growth provides the impetus to facilitate the penetration of new and more efficient technology into the market place. This dynamic economic process is accompanied by policy initiatives on energy efficiency norms and standards, and incentives to use energy more efficiently. In this way, consumers are able to meet their needs in an environmentally conscious manner. In Scenario 3, consumer energy prices follow world market trends.

Scenario 4 shares the same assumptions as Scenario 3 concerning improvements in energy intensity. However, tensions are reduced by means of more moderate economic growth (similar to Scenario 1) and by higher end user prices.

These four scenarios provide two contrasting paths along which our energy futures may develop.

Figure 4.1: Primary Energy Demand

Two Different Views



Our analysis offers some indications of the consequences, both in terms of the efforts required and the possible results of choosing one or other of these broad directions. The analysis presented does not seek to predict a final outcome, but rather to contribute to the debate which will determine the direction in which we will head.

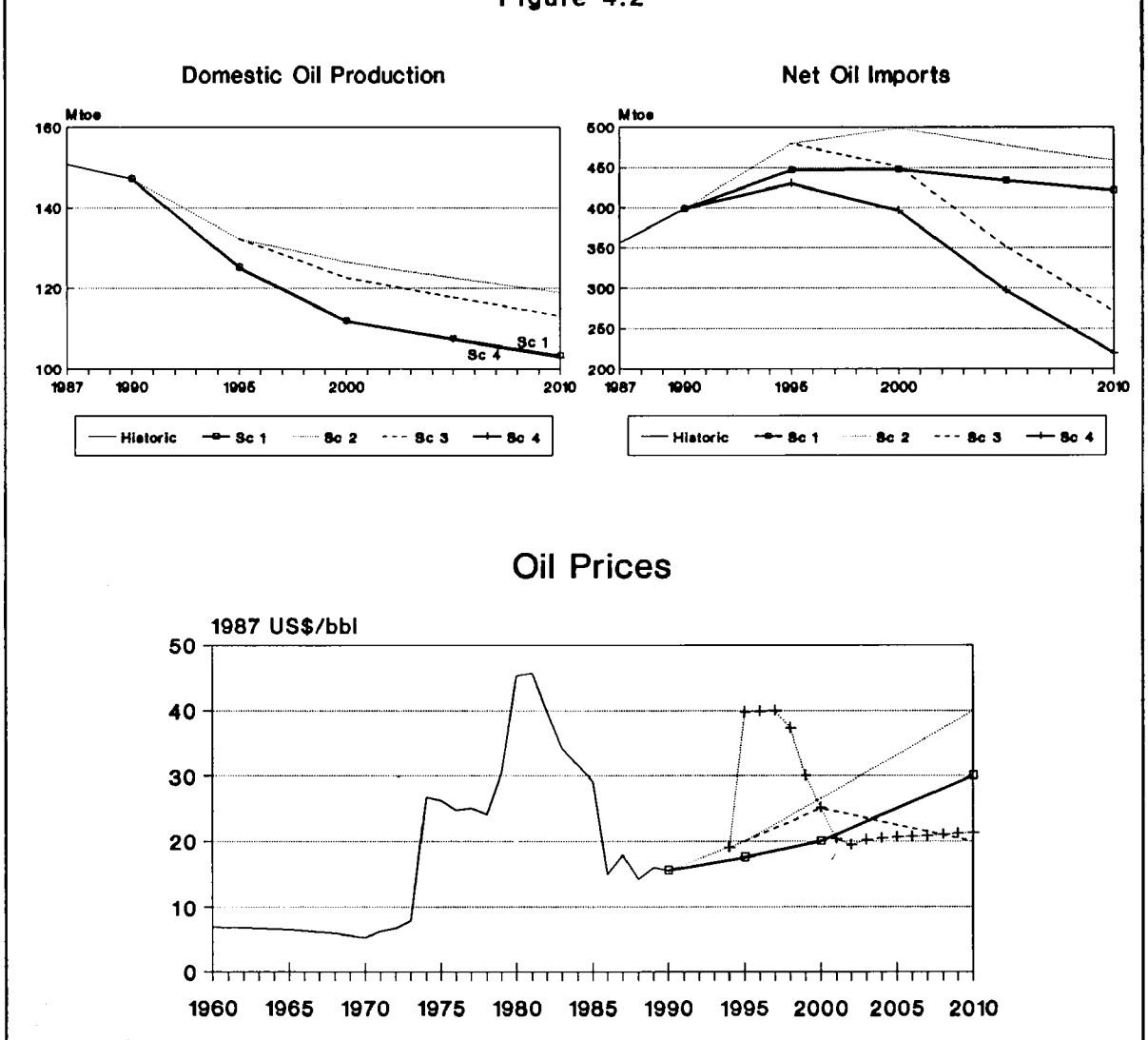
This chapter consists of a discussion of the implications of the Community's possible energy futures for each of the key fuel sectors. Overall economic conclusions are drawn with regard to the major energy themes of growth, environment and energy security. And finally, these themes are placed in a global setting but in particular with regard to recent developments in eastern Europe.

Fuel sectors

In the preceding chapters, the four scenarios were developed for each of the principal energy-using sectors. The results for specific fuel sectors were highlighted within each individual scenario. Here we take a broad view of possible implications for each fuel sector - looking at pricing, indigenous production, import requirements and market potential.

Oil

Figure 4.2



Looking at the world market:

- The key uncertainty is the degree to which OPEC will succeed in managing the market;
- Non-OPEC production levels are unlikely to increase significantly from current levels. Growth in world oil demand will therefore result in a higher call on OPEC;
- In the scenarios developed, the call on OPEC converges into two ranges:
  - between 30-35 mbd under Scenarios 1 and 2
  - between 20-25 mbd under Scenarios 3 and 4;
- Three broad price levels in 2010 emerge (expressed in 1987 $US per barrel):
  - around $40 - Scenario 2
  - between $25-30 - Scenario 1
  - around $20 - Scenarios 3 and 4

A separate shock scenario was developed as a variant on Scenario 2, where prices increased to $40 in the late 1990s.

Further discussion of the world oil market can be found in Working Paper No 12.

On the supply side:

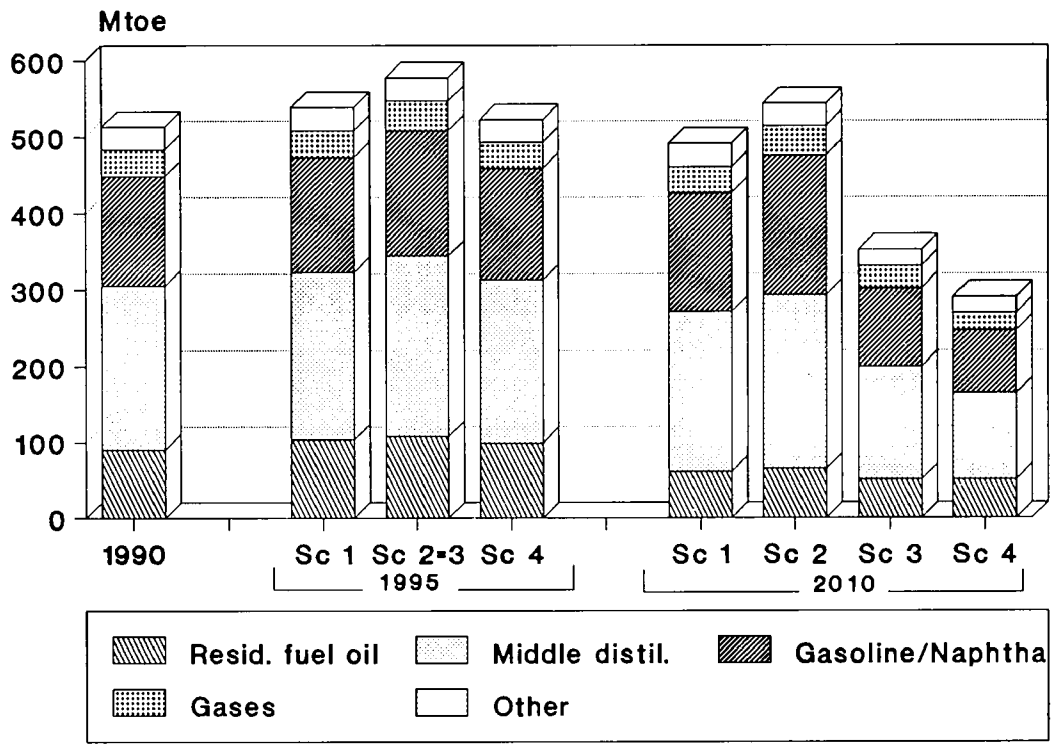
- Community oil production is expected to decline. This fall may be more rapid in the 1990s, but slowing thereafter;
- Producers profits are clearly sensitive to the oil price but significant savings in production costs could allow for acceptable returns to be made at prices as low as $15/bbl;
- Downstream prospects appear less certain. Assessing the requirement for additional investment in refining capacity will be difficult;
- There is a real possibility of strong growth in oil demand in the short term, followed by a downturn should policies to reduce transport demand or emissions of carbon dioxide be put in place.

Oil will continue to play an important role over the period to 2010. From a current consumption level of 513 Mtoe (10.3 mbd), demand by 2010 could range from 290 to 540 Mtoe depending upon the scenarios.

On the demand side:

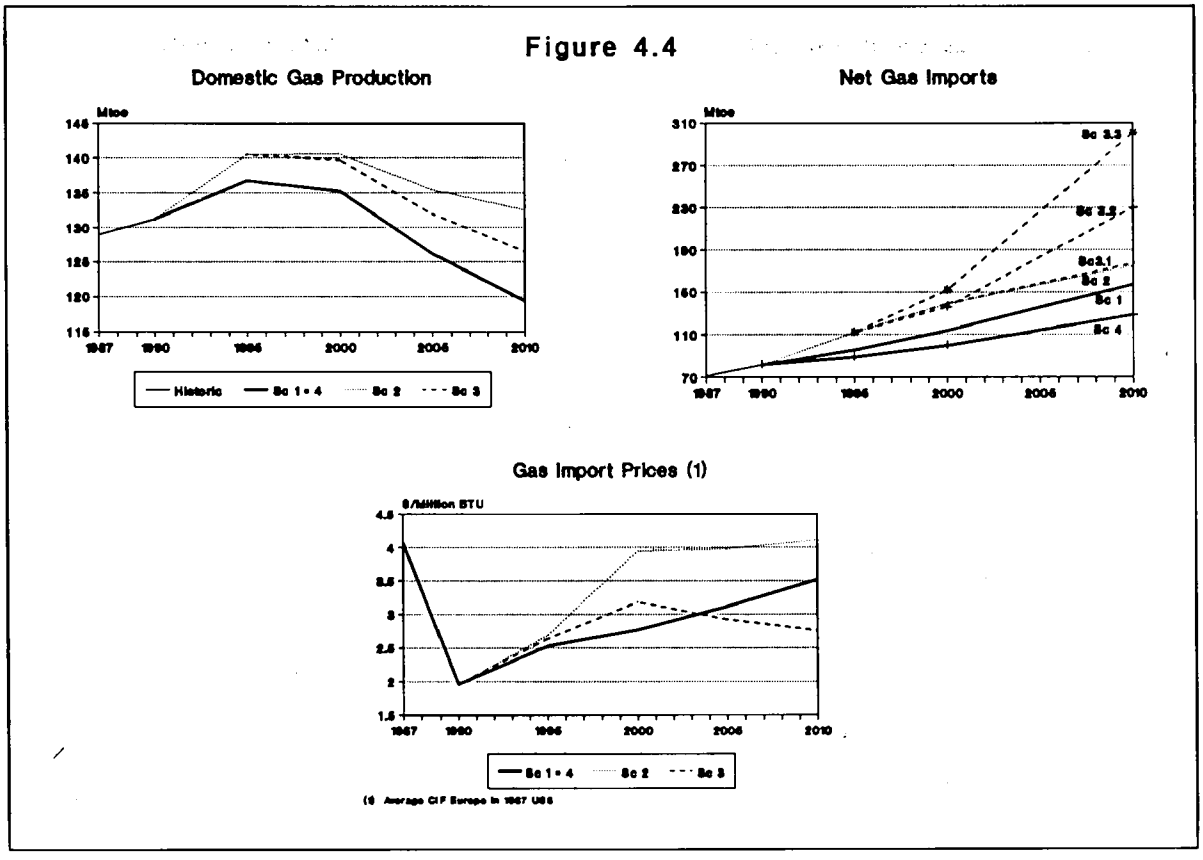
- Longer term trends in transportation fuels pose the greatest uncertainty depending on whether we are in a "conventional" or "conservation" world;
- Residual fuel oil demand is also uncertain. In the short term, power utilities may increase the utilisation of existing plant. Longer term, as the plant is replaced and as oil increases in price, a decline in demand is likely;
- Overall, the structure of the demand barrel is likely to continue to shift in favour of lighter products reflecting stronger transportation demand growth;
- Tax harmonisation (see Working Paper) will add to uncertainty on the structure of oil demand due to changing relative prices in different countries;
- Consumers who have invested in fuel switching capability will be better placed to withstand oil price volatility and uncertainties.

Figure 4.3: Oil Demand by Product



Gas

Figure 4.4

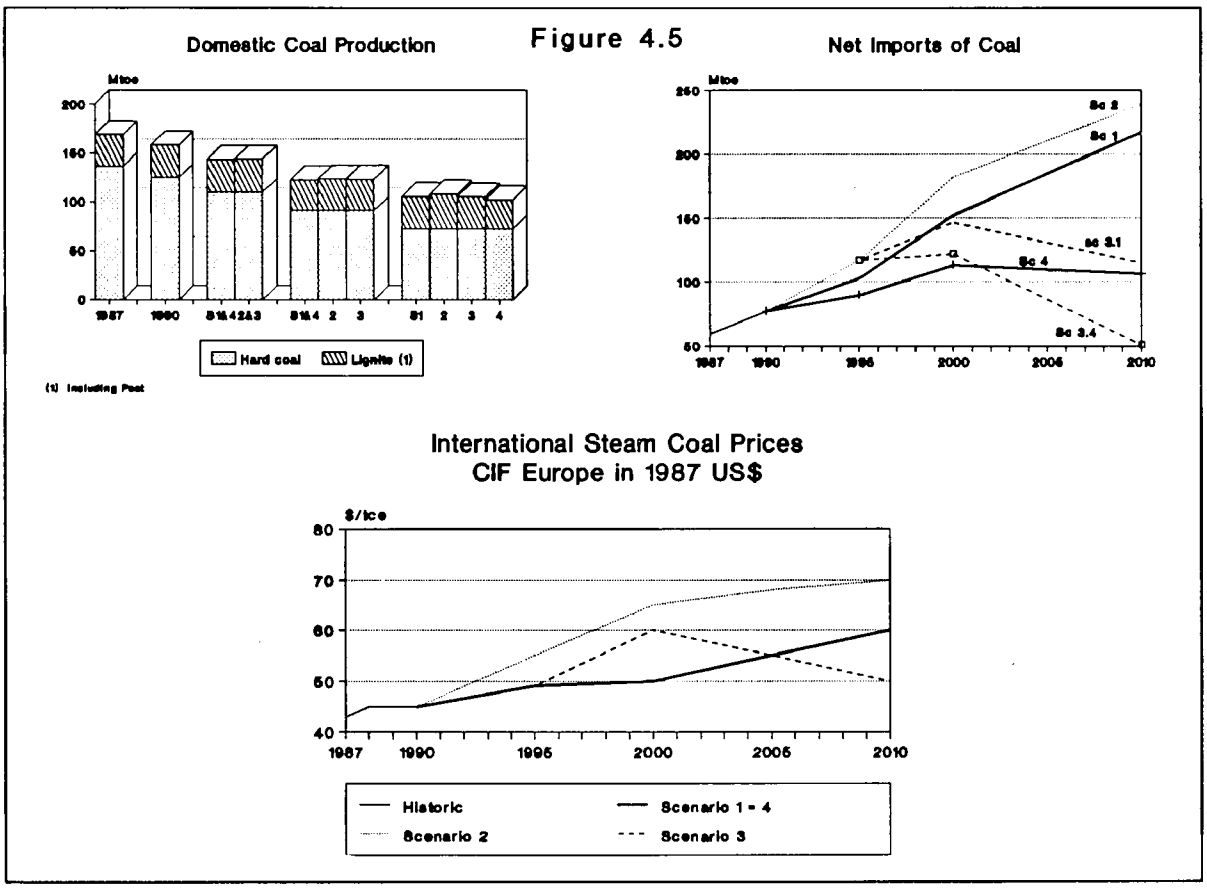


Strong growth in Community gas demand is likely;

- Imports will be the main source of additional supply;
- If Community gas producers' sales volumes remain fairly constant as assumed in this analysis, their market share will fall from 64% in 1987 to between 40 and 45% by 2010. However, this assumption could prove to be conservative;
- Prices will be driven by conflicting forces:
  - upward pressure from increased demand reflecting the environmental benefits of gas
  - downward pressure from competition amongst major producers such as USSR, Norway and Algeria and possibly increased competition between European gas utilities;
- In the early years over-supply is likely to produce downwards pressure on prices. However, as demand increases, the market will tighten, with upward pressure on prices;
- If greater access to networks is realised, producers may seek to move downstream, particularly to sell directly to electric utilities;
- Uncertainty in future demand is largely determined by uncertainty in gas use in the power sector (as discussed in Chapter 3).

Coal

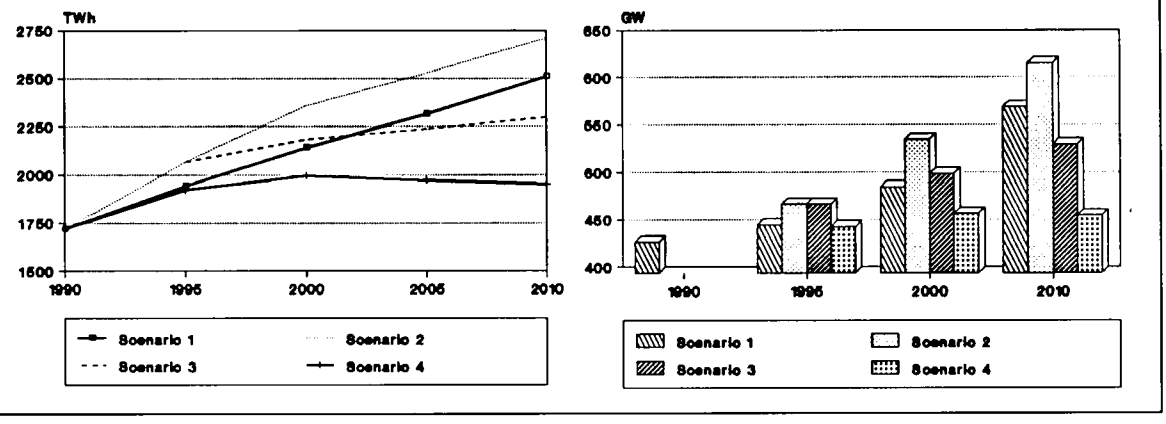
Figure 4.5



- Demand for coal depends largely on its use in power generation;
- The range of possible coal burn depends on environmental emission standards and the relative cost of using the different fuels;
- Considerable progress is possible in reducing SO_2 and NOx emissions but CO_2 presents a clear challenge. If concern about this pollutant increases then there will be additional pressure placed upon other less or non-polluting substitutes;
- The analysis in Chapter 4 indicates that a serious reduction in coal's contribution is likely to require very substantial growth in either nuclear or gas to compensate;
- There is a need to improve the efficiency and cleanliness with which coal is burnt - an R&D challenge;
- The market for indigenous coal production depends on:
  - total coal demand
  - interfuel competition
  - world coal prices
  - the weight given to security considerations
  - commercial integration downstream, particularly with the electricity sector
  - state aid policies
  - changes in the structure of the market - move from long-term to short/spot markets.

Electricity

Figure 4.6



The rate and pattern of electricity demand growth is a key uncertainty:

- Average growth rates could range between 1.7% p.a. and 3% p.a. In turn, additional capacity requirements could differ by as much as almost 170 GW;
- The pattern of electricity demand growth could vary considerably. Policies which achieve reductions in electricity intensity could substantially lower growth rates in the future;
- Electricity's share of total final energy demand is likely to increase, gaining from solid fuels in the industrial sector and oil in the residential and tertiary sectors;
- Interest may develop in finding ways to stimulate greater end use efficiency to improve flexibility in meeting increasing demand;
- Governments may encourage utilities to develop additional services promoting electricity efficiency.
- Utilities face possible over-capacity and low returns on investment if growth rates are substantially reduced after a period of buoyant growth;

Investment will also be influenced by:

- Moves towards integration of the electricity market;
- The priority given to environmental issues such as waste, siting and, in particular, air pollution;
- The need for greater response-time flexibility in managing uncertain demand growth;
- The need to maintain a balanced, flexible supply system;
- Limits in fuel option choices - nuclear's public acceptability and its attractiveness in cost and financial terms;
- The potential for increased use of renewables.

Major themes in energy

The four scenarios were developed to provide insight into the dynamics of the relationship between energy and economic growth, environment, and energy security and fundamentally to address the question:

> "Are robust economic growth, a clean environment and moderately priced and secure energy supplies compatible objectives?"

Clearly there are tensions, but are these sufficient to block progress? While economic analysis may contribute to the debate the final direction will be based on political decisions.

Energy and economic growth

A number of important issues emerge.

The twelve member states are not all at the same stage of economic development. Indicators such as GDP per capita reveal a significant spread across the Community. Expected rates of economic growth are such that some of the differences are likely to increase rather than diminish. This presents the Community with an exacting challenge.

Wealthy countries are more able to make the tradeoff between economic growth and other factors, such as environmental improvement. Tensions may emerge if richer Member States attempt to influence the Community's agenda in ways which other member countries feel are detrimental to their own growth prospects. This tension is also reflected on the world stage between different regions.

Completion of the internal market offers large potential benefits through increases in economic welfare. As eastern Europe moves on from its current economic problems, the impetus may grow for trading on a pan-European basis. Growth in economic activity will support greater cohesion within the Community and with eastern Europe.

Better energy management emerges as the first priority in reconciling the tensions between energy growth, environment and security. Improved energy efficiency, linked to structural changes and lower energy intensity, is projected to some extent in all four scenarios:

- In Scenarios 1 and 2, improvements in energy efficiency are achieved through market forces, as high demand leads to higher prices;
- In Scenario 3, greater competition, economic efficiency and capital stock turnover lead to the uptake of more efficient technologies;
- In Scenario 4, growth and higher energy prices for consumers stimulate greater energy efficiency. More moderate economic growth reduces demand pressures.

In Scenarios 3 and 4, the rate of reduction in energy intensity between 4.5 and 5% p.a. is outside our historical experience. Market forces alone are unlikely to achieve these gains. Policy initiatives are required.

Working Papers 5 and 6 provide further information on the efficiency potentials for both energy use and production.

Energy and environment

Within the European Community concern for the environment is growing and is already having a major impact on policy decisions in many areas. The scope of this concern is broad and includes air pollution, water quality, waste disposal, the use of toxic substances in manufacturing, urban congestion, land use and siting issues. Few would argue that this heightened environmental awareness will diminish in future.

The 1980s saw the emergence of the latest, and some would argue, the world's most difficult environmental challenge - that of global warming. Much uncertainty surrounds the greenhouse effect. For example, we do not fully understand the role of each of the many so-called greenhouse gases, the interaction between those gases and the extent to which other gases are involved. But we do know that the most important gas, accounting for an estimated 50 per cent contribution to global warming, is carbon dioxide. A consensus amongst scientists is now emerging of a linkage between the increase in carbon dioxide levels and average global temperatures. The problem is not totally related to energy - increasing deforestation would also appear to be an important factor.

There are three ways of reducing gaseous emissions associated with energy use:

- Prevent the emission of polluting gases by some technical removal process;
- Use energy sources which are non-polluting;
- Consume less energy.

But each has problems associated with it.

Technical removal processes:

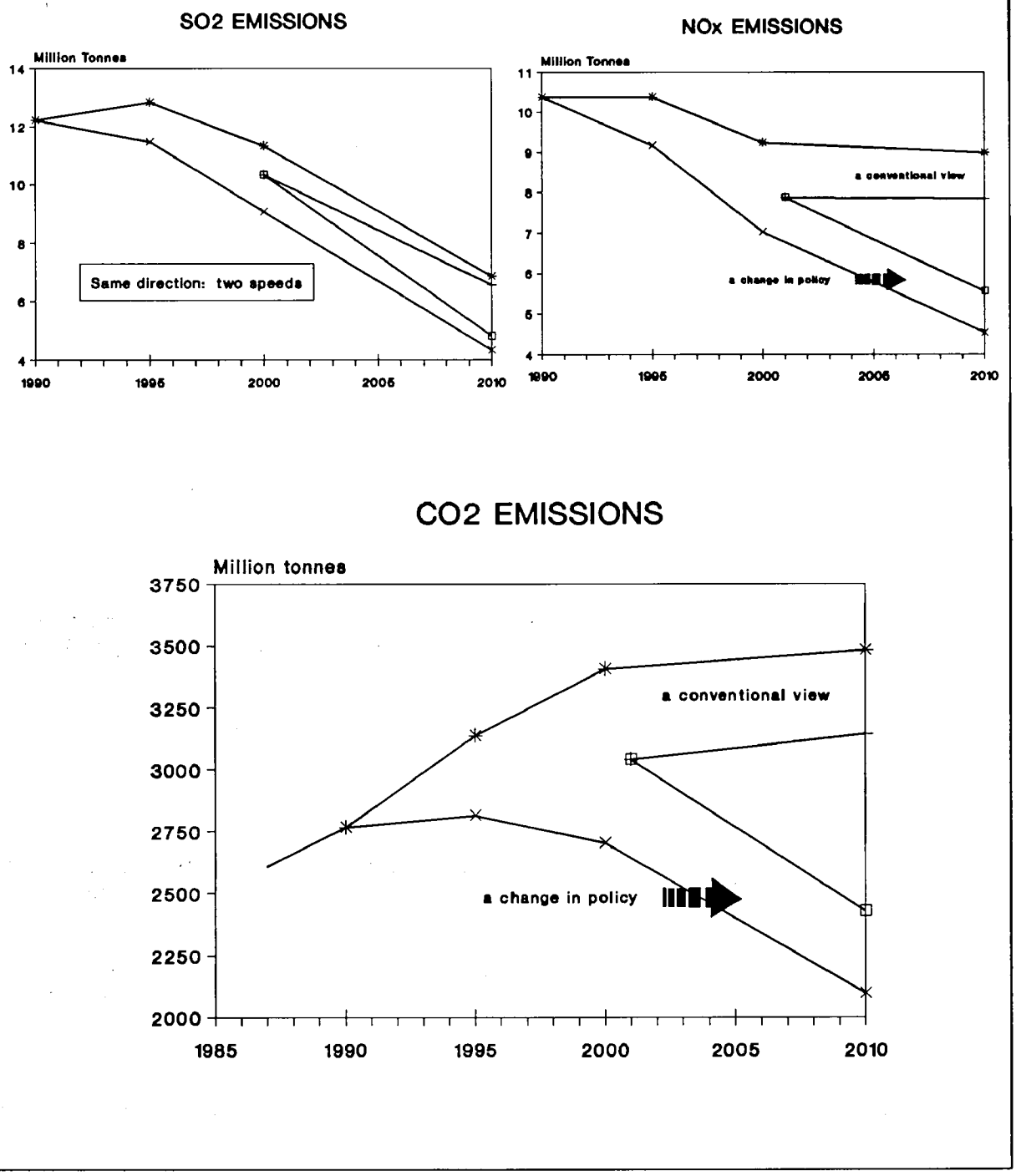
- Using flue gas desulphurisation equipment reduces efficiency leading to greater carbon dioxide production per unit of electricity produced. It also creates new waste products with potentially damaging effects.
- No technical fix is available now, or in the foreseeable future, for removing carbon dioxide from fossil fuel following combustion.

Using energy sources which are non-polluting:

- Nuclear power does not produce gaseous emissions but has its own environmental problems - disposal of nuclear waste, decommissioning of old reactors, and the potential accident threat.
- Renewable energies have associated problems. Good examples are the visual intrusion and considerable land requirement associated with wind turbines and the ecological damage to estuarine habitats associated with major tidal power schemes.
- Gas is an environmentally attractive fuel but the carbon dioxide emitted when it is burned is not negligible, albeit it is only 60% of that produced from an equivalent amount of coal.

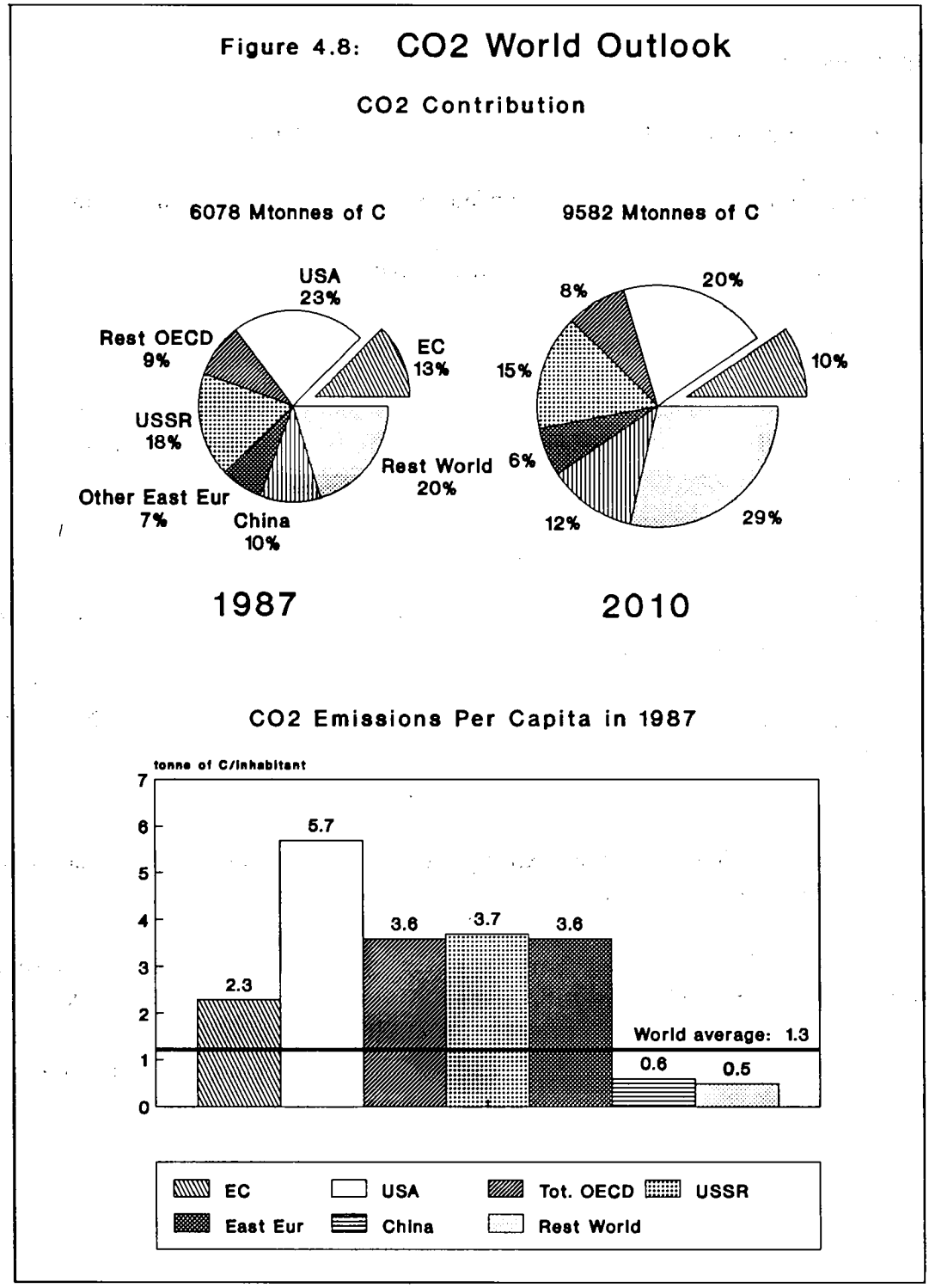
Consumption of less energy is likely to be an environmentally attractive option. But achieving the substantial energy reductions which may be necessary to minimise the threat of global warming without sacrificing other objectives, both at the Community and world level, presents a difficult challenge.

Figure 4.7



Global problems require global solutions. The Community acting alone would have relatively little impact. To overcome this problem, a coordinated approach will be required with the OECD, USSR and other Eastern European countries, and the developing countries, each making their contribution.

Figure 4.8: CO2 World Outlook



The Commission's programme on climate warming is being completed. R&D analysis on the means and costs of dealing with the CO_2 problem is in progress. This and other work will contribute to the ongoing Intergovernmental Panel on Climate Change (IPCC) process.

Moderately priced energy

If energy demand continues to grow, then upward pressure on prices is likely. Hence, policy measures designed to reduce energy demand growth would be consistent with the objective of achieving moderately priced energy.

Energy demand depends on a number of key factors:

- The energy intensive nature of a country's economic structure;
- The penetration of energy using appliances and processes within the economy;
- The utilisation of such equipment and appliances;
- The efficiency of the energy using capital stock.

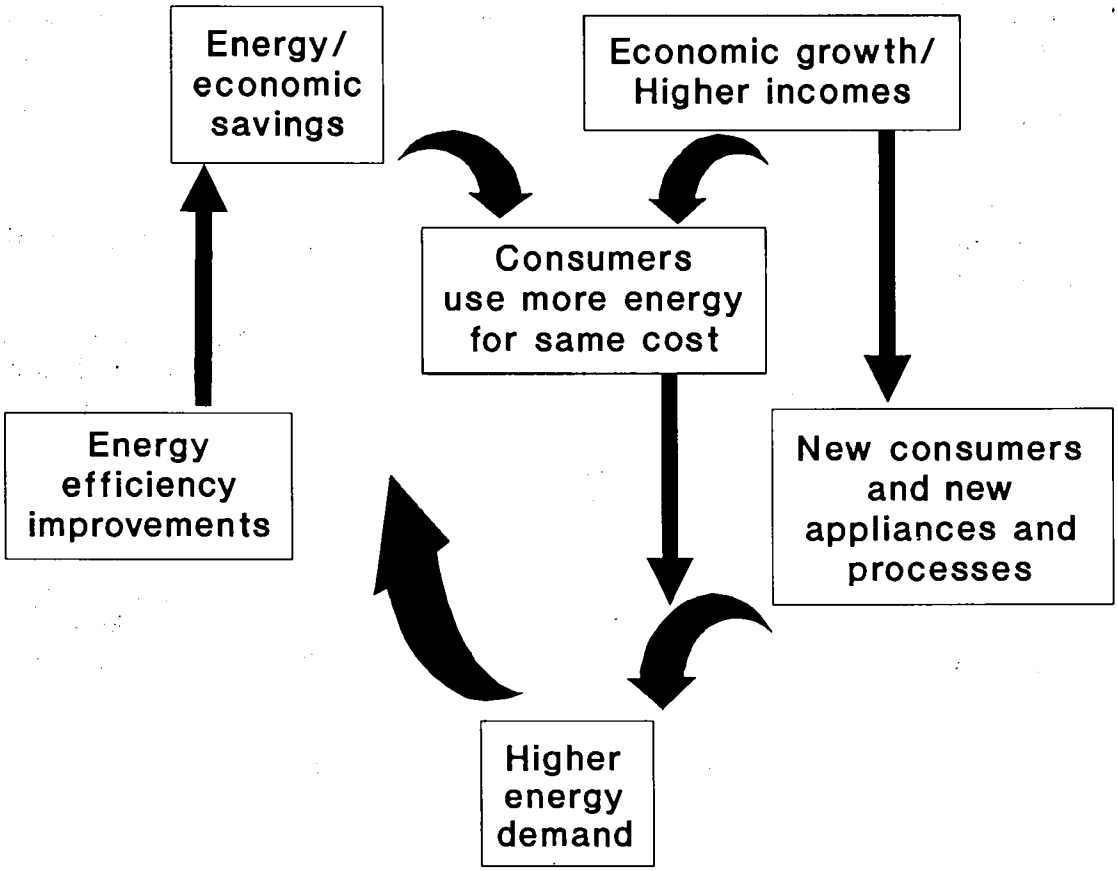
It can be argued, at the simplest level, that improving energy efficiency will lead to downward pressure on demand. Such improvements are likely to be most pronounced when economic growth is strong. However, there are countervailing forces:

- Gains due to energy efficiency improvements may be offset by higher utilisation rates;
- In the domestic sector, the benefits of better insulation may be taken in the form of improved comfort levels;
- In the industrial sector, technological developments which bring about efficiency improvements may also lead to a wider range of applications of such technology, offsetting potential savings.

Even with significant improvements in energy efficiency, the upward spiral of energy demand may well continue. This is the type of future presented in Scenarios 1 and 2.

To break this spiral, it will be necessary for energy consumers of all classes to change their behaviour so that the full benefits of energy efficiency are translated into lower energy consumption. To achieve this goal, stringent efficiency standards and norms will be required, and fiscal measures may also play a role. These are the types of future presented in Scenarios 3 and 4.

Figure 4.9: Energy Demand Spiral



Energy efficiency improvements bring benefits to all consumer classes. But these benefits do not necessarily take the form of lower energy use. Instead they can lead to an increased penetration of previously uneconomic processes and equipment and to improved standards of comfort - buildings which are warmer in winter and cooler in summer. In spite of efficiency improvements, energy demand may continue to spiral upwards

Secure energy supplies

There are three main strategic routes by which energy security could be improved:

- Increasing the supply of indigenous fuel sources;
- Improving diversity of both fuels used and fuel suppliers;
- Reducing energy demand.

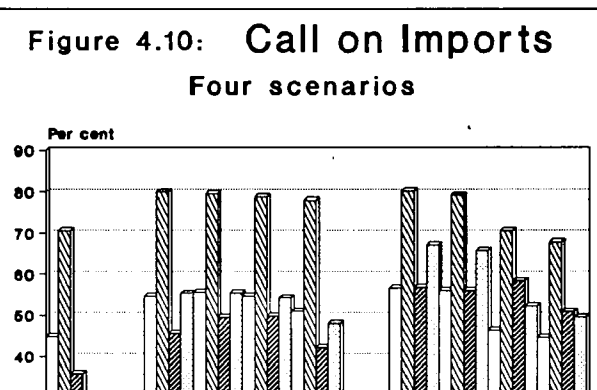
All have contributed to the decrease in the energy security threat faced by the Community over the period since the early 1970s. However, it needs to be recognised that much of the slow-down in energy demand growth was due to economic recession, as well as specific energy-focussed strategies.

As energy demand is again growing at a more rapid rate, energy security concerns may re-emerge in the period to 2010. In particular:

- Due to greater concern for the environment, significantly increased gas imports to the Community may present a security concern. However, this threat could be minimised by maintaining a diverse portfolio of supplies;
- Given the massive concentration of oil reserves in OPEC countries, concerns may grow again as OPEC's market share increases. OPEC's own pricing and production policies will be crucial in this respect;
- There is uncertainty about the volumes of imported coal which may be required depending on whether the direction followed is closer to "conventional" or "conservation" paths;
- Nuclear has played a key role in improving the Community's energy security position. However, nuclear's contribution in the future is now anticipated to be lower than was previously considered. The risk of accident and supply disruptions which could follow such an event bring their own security concerns.

Figure 4.10: Call on Imports

Four scenarios



Import requirements for each fuel were considered in the scenarios. The world oil market analysis examined the consequences of a sharp increase in prices, while a sharp reduction in nuclear generated electricity was considered in one of the Scenario 3 sub-scenarios. Without doubt, energy security will remain a key policy concern during the 1990s.

The Community in a global setting

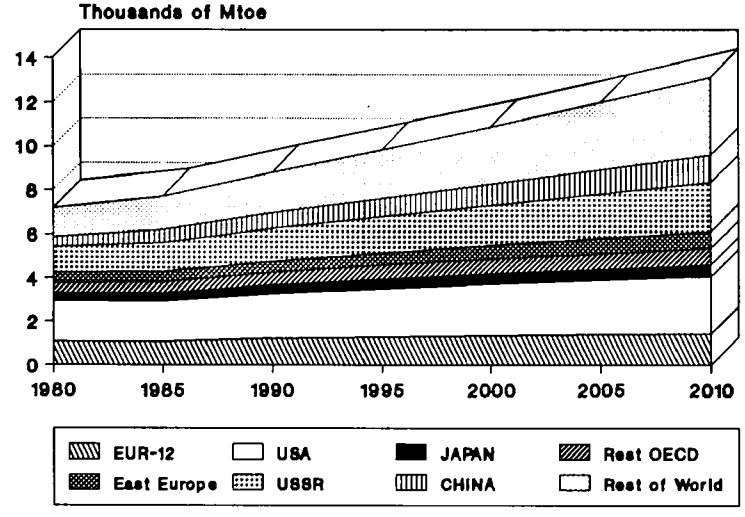
World energy outlook

Conventional views about global energy demand suggest long term growth rates of between 2% and 2.5% p.a. Uncertainties would seem to exist about this range of growth rates as there were when the "conventional wisdom" scenario for the Community was tested. Such an exercise might indeed yield results similar to Scenario 2 - that globally the energy sector is "driving into tensions". Our world energy analysis is limited to a matching "conventional wisdom" approach. But some recent published work lends credence to the view that world demand is likely to grow at a faster rate than previously anticipated.

In particular, in both eastern Europe and the Mediterranean Basin there appears to be considerable latent pressure for higher rates of growth in energy use. Under favourable economic conditions, this could manifest itself during the 1990's. As their economies develop, energy consumption patterns in eastern Europe could follow those of western Europe during the late 1950's. Similar pressures are evident in the Pacific Basin where a number of countries are recording energy growth rates similar to those experienced in Europe in the 1960's. Finally, we cannot ignore the traditional developing countries which will also require increases in energy to match their economic ambitions.

(See Working Paper 14 for more detail on the world energy situation).

Figure 4.11: World Primary Energy Demand



Eastern Europe

Current developments in the political and economic structures of eastern European countries and in the Soviet Union will have major implications for the Community. Today we cannot be other than uncertain as to what the energy implications will be for these countries. But looking at how these countries' energy situation has developed (subject to data limitations) it is possible to obtain some key indications of the types of problems which are likely to arise in eastern Europe (which includes Bulgaria, Czechoslovakia, the German Democratic Republic, Hungary, Poland, Romania and Yugoslavia).

These countries consumed about 500 Mtoe of primary energy in 1987.

- Their consumption per capita is higher than in EUR-12;
- Indigenous production, mainly in the form of solids, accounts for about 75% of total consumption;
- In 1988, 650 Mtoe of brown coal and lignite were produced, about 45% of total world production.

Net imports of energy represent about 130 Mtoe (25% of primary consumption).

- These imports come mainly from the Soviet Union, and account for about half of Soviet net exports of energy;
- Due to declining indigenous production and rising energy consumption, net imports are likely to increase in future;
- Difficulties in the Soviet Union could lead to uncertainties about their export capacity, requiring eastern European countries to participate in international energy markets.

Although there are difficulties in measurement, it would appear that energy intensity in eastern Europe is roughly double that of the Community.

- Final energy demand is dominated by the industrial sector, which is highly energy-intensive in structure;
- Restructuring of the industrial sector towards less energy-intensive products would also have a significant effect on energy intensity;
- Intensity could be reduced if market pricing were introduced in place of central allocation;
- On the other hand, transport energy demand is extremely low. As incomes rise, the demand for private cars is likely to rise very rapidly, impacting on oil imports and the refining sector.

In 1987, gross electricity generation was around 570 TWh, about 35% of EUR-12.

- Losses and own use by the energy sector accounted for 24% of this, compared to only 16% in EUR-12;
- Industry again dominates, accounting for 60% of final electricity demand;
- Consumption in the domestic/tertiary sectors is at a very low level. Latent demand is no doubt considerably higher.

Electricity supply is under stress due to demand growth. Currently in excess of 30 TWh need to be imported from the USSR.

- Nuclear (capacity about 10 GW in 129 GW total) generation has been growing at a rate of 15% p.a.;
- Plants under construction could more than double the installed capacity by 1995;
- Longer term, financial and environmental constraints are likely to become increasingly important.

Environmental problems are significant.

- SO_2 emissions are very high by any standards;
- CO_2 emissions per capita are significantly above EUR-12 levels because of the extensive use of solid fuels;
- Safety standards in some nuclear plant are at unacceptably low levels.

In conclusion, the energy situation in eastern Europe is extremely difficult from many perspectives. Given the political and economic uncertainties in these countries at this moment it is very difficult to consider how it might evolve over the short, medium or longer term. (More details on the eastern European energy situation is given in Working Paper 13 on the subject).

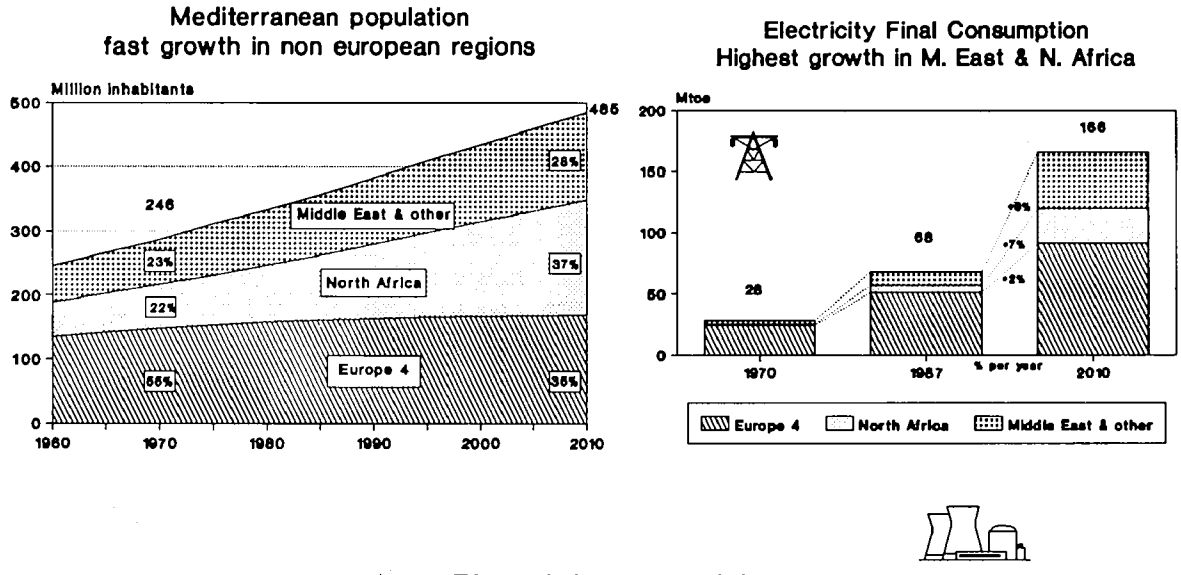
Mediterranean Basin

In the Mediterranean Basin, rapid population growth, particularly in the non-European areas, will lead to more rapid energy demand growth in the future.

Electricity demand is likely to grow most rapidly with perhaps 300 to 350 GW of additional capacity required by 2010. These capacity requirements imply very high investment programs. Given this rate of growth, tensions may emerge with regard to land use between energy production, agriculture and tourist activities.

The challenge facing these countries is to reduce this latent demand growth through improved energy efficiency, while at the same time improving their economic welfare.

Figure 4.12: Energy and the Mediterranean



Electricity capacities

300 to 350 GW of additional capacities are expected to satisfy the demand up to 2010. About 2/ 3 of these new capacities will be built in the southern and eastern mediterranean countries, most of them on the coast (because of need for cooling)

Therefore, the challenge is to manage the landuse between energy productions, agriculture areas and touristic activities

Can this latent demand be reduced through energy efficiency permitting these countries to improve further their economic welfare ?

Conclusions

We have focussed on a number of key objectives which energy policy could seek to promote: robust economic growth, a clean environment, moderately priced energy and secure energy supplies. In the past these objectives have rarely been in balance. For the future, the challenge is to make acceptable tradeoffs between key objectives in order to develop an energy strategy for sustainable development.

At this stage we cannot say whether we are entering a growth-led or environmental-led future. However, the choice is to some degree in our own hands. The political decisions which will direct us down one path or the other now need to be taken. This report has sought to provide a better understanding of the likely consequences of such decisions with the hope of facilitating a more focussed debate on the choices with which we are faced.

Major themes revisited project

Acknowledgements

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The following persons contributed to the project:

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Energy for a new century:

The European Perspective

Conference Proceedings

Contents

Conference Programme

Wednesday, 2 May, 1990

Afternoon Opening of registration and distribution of the meeting's documents

Thursday, 3 May, 1990

09.15 **Inaugural Session - Global Consensus for Global Problems**
Chairman: Mr. Cardoso e Cunha, Member of the Commission

Inaugurating the conference Commissioner Cardoso e Cunha will address the political issues for energy in the coming decade. Distinguished guest speakers include:

Political Challenge:

- *The Rt. Hon. W. Henson Moore, Deputy Secretary of Energy (United States)*
- *Mr. B. Tackaev, Vice Minister, Government of the USSR*
- *Mr. Antonio La Pergola, Chairman of the Committee on Energy, Research and Technology of the European Parliament*
- *Mr. Robert Molloy, President in Office of the E.C. Council of Ministers (Energy)*

11.00 Coffee Break

11.30 **Energy Policy Challenges**
Chairman: Mr. C. S. Maniatopoulos, Director-General of the Directorate General XVII

- *Mrs. Helga Steeg, Executive Director, International Energy Agency*
- *Dr. Subroto, Secretary General, OPEC*
- *Dr. Abdullah El-Kuwaiz, Assistant Secretary General of the Gulf Cooperation Council*
- *Professor Jacques Lesourne, President, Conservatoire National des Arts et Métiers (Paris), presenting on behalf of the "Groupe des Sages" the report on the "Major Themes in Energy"*

12.45 Lunch

Guest Speaker: Mr. Umberto Agnelli, President of Fiat Auto
The Industrial Dimension

15.00 **Session 1 - Energy and Economic Growth**
Co-chairmen: Professor Jacques Lesourne & Dr. Heinz Horn, Chairman of Ruhrkohle

Issues: What changes could occur in the relationship between economic growth and energy demand in the future?

Members of the Panel:

- *Mr. Gordon Adam, MEP, Chairman of the Committee on Energy Research and Technology of the European Parliament*
- *Mr. Philippe Bodson, Outgoing President of FEB*
- *Mr. Pierre Desprairies, President of CIFOPE, Paris*
- *Dr. Klaus Liesen, Chairman of Ruhrgas, Germany*
- *Mr. Robert Malpas, Chairman of Powergen, UK*
- *Mr. Michel Pecqueur, Vice-President, ERAP, France*
- *Mr. Henny de Ruiter, Managing Director Royal Dutch-Shell*
- *Mr. Masaji Yamamoto, Director General, Agency of Natural Resources & Energy, MITI (Japan)*

16.15 Coffee Break

16.45 **Discussion**

18.30 End of Session

Friday, 4 May, 1990

09.30 **Session 2 - Technology, Efficiency and Environment**
Co-Chairman: Professor Umberto Colombo, President of the ENEA, Rome & Dr. Pieter Winsemius, Director, McKinsey and Company, Amsterdam

Issues: What environmental agenda is emerging?
How can technology improve energy efficiency and help solve environmental problems?

Members of the Panel:
- *Mr. V. Bushuev, Energy Committee of the Supreme Soviet*
- *Mr. John Easton, Assistant Secretary of Energy for International Affairs, Department of Energy, United States*
- *Mr. Robert B. Horton, Chairman, British Petroleum*
- *Dr. Klaus Knizia, Chairman of VEW (Vereinigte Elektrizitäts Werke Westfalen)*
- *Mr. Paul Lannoye, MEP, Chairman of the Committee on Energy, Research and Technology of the European Parliament*
- *Mr. Aldo Romoli, Président du Comité Economique et Social, Section de l'Energie*
- *Dr. Ernst von Weizsäcker, Director, Institute for European Environmental Policy, Bonn*

11.00 Coffee Break

11.15 **Discussion**

12.30 Lunch

14.00 **Session 3 - The Geopolitics and Supply of Energy**
Co-chairmen: The Rt. Hon. D. Howell, M.P., U.K. & Dr. M. Gallego, President, Hidroastur, Madrid

Issues: The developments in world energy and the issues confronting energy suppliers

Members of the Panel:
- *Mr. Antonius H. P. Grotens, President, Gasunie, The Netherlands*
- *Mr. Rolf Linkohr, MEP*
- *Mr. A. Macarov, Academy of Science, USSR*
- *Mr. Alessandro Ortis, Vice-President, ENEL, Rome*
- *Mr. William C. Ramsay, Deputy Assistant Secretary of State for Energy Resources and Food, Department of State, United States*
- *Mr. Garcia Sanchez-Sierra, Secretary General, Latin America Energy Organization, Equador*
- *Mrs. Helga Steeg, Executive Director, International Energy Agency*
- *Mr. Kunihiko Uematsu, Director General, Nuclear Energy Agency, OECD*

15.30 Coffee Break

15.45 **Discussion**

17.30 **Concluding remarks** by Mr. C. S. Maniatopoulos, Director-General of the Directorate General XVII, and end of the Conference

INAUGURAL SESSION

Global Consensus for Global Problems

Cardoso e Cunha, EC Energy Commissioner

In ten years we will find ourselves on the threshold of a new century. In energy are concentrated the hopes and question marks of our future; we must strike a balance now between two approaches to energy policy, the idealistic and the practical/accountable approach.

World demand for energy is again going through a phase of sustained growth, while there is a gradual tendency once again for diversification of supply to reach limits. In the European Community, there is an upturn in our dependency on imported energy supplies.

This growth in energy consumption is generated by economic growth and in turn affects the environment. How do we stimulate growth and at the same time protect the environment without jeopardising the security of our energy supply, given the finite nature of fuel resources?

The first priority is to control growth in energy demand by making more efficient use of energy and by diversifying available resources. We can expect rises in the cost of supplies, and we will have to alter our life-style and our energy consumption habits. We must act quickly while we can still opt for homoeopathic remedies, rather than the painful surgery that will become necessary as a result of delay or negligence.

The second priority is to discover and transport sufficient energy to satisfy growing needs. For social and political reasons, we must encourage growth - and therefore an increase in energy consumption - in the developing countries; there must be a major transfer of financial resources and technology from the North to the South.

This effort of solidarity will have to be accompanied, in the industrialised countries, by the implementation of measures to improve price forecasting and ensure security of supply, rendering all the more urgent the need to tackle problems on the basis of large international groupings - such as the European Community. Going beyond this, the EC can provide, through its culture and democratic traditions, the focal point to draw the international community together in this urgent effort to provide energy for a new century.

Political Challenge

Rt. Hon. W. Henson Moore, US Deputy Secretary of Energy

Energy is a global commodity, critical to every nation's economic, social and strategic well-being; international in terms of its economic, environmental and strategic impacts.

Accordingly, it must be traded freely in a global market-place of open competition. Energy production and trade must not be manipulated for self-interest, by overt cartel practices or subtle 'local preference' barriers. Either approach would result in economic and social dislocation affecting all countries.

Countries must develop long-term plans to serve as a framework for identifying future supply needs and sources and determining the appropriate balance between economic and environmental interests. The key objectives of the "Groupe des Sages" Report are those we seek in our national energy strategy: strong economic growth, a clean environment, moderately priced and secure energy supplies.

An emphasis on conservation and renewable technologies must be central to the energy plans of all nations, developed and developing alike. Energy efficiency serves the economic interests of all countries and the environmental interests of our entire planet.

But even 'economic' approaches to environmental improvement come at substantial costs, which can only be absorbed by countries with growing economies. Economic growth is essential to environmental progress.

The developed nations have an obligation to share technology through a global marketplace of free trade and open competition. A true partnership among nations will serve our mutual advantage.

Fifty years ago, much of the world stood at the edge of a cataclysm. Through staunch alliance, Western Europe and the United States successfully met a series of severe challenges. Now, if we are to realise the potential of the new century, we must reaffirm our partnership and extend it to all who share our values. Free nations engaged in open markets and cooperating over environmental problems ensure a better life for people everywhere.

Mr. B. Tackaev, Vice Minister, Government of the USSR

The USSR is the world's largest producer of primary fuel and energy resources.

To maintain oil production, we plan to develop fields in Western Siberia, Kazakhstan, the European USSR and in the seabed. The environmental and geological effect of investigations of technological geodynamic processes at Tengis oil deposits is of world-wide experimental value.

Natural gas is increasingly important in Soviet industry. A common gas supply unites all gas industry enterprises, transport systems, underground gas storage facilities and supply systems. New deposits are being developed.

New thinking and our state policy reflect urgent problems. The idea of a 'Common European House' provides for the development of mutually beneficial energy cooperation and integration processes.

Priorities must be developed to make best use of available resources. The USSR's share of world coal resources is 45% and in the east, we have practically unlimited possibilities for steam coal production expansion. There are wide opportunities within the EC to work out large-scale

processing technology. We have already done substantial preliminary work and a coal liquefaction pilot plant has been erected in the Moscow region.

Integration of power consumers in the USSR results in levelling the supply schedule. There are similar trends in the EC, and the USSR can increase its participation in EC energy generation. We have an offer from Electricité de France for participation in the European power generation, and we supply energy to Norway, Turkey and East Europe, and have power exchanges with Austria and Greece.

Cooperation on energy saving and efficiency is a priority. Energy-saving technology and replacing out-dated equipment will save resources on mutually beneficial terms.

Our power generation scale determines widespread toxic pollution. Toxics know no national boundaries and while possibilities for using nitrogen and sulphur oxides, and ash reduction, in the USSR will improve the environment, international cooperation here is essential.

We also aim at cooperation through joint ventures in energy; 30 already exist and a further 62 are being negotiated.

Mr. Antonio La Pergola, MEP, Chairman of the Committee on Energy, Research and Technology of the European Parliament

In the energy debate, the European Parliament represents a public not adequately represented otherwise. On matters so critical to their future, the voice of the public should be heard more clearly.

We can all agree that growth in energy demand, a function of the growth in the world population, will change our environment, and that it will be too late by 2010 to start taking action on energy demand that is contributing to the greenhouse effect and to global warming.

But counter-measures should not affect the less developed countries adversely, turn economic growth into decline or increase economic disparities within countries; they should lessen them. We should encourage efficient use of energy resources and develop renewables through focussed research.

Here we may begin to diverge. Options include an international convention to reduce emissions, a carbon tax to raise funds internationally for this reduction; international production quotas, and leaseable or tradeable carbon emission permits.

As a regional grouping with institutional decision-making structures, the EC can help show the way. We need a large integrated energy market with greater competition and assured supply, which would make energy savings possible and reduce disparities between peripheral and central nations. In transport, agriculture, industrial manufacture and urban heating, we need to combat environmental problems. We must also help our East European neighbours in these areas.

We need too a clear public commitment to fund further technological research in energy and environmental issues. Revision of the Community treaties on energy, research and development is an essential part of development towards political union. In its April 1990 plenary session, Parliament called for an updating of the Coal and Steel Treaty and the Euratom Treaty. Our committees will also be studying economic instruments for environmental protection, and the energy challenges for the twenty first century.

A cautionary note: we must act on global warming and the greenhouse effect now. Failure to foresee the consequences in this area will be catastrophic.

Mr. Robert Molloy, President in Office, EC Council of Ministers (Energy)

I will concentrate on three vital areas requiring imaginative political responses and multilateral cooperation: nuclear energy, oil and gas supplies, and energy and the environment.

The problem of nuclear energy, and nuclear safety, is urgent. Four years after Chernobyl, the consequences are still emerging. The Gardner report on Sellafield in the UK and recent disclosures from East Germany raise further misgivings about unnecessary and avoidable risks in civil nuclear operations.

I recognise that nuclear plays an important role in the electricity supply of many countries, but nuclear countries must also recognise the legitimate concerns of their non-nuclear neighbours. A new spirit of openness must replace the nuclear industry's traditional history of secrecy so that nuclear installations can be seen to be safe.

The Community should pursue closer international cooperation and above all stronger institutional arrangements including independent inspection and mutual verification of facilities and regulatory regimes. Obsolete facilities should be phased out and smaller and safer reactor types researched. Waste should not be accumulated only in one or two regions of the Community and discharges into fresh and sea water must be stopped.

As far as oil goes, the geopolitics are intrinsically unstable, and a chasm still exists between producers and consumers which could be overcome by a joint forum representing the interests of both sides. An internal energy market in the Community involving gas and electricity grids across boundaries would utilise the vast resource of gas to ensure security of supply.

Our most serious environmental problems are of a global nature and we must act together to solve them. We must fund world-wide research into climate changes and we must reduce the technological resource gap between developed and developing countries.

The stabilisation of CO2 emissions must be fixed soon and alternative energy policies analysed. Getting the fuel mix right from an environmental viewpoint will carry a price tag, and governments must remain committed to conservation and the effective use of existing resources.

Energy Policy Challenges

Summary

The current international energy situation is characterised by four factors:

- relatively low prices;
- concern about the use of fossil fuels and their impact on the environment;
- safety fears about nuclear power, which have contributed to the small amount of new nuclear development in Europe;
- a general impression that hydrocarbons are in abundant supply and accessible at durably low prices.

In the future, however, the world market for energy will change as the factors governing supply and demand change:

- Demand -- rapid growth of oil imports, particularly in the United States and Japan; growth of natural gas use in Europe; new technologies and the need for strict emissions control standards.
- Supply -- re-structuring efforts of the European coal industry and structural changes in the energy industry in general.

New energy policies are urgently needed in a world where demand is increasing while resources are being depleted: The global nature of energy and its effects on the environment mean that a global approach must be sought: The EC, given its experience of international cooperation, could play a pivotal role in developing global consensus.

Three areas were identified in which effective multilateral cooperation is necessary: nuclear power, oil and gas, and the energy-environment relationship.

In addition, the EC has several major concerns in the energy field which are shared globally:

- improving energy efficiency and diversification;
- discovering and transporting sufficient resources to satisfy requirements; and
- disseminating technical information, particularly that which promotes the environment.

The draft Directives currently before the Council promise benefits for the EC in all these areas, as well as forming the basis for a cohesive energy policy.

Oil supply will remain a predominant issue for the foreseeable future. Understandably, producers and consumers of oil may have different or conflicting perspectives. Consumers, including oil companies, are willing to invest in greater production of oil if a secure investment climate exists in producer countries; producers, on the other hand, want demand security to justify their own enormous investment in production and new technology. A balance must be struck between the interests of these two groups if future oil shocks are to be avoided.

* * *

Mr. C.S. Maniatopoulos, Director General, Directorate-General XVII

The energy market today is characterised by four factors: relatively low prices; concern about the use of fossil fuels, their finite nature and their environmental impact; little new nuclear development in Europe, due to safety and waste problems; and a general impression of cheap and abundant hydrocarbons, encouraging lax attitudes to use.

On the other hand, the European public is becoming increasingly interested in environmental protection, while security of supply also remains a major issue.

In determining the future of the international energy market, the prime factor affecting demand is the increase in consumption of hydrocarbons, especially in the US and Japan, as a result of economic growth and low oil prices. The penetration of natural gas as the energy of the future in Europe is a reflection of the same trend.

The European internal energy market will bring more competition and a downward pressure on energy prices. The completion of the internal energy market, together with the penetration of new technologies, may stimulate increased energy demand. We must be vigilant about this impact. However, a consensus in favour of limiting pollutant emissions and mandatory standards governing efficient use of energy is emerging in Europe.

On the supply side, there is a restructuring of the European coal industry under way, and a more reliable contribution from hydrocarbons. We can expect better use to be made of the European electricity and natural gas transport networks. EC planning policies and associated programmes to improve energy infrastructures and interconnections are crucial for a better economic and social cohesion of the peripheral countries.

We must also work to establish a balance of interests between producers and consumers of hydrocarbons to avoid a new oil crisis.

These are the areas of crucial importance for the future of the energy sector. At the heart of the debate I would pin-point: the rational use of energy, the role of natural gas and nuclear power, dependency on fossil fuels, environmentally-friendly energy policies, growth and security of supply.

Mrs. Helga Steeg, Executive Director, International Energy Agency

I agree with the "Groupe des Sages" that the major challenges faced are demand and supply balances; energy security, protection of the environment and economic growth, and the need to integrate them; and the changing geopolitics of energy. Energy import dependence is in itself not a critical issue, though risks arise when economies are dependent on a single energy source.

Oil supply remains the predominant energy issue for the foreseeable future. Governments must play their part by setting the framework for competition and reducing barriers to trade.

Rising oil demand, which has been and will be greater outside the OECD than within, means the question is no longer 'will oil prices rise?' but how and to what extent? I do not foresee a third oil crisis, but I expect prices to fluctuate. Oil companies will invest during a period of rising demand if they find a secure investment climate in producing countries.

Three specific issues I wish to raise are : the need for a more realistic assessment of energy developments in Eastern Europe; the need to maintain emergency stocks; and the need for continued integration of investments by producer and consumer nations in each other's upstream and downstream energy activities.

Environment need not be the Achilles heal of energy supply and use. Pollution control has long been included in energy costs, but the increasingly complex environmental/energy challenge, and the issue of climate change, makes calculations harder.

Longer term response measures will hinge on the protocols of what emerges as an international framework agreement on climate change. For the world economy to achieve CO2 stabilisation within two decades would require a massive and probably impossible effort. OECD countries would find this difficult; the problem is compounded by economic growth and thus rising energy demand in the non-OECD countries over the next 20 years. Even with improved energy efficiency, this will push up CO2 emissions.

We need to examine energy technology developments and offer cooperation to East European countries in these areas. Our focus must go beyond a regional to a global perspective.

Dr. Subroto, Secretary General, OPEC (speech delivered by Dr. Osayimwese)

Concentrating on the issue of supply security, the OPEC member countries hold between 77% and 84% of proven reserves. The problem, therefore is not supply, but production and export capacity. The OPEC countries currently have a sustained production capacity of 27 million barrels per day. However, this will not be sufficient to meet world demand beyond 1995.

Production capacities must consequently be developed as soon as possible; this requires an investment of between 40 and 60 billion dollars (a production rise of 6 million barrels per day) if an energy gap between now and the end of the century is to be avoided. However, the OPEC countries are capable of supplying oil for the next 100 years, compared with only 16 years for other producing countries. The EC countries should have more confidence in OPEC's ability and reliability to meet its future oil requirements, instead of embarking on policies that depict OPEC as an unreliable source of oil supply, when the Single Market comes into being.

It is certain that oil will continue to be the main energy source, at least for the transport sector, in the foreseeable future. According to various scenarios drawn up by the OPEC Secretariat, the OPEC countries must enjoy a price of 18 dollars a barrel in real terms between now and 2000 if they are to have spare revenue to invest in boosting production capacity. Furthermore, even if demand remains predictable, other uncertainties persist. For example, there has been talk of a tax on oil products. This exacerbates the dilemma for producing countries.

While we welcome developments in Eastern Europe, the rich nations should not, in their enthusiasm for Eastern Europe, forget their commitments to the developing countries.

The OPEC countries are in a position to supply oil on a secure basis and in an environmentally friendly manner, provided that they are guarantied demand security and consumer countries are willing to work with them on the development of "clean" technologies.

Dr. Abdullah El-Kuwaiz, Assistant Secretary General of the Gulf Cooperation Council

Coming from an oil producing region, I associate myself with the conclusions of the "**Groupe des Sages**" on security of supply, stability of prices, adequacy of world energy for a sustainable level of economic growth and the encouragement of efforts to lessen adverse effects on the environment.

This is an opportunity for me to state the Gulf Cooperation Council's (GCC) position. GCC contains more than 45% of world oil reserves and has a productive capacity of over 30% of global capacity. Given favourable market conditions, GCC can comfortably be called upon to meet world oil needs as has been proven in the recent past. We take a long range approach on pricing, guided by market mechanisms. Security of supply for expanding demand means adequate prices that encourage investment in new capacities. GCC members have been moderate in discouraging the attempts by other producers to raise prices unreasonably. We believe price shocks are harmful to long-term interest and for the world economy.
We have called for regular consultations between producers and consumers, similar to the present forum to exchange information between GCC and the EC.

We support efforts at environmental protection through setting standards, R&D, and efficient use of energy. But we do not believe an environment tax is helpful for the environment or for investment for new capacities. It has been shown that the introduction of a US $50 per ton of coal equivalent contributed only marginally to a reduction of CO2 emissions. Since demand has a low elasticity, carbon taxes are bound to have a small impact unless set at prohibitively high levels.

Consuming countries in general collect more taxes from oil than oil producing countries, whose revenue is not net of cost production. To meet growth in world demand requires massive investment in new capacities by major producers. This is a very relevant matter since investment in new capacity is going to compete in a world facing possible shortage of investable funds as demonstrated by the present trade in interest rate.

Prof. Jacques Lesourne, President of the Conservatoire National des Arts et Métiers, Paris, presenting the report on the "Major Themes in Energy" on behalf of the "Groupe des Sages"

Broadly speaking, energy is a world problem in which governments, citizens and companies must be increasingly sensitive to the globalisation of human relations and markets.

Six major questions were raised in the report by the "Groupe des Sages". The first is that today's energy sources are national in scope, but in the future, two models will probably prevail : a market economy with free competition and a more extensive system relying on investment planning, a certain degree of synergy and consideration of yields and economies of scales.

The second major question, the environment, is particularly difficult because it encompasses such a wide range of subjects, from air and water pollution, climatic change to industrial hazards.

Third is the Eastern bloc's future as a consumer of energy. As these inefficient industries are restructured, demand for energy and energy efficiency will be enhanced. As for the Soviet Union, we can expect its economic and social system to encounter difficulties in making efficient use of energy reserves.

The fourth major question is the developing countries. The World's population will grow by 2 billion between the years 2000 and 2025 and this growth will primarily take place in the developing countries. This, coupled with improved standards of living, will mean a sharp increase in energy consumption in the Third World.

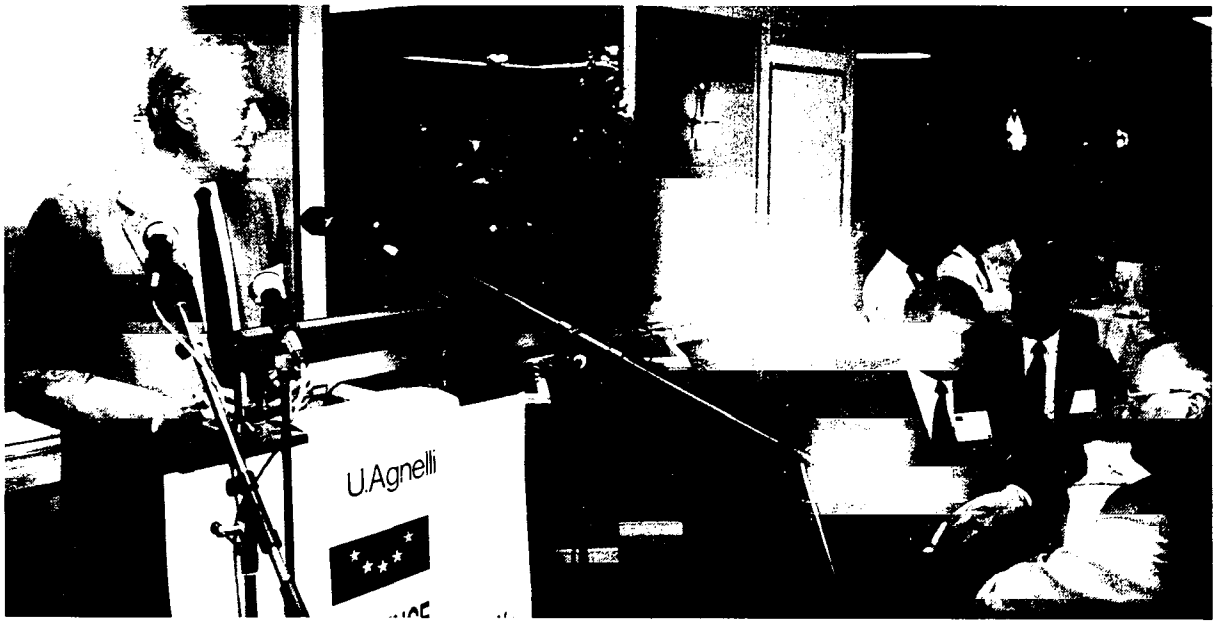
The fifth area dealt with is technology. Today we have the means and the time to give practical application to new and better technologies in the field of energy.

The sixth is geopolitical security. We live in a dangerous world that is full of surprises. This gives rise to numerous and formidable difficulties for both producers and consumers of energy.

In conclusion, I would says that there has to be better coordination between growth in the world's economy and environmental protection. There is no free lunch. Regardless of whether one is talking about energy produced by coal, gas, oil, nuclear or renewable sources, the choices will depend primarily on advantages and the cost.

Consequently, we have to keep three things in mind. Western society cannot take an all-or-nothing stance and must reach a compromise. Standards, subsidies, incentives and tax breaks are of crucial importance and there must be an international exchange of ideas in order to reach a global and rational use of energy.

Lunch address: The Industrial Dimension



Mr. Umberto Agnelli, President, Fiat Auto

Energy is a central problem for industry and a double problem for the car-maker, for the car lives on energy. For the motor industry to develop, legal and political constraints (taxation) must not create insurmountable barriers to vehicle energy consumption.

A car-maker has to face two challenges, resulting in a compromise between immediate cost-competitiveness and a medium-term outlook involving new environmentally-friendly technologies such as the non-polluting car.

European industrialists are concerned about non-homogeneity of energy supplies and of prices and taxation as major obstacles to free competition. Businesses in regions like Italy, where energy products are disadvantageous compared to EC competitors, are especially worried.

If we are to build up European energy supply, harmonisation and innovation must come from the top. Achieving a single energy market is hampered by national supply monopolies and electricity transport difficulties; deregulation is essential. The EC can play a catalysing role by bringing together the major players with their different requirements in order to reach a real consensus.

As demand grows, we must mobilise national and community resources, public and private, for high efficiency. The accent is on growth in qualitative terms. Technological development is a major player in this process, whereby damage to the environment could be repaired.

The car industry has strived to prove this over the past decade. It is a mistake to think car manufacturers are 'on the other side' from those wishing to safeguard the environment. We have solved a host of problems and it is in our own interests to reduce vehicle-related pollution.

Let's not blame the car for its success by curtailing its use and tightening taxation. To reconcile energy consumption with the needs of the environment, we need faith in development rather than sullen prohibitionism. Prohibitionism never paid.

SESSION 1: ENERGY AND ECONOMIC GROWTH

Co-chairmen: Professor Jacques Lesourne & Dr. Heinz Horn, Chairman of Ruhrkohle

Summary

Energy is a means to an end. The importance of energy rests on its ability to extend the quality of life -- a term which embraces economic growth as well as a healthy environment.

The EC will be competing for energy resources in a fast growing international economy. It must find a way to ensure a cost-effective supply of energy that does not at the same time harm the environment or otherwise diminish the quality of life.

New technologies offer significant promise in the effort to reconcile environmental protection and energy growth while supporting economic growth. Technology may also be the key to solving the energy problems in Eastern Europe. The EC can play a major role through technology transfer as well as financial and management support of clean energy options.

The proper role of regulation must be determined. Industry representatives prefer to deal with pollution through standards, financed through the capital programme and recouped in the price of electricity, while others - notably environmentalists - favour a greater degree of external control.

The most effective industry structure is also open to question. Because the public expects low costs, this implies a monopoly combined with an obligation to supply. However, it was noted that liberalisation of the electricity and gas markets in the UK encouraged environmentally sound energy generation; a freer internal energy market in the EC might have similar beneficial effects.

As industry seeks the best balance between a cost-competitive approach and an environment-friendly one, a single energy market with homogeneity of supply, prices and taxation would remove some of the major obstacles to success.

A coherent Community energy policy, however, is a prerequisite to a "common market" in energy. Such a policy should be developed in cooperation with industry and cover a period of at least ten years. Care for the environment and encouraging growth through technology should be cornerstones of the policy.

The policy should take into account several assumptions:

- energy changes in Eastern Europe in the next ten years will lead to net demand increase;
- international dependence on Middle East oil and gas will rise;
- coal will continue to play a major role;
- the EEC will import more and its energy dependence will rise with some concern expressed about indigenous production, particularly about coal production;
- price volatility will continue.

The policy should also avoid a number of assumptions, e.g., natural gas at low prices or free competition in the energy market.

An unfortunate fact of life is that fear is often the key to change. Until the public believe their quality of life is threatened, they will not act, and any energy policy will fail. Public education is critical to the achievement of Community energy goals.

Panel

Dr. Heinz Horn, Chairman, Ruhrkohle

The global view of energy is essential. Economic growth is expected in the industrialised countries; to limit future demand, we in Europe should insist that the private consumer, industry and the traffic sector save and use energy as efficiently as possible and invest for these purposes, despite today's low prices.

The time of low energy prices will soon end. Saving energy by investment and behaviour can also be achieved in periods of growth; the conviction of people can change the world - both these have been proved.

Increasing growth in the developing countries, with growing populations, is indispensable. Consumption will increase, a trend having important impact on world energy markets.

Energy imports of the European Community will increase anyway. We must safeguard the peaceful use of nuclear generation and convince people that it is reliable. Indigenous oil, gas and coal production will also be important in security of supply in Europe.

Mr. Gordon Adam, MEP, Chairman of the Committee on Energy, Research and Technology of the European Parliament

The importance of energy rests on its meaning for people and society, and its ability to improve the quality of life. So we should consider carefully who will be called on to curtail their requirements if the politicians decide to control the stimulus to demand.

There is as yet no certainty as to the extent to which CO2 emissions are causing global warming nor of the effect. If the most predictions are proved, there will have to be a total move away from fossil fuels. For the time being, i am much more in favour of looking for the answer to the environmental problems of energy use by regulation and not in fiscal control. The latter presupposes that technical progress has come to a standstill. I doubt the value of increasing prices as a means of trying to control energy policy.

As the recent Commission Communication on Energy and the Environment showed, the way ahead for energy efficiency is unclear and must be brought into sharp focus. Simple problems such as reducing the use of domestic energy must be tackled before more complex problems.

Mr. Philippe Bodson, President of Tractebel

I would like to talk from the stance of the industrial consumer, given my experience in the glass industry, which is a large energy consumer.

I must disagree with Mr. Adam on the role of prices in solving energy problems, because while companies can get round regulations, they can't get round prices. Since increasing prices affect everyone, the user will accept the increase grudgingly, and look for ways to reduce energy consumption: what the economists call trying to reduce the energy intensity of economic growth.

This is a long-term exercise but slowly it happens, because the motivation - price - to cut waste and increase energy saving is there.

I suggest a recoverable tax which could be claimed back by EC companies exporting to the rest of the world. This would ensure the competitiveness of EC companies in the world market, and it might be possible to persuade Japan and the US to follow similar policies. But the tax must

be modulated to ensure that no positive advantages are given to pollutant fuels or resources which are not available.

Mr. Pierre Desprairies, President of CIFOPE

I must stress the need for the EC to take account of global concerns - including the world energy market - which affect EC policy. Of the scenarios developed by the Commission of possible future developments in energy, I find scenario 3, which assumes stable prices, security of supply and economic growth, unrealistic. I take scenario 1, 'business as usual', to be the most likely.

The only way to increase drastically spending on environmental protection and reduce energy consumption would be through an ecological disaster, for example, a three- year drought in Europe and the US. People do not believe in the greenhouse effect.

I also think we must expect oil prices will rise steeply in 20 years or about as all the supplementary production becomes restricted to the Gulf countries, producing at their maximum capacity.

Dr. Klaus Liesen, Chairman of Ruhrgas

We have already talked about the importance of natural gas in the future, when it will make up 20% plus of EC energy sources. I would like now to underline the main objectives of the gas industry in the internal energy market, which I see broken down into four points.

Firstly, gas must remain competitive against other sources of energy to maintain its market share in the Community.

Second, we must agree additional volumes from gas exporting nations under contracts running a minimum of 20 years, under which importers would have to guarantee sales. This is the way to motivate exporting nations to invest adequate capital in the development of gas fields for export.

Third, we must develop gas regions in peripheral EC regions, and fourth, we must achieve integration with Eastern Europe gas networks. A policy of autarchy in energy supplies in Eastern Europe until now has resulted in little technological innovation, pollution, poor energy savings and subsidies which have no relevance to market prices - all problems the gas industry in the EC can help solve.

Mr. Robert Malpas, Chairman of Powergen

Energy is a means to an end, produced because people want light, heat, cold, transport, communication, etc.

The objective for all of us must be to provide more of these benefits, and greater economic growth, for less use of energy.

How do those of us whose business it is to provide energy, justify advocating less of its uses?

Firstly, the need for energy is not going away. However efficient the world becomes in its use there will always be an enormous demand, so there will be a very large market for energy within which to do profitable business.

Secondly, business is about recognising the realities. Concern for the environment and the increasing interest in energy efficiency are now firmly established as major market forces.

So businessmen in the business of providing energy are on the side of the solutions, not part of the problem, as in generally assumed.

Increased energy efficiency on the demand, as well as the supply side, is the obvious policy option that must be stimulated by all societies.

However, though the hundreds of millions of individuals who make up the demand side may fear the greenhouse effect of their CO2 emissions, they are unlikely to do much whilst the price of most forms of energy remain as low as they are to-day. Higher prices, through heavy, value added type taxation will, in my opinion, be the most effective policy option.

Finally, a comment on the "Great British Experiment".In its first month, the world's most competitive electricity commodity market is already proving that competition is real and is bringing strong downward pressure on prices. The common carrier policy is effective, allowing for instance, small generators to compete with large. This open, competitive, market will stimulate greater economic growth for correspondingly less use of energy

Mr. Michel Pecqueur, Vice-President, ERAP

We need to develop a realistic energy policy through the "sophisticated analysis" of each sector affecting energy policy - technical developments, lifestyle, transport tertiary sector and residential considerations.

There are three stages in the development of energy intensive proposals. First comes structural development; energy intensity will drop as industry develops.

Second, we need the optimisation of systems where incentives will ensure financing will go to energy savings. And finally the most difficult stage, restrictions limitation - reductions in energy use by industry and consumers, encompassing perhaps a ban on traffic at certain times.

For this third stage to be feasible, people must be well informed about the optimum choices to be made, but also the drawbacks involved. Energy is a necessary impetus for economic development and we must use all the forms at our disposal, including nuclear power.

Mr. Henry de Ruiter, Managing Director Royal Dutch Shell

Although the experience of the industrialised world has shown that economic growth can be sustained at lower levels of energy intensity than 20 years ago, we all know that economic increases will mean an increase in energy use.

The EC will be competing for energy resources in a fast growing international economy - notably the developing world where population growth and industrialisation will mean increased use of primary energy sources.

We have to address problems of both quality and quantity; fuels must be increasingly efficient and environmentally sound. Shell's efforts to increase energy efficiency have resulted in a 40-50% reduction in the use of energy in refineries.

As far as long-term efforts go, we need to develop new gas fields, and we must guarantee sales and avoid legislation which would limit the open gas market, and look at new technologies to lessen the pollutant effects of coal.

Mr. Masaji Yamamoto, Director General of Energy, MITI, Japan

Japan is the fourth largest world consumer (5%) and the largest net importer of energy. Therefore, the supply/demand situation in Japan affects the rest of the world, and vice-versa.

Energy demands in Japan have risen sharply recently (5.7% in 1989) due to expansion in the economy and lower oil prices. This was a much bigger increase than long-term figures had suggested and indicates a trend Japan believes to be unacceptable.

Since Japan already leads the world in energy conservation, we plan to make the social system more efficient. Japan is at present developing a 'new earth 21 programme', a 100 year project to clean the environment, for which we hope to gain international cooperation. The plan is to gradually phase in better technologies, renewable sources of energy, energy saving processes, and to develop nuclear fusion, thus halving emissions of greenhouse gases by 2050.

Discussion

Mr Van Hoek (SEP) referred to the question 'how will electricity utilities adapt to increasing demand faced with uncertain supply?' He said the utilities would not let this situation develop as they have an obligation to supply, but uncertainties would cost the consumer money.

He suggested rewording question 3 to read: could the public and politicians be made aware that opposition through fear may drive utilities to make more costly decisions. Everyone wants to avoid the alternative - inability to supply.

On the question (pl.7) of greater efficiency from structural changes, reforming monopolies and open access to networks, Mr Van Hoek said electricity is different. It cannot be stored so delicate balancing of generation is needed, yet continuous cheap supply is taken for granted. This is only possible in a combination of monopoly and an obligation to supply.

Meeting demand by more efficient use of networks (p24-25) is a misunderstanding, said Mr Van Hoek, as networks are already used to their best capability. This means secure, high quality supply, not long distance transport, which said Mr Van Hoek, would lead to lower reliability and higher costs.

Finally, said Mr Van Hoek, common carrier is disadvantageous to small consumers and would not be needed if the EC start from the basis of harmonised conditions for generating electricity.

Sir Keneth Cousins of British Coal stated that the aim of industry must be to help the Commission draw up a new energy policy for a period of at least ten years, combining economic growth and care for the environment. It is important that the Community has a robust policy. This policy statement must avoid a number of pitfalls: it must not rely on a "great surge" of electricity in the European Community; it must not rely on a boundless supply of natural gas at a low price; it must not rely on massive government intervention in prices and management and must not assume that the international energy market is a normal economic market with free competition between the main players. On the other hand, it should take account of a number of points. Firstly, that the energy changes in Eastern Europe in the next ten years will lead to net demand.

Secondly, that international dependence on Middle East oil and gas will rise. Thirdly, that coal will continue to play a major role. Fourthly, the EEC will import more and its energy dependence will rise. Finally, there will continue to be price volatility. He concluded that there were two lessons to be drawn from all these points: the European Community must not wilfully increase its energy dependence and that the main environmental gains in the nineties would arise from Eastern Europe and the application of new technologies.

Mr I. Osayimwese (OPEC) stated that scenario 3 was unrealistic, in that it implied a drop in oil consumption during a period of economic growth. Scenario 1, corresponding approximately to OPEC's middle price scenario, was very much business as usual. He felt that the solution was rather to look in the 21st century at the relationship between growth and demand.

Mr Simon Roberts (Energy Campaigner, Friends of the Earth, UK) was the first environmentalist to speak at the conference. He spoke of a Friends of the Earth report which analyses the amount of money which must be spent in order to meet energy demand while reducing environmental impact. This report drew three conclusions. Firstly, it is possible to achieve stable CO2 emissions by 2000 at negative cost to the nation. Secondly, nuclear power is the least cost effective measure to satisfy demand while reducing environmental damage. Lastly, the energy market in the UK and the EC is targeted on the least cost effective measures. Policy must consequently be re-thought.

Mr J. Tassart (ETUC) put a question to Mr Adam: should not an energy policy at European level precede a "common market" in energy? The ETUC views such an approach as indispensable, notably to help reduce environmental damage. Mr Adam (Member of the European Parliament, Vice-President of the Committee on Energy Research and Technology) replied that one of the priorities must be a rational and efficient use of energy.

Mrs Taschner (European Environment Bureau) stated that a single energy market would stimulate competition. This could lead to greater energy use and consequently to more environmental problems. She asked Mr Malpas whether his company preferred dealing with pollution through standards or through taxation of pollution? Mr Malpas (Chairman of Powergen, UK) replied that he preferred emission standards. This will be financed through the capital programme and it will be recouped in the price of electricity.

Mr G. Sanchez-Sierra (Latin American Energy Association) stated that the Association's 26 member states had come under pressure from multilateral banks to privatise their power sector. He asked the question of what happened to the nuclear plants in the UK privatisation programme? Mr Malpas replied that you can only run a business if you know the costs. In the UK, a great deal of confusion surrounded the real costs of running the nuclear plants, particularly as regards re-processing and de-commissioning.

Mr Wilson (CEFIC) stated that the process of liberalisation of the electricity and gas markets in the UK had boosted the production of environmentally-sound energy generation. As a consequence, emissions of SOX and CO2 will drop in the next ten years. We can conclude that an internal energy market in the EC will have similar beneficial effects. Mr Malpas expressed his support for this viewpoint.

Mr Frigola (Permanent Representation of France to the European Communities) stressed that developing countries will not benefit immediately from a technology transfer. They will consequently follow the same path as that of the developed world in earlier decades. Their energy needs, particularly primary energy, will grow in the future. They could consequently make two claims: access to fossil fuels and a right to pollute. Mr Desprairies (President of CIFOPE) replied that developed countries must help the developing world to avoid taking the same path. However, even if the will is there, they would be unable to stop polluting at the same rate as the developed nations. The best solution, he felt, would be to encourage companies to invest in developing countries and help them thus exploit their own fuel resources.

A participant raised the question of research and development. He stated that the only way of reconciling environmental protection and energy growth while not jeopardising economic growth was to develop new technologies. He raised the question of whether we were doing enough

SESSION 2: TECHNOLOGY, EFFICIENCY AND ENVIRONMENT

Co-Chairman: Professor Umberto Colombo, President of the ENEA, Rome & Dr. Pieter Winsemius, Director, McKinsey and Company, Amsterdam

Summary

If we solve energy problems, we help solve environmental problems. Recent concern for the environment has centred on the greenhouse effect, but other problems remain: acid rain, the danger of nuclear accidents. A long-term strategy must be devised which ensures that solutions for one problem do not exacerbate another. There is also a need for short-term solutions to urgent pollution problems.

Two key questions need to be addressed:

- what environmental agenda is emerging;
- how can technology improve energy efficiency and solve environmental problems.

In the future there will be a change in the perception of environmental problems - moving away from the toxic substances themselves to the wider issues of energy, technology, world trade and transport. This, in turn, will suggest political solutions, addressing such issues as dispersed population patterns, use of mass transit, and efficient use of alternative energy. Government's weapons are legislation and taxation; in addition, private initiatives should be encouraged.

Technology can help to solve problems, such as lessening the environmental impact of "dirty" energy sources. But it is up to society to bring about lasting change. Governments, in particular, should introduce measures which correct the "myopic" and short-term aspects of the market place.

New technologies have made greater conservation possible, but they must be pursued on a continuous basis. Research and development should be stepped up and carefully focused. Several of the points mentioned during the session are now reflected in EC research programmes.

It is important to note that choices affecting conservation are not made on ecological grounds, but on economic criteria. Efficiency gains from technology are often offset by consumer behaviour. This view is supported by research in the US which showed that industry made the greatest contribution to energy conservation; consumer behaviour accounted for only 15% of total savings and was not a durable factor.

A number of crucial questions remain unanswered:

- If the EC had to reduce CO2 emissions by 20% by 2005, could it do it? Should we in fact be aiming for stabilisation, not reduction?
- If nuclear accidents such as Chernobyl still catch us off guard, how can we claim to have mastered the technology?
- If a total reversal of the economy is necessary to deal with environmental problems, will it be possible to alter consumer behaviour?

Panel

Prof. Umberto Colombo, President of ENEA

The key questions to be tackled are: what environmental agenda is emerging, and how can technology improve energy efficiency and solve environmental problems. Western countries should ensure vigorous introduction of energy efficiency world-wide to close the intolerable gap in the use of energy, with 75% of the world's population - in the developing countries - using 10% of supplies.

On global climate and man's role in climate change, technology can help solve problems (acid rain, protecting the ozone layer), but society must bring about real changes through economic, efficient energy techniques. Government measures - carbon taxes, standardising legislation - could help correct myopic attitudes.

With 88% of total energy consumption currently from fossil fuels, there is a danger in relying too heavily on one energy source. We must look unemotionally at the possibilities of nuclear power and renewable fuels - the latter in particular benefiting developed countries with less structured energy industries - such as biomass from agriculture. We can no longer afford to remain prisoner of short-term thinking.

Mr. John Easton, US Assistant Secretary for Energy Affairs

Among US conclusions on the use of technology in improving energy efficiency, based on research between 1973-1988 into energy efficiency, are the following.

First, although prices affect conservation gains, other factors remain important. Second, the development of new technologies have made greater conservation possible, but technology does not just appear; it must be pursued on a continuous basis, even during periods of lower prices.

Third, the turnover of capital stock is the primary mechanism of conservation gains. Choices affecting conservation are not made on ecological grounds, rather on economic criteria.

Fourth, growth and structural change make energy conservation a moving target. Industry has made the greatest conservation savings, but fifth, we found conservation trends reflect a diversity of response within each sector of the economy, each achieving different savings. And lastly, although consumer behaviour reinforced those gains, it made up only 15% of total savings and was not a durable factor.

Mr. Robert Horton, Chairman, British Petroleum

New technologies have played an important part in energy saving, but the slow turnover of stock makes conservation gains a long-term issue.

Efficiency gains from technology are often offset by consumer behaviour, given that consumer saturation point, particularly in the areas of travel, appliance ownership, housing space per capita, has not been reached.

So higher energy prices, new regulations and information on cost saving measures are required to help reverse these trends. We need to switch to non-fossil fuels to cut emissions, but nuclear power still faces public opposition and the high capital costs and uncertainty of renewable sources make them risky investments in an increasingly competitive electricity industry.

About half the carbon emissions come from outside the OECD where energy efficiency is low. It is likely to take 25-30 years of replacing buildings and much existing equipment with new technology before we see any significant reduction in such emissions.

Dr. Klaus Knizia, Chairman, VEW

The electricity industry should be based on coal supplies and nuclear energy, because they are the most abundant resources. We have to decrease dependence on oil with the help of electricity, expecting a probable third oil crisis in the next decade, due to decreasing reserves and a higher proportion of them situated in the Persian Gulf.

We don't fear a lack of energy taking all energies into account but we will have a lack of capital so we will have to make the best of it. Now some thoughts about the techniques.

CO2 emissions could be substantially reduced through technologies, for example the gasification of coal and use of combined fuel. If atmospheric pollution by CO2 is to be reduced, the discrimination against nuclear power and electricity in general must cease. We need to reduce the risks associated with nuclear power. There are also dangers in forcing prices up and thus forcing electricity generating companies to relocate abroad.

Mr. Paul Lannoye, MEP, Chairman of the Committee on Energy, Research and Technology of the European Parliament

Energy is the key parameter of environmental problems; if we solve energy problems we solve environmental problems. Recent concern has centred on the greenhouse effect, but other problems - acid rain, the danger of nuclear accidents - remain. So we need an overall consistent strategy to ensure solutions for one problem not to exacerbate another.

Nuclear energy is not better than fossil fuel; we need a long-term strategy based on renewable energy and rational use of resources. But short-term solutions must be found to urgent pollution problems including East Germany's air pollution.

Carefully focussed research and development must be stepped up, but the real response to environmental problems is political. Present wasteful patterns of consumption and production (dispersed accommodation problems, inefficient use of solar power, use of road not rail) must be used to guarantee energy savings, if properly organised with the same standards pertaining across the EC. Taxation and legislation are also weapons in the environmental fight.

Mr. Aldo Romoli, President, Economic and Social Committee, Energy Section

The focus has changed in the energy area; in the past market price has been the primary motivator but now we must take into account the cost of pollution. We cannot leave the policy of monitoring environmental problems to the market, but must develop a policy of rules and taxes.

We should look at the use of agriculture for energy. In the future grain-producing nations in Eastern Europe are likely to introduce on to the world market surplus agricultural produce, which could be used for energy given sufficient research.

The ESC is concerned about contradictory national practices, rather than Community norms, in the use of nuclear power. The Commission has failed to address the most important issue of nuclear power - safety - and the research budget for safety in the new programme has been reduced.

On Eastern Europe, I suggest not a shift from coal but the introduction of better desulphurising and management techniques. The situation must be tackled urgently.

Dr. Ernst von Weizsäcker, Director, Institute for European Environmental Policy

What is the environmental question ahead? There will be a change in the perception of environmental problems, moving away from specific toxic substances to wider issues of energy, technology, world trade and transport.

I expect a move towards greening the economy from within rather than fighting hundreds of uphill battles at the ends of hundreds of pipes. Therefore attention will turn to instruments which rather change the slope of the battlefield.

Our task is to internalise external costs, as in Scenario 4. Where solid proofs are available, the polluter pays principle is applied today. But the burden of proof should not fall on the state. A key instrument for change should be an environment tax, to be introduced gradually over a long period - a 5% increase a year - to prevent economic mayhem. To maintain a stable tax burden other taxes should be reduced. This policy would provide companies with the motivation to make long-term ecological investments.

Mr. V. Bushuev, Energy Committee of the Supreme Soviet

The USSR would like to develop closer cooperation with the EC as a whole as well as with individual member states. Energy is a major Soviet export which would benefit from reliable European partners.

Environmental problems from energy are a global concern, and we must cooperate to improve the situation at a European level. The Supreme Soviet's energy policy to 2005 aims to stabilise consumption through energy saving techniques and increased localisation of resources, including development of small gas and hydro-electric power stations and the use of solar power and renewable energy. In this the USSR needs Western expertise.

I would like to take this opportunity to apologise to you all for the disaster at Chernobyl. We need nuclear power, and we need to popularise it, but since Chernobyl, USSR developments have slowed down to ensure greater reliability.

We need more USSR-EC cooperation on new technologies for fossil fuels and electricity as our environment standards move closer. The USSR has an initiative for a centre for the development of energy efficiency and new technology.

Mr. Pieter Winsemius, Director, McKinsey & Company

The environmental agenda is changing. The issue is not whether we will spend the money but where. In Western Europe, or will it be better for the environment, though politically difficult, to spend it in Eastern Europe, for example?

Another question is the role of capital stock. Is the economy the enemy of the environment or do we need economic growth with increasing turnover to get an improvement in the environment? Certainly Scenario 1, business as usual, will lead us into an environmental hole.

Then, questions from a technological viewpoint. If we had to take action to reduce CO2 emissions by 20% by 2005, could we do it? In nuclear power, we have not yet mastered the technology, because we are unable to cope in a crisis. The reaction of Europe to the Chernobyl disaster could be called the ostrich approach.

Is a total reversal of the economy needed to deal with environmental problems, and can we alter consumer behaviour to this end? Despite the US research, I believe this to be possible, and that we should be asking if the EC should aim to stabilise CO2 emissions by 2000.

Discussion

Mr. Richard Eden (Cambridge University), reacting to a comment by Mr G. Sfligiotti, stated that a dichotomy existed between those in favour of free play of market forces and those who prefer regulation by government intervention. This has been reflected by what has been said during the conference. He went on to stress that there must be awareness of the risk that targets for pollution reduction may not be attained and consequently contingency plans must be drawn up. In other words, we must learn to adapt to climatic changes in the event of possible failure.

Mr. Eric Price (Department of Energy, UK) stated that one of the main topics was greenhouse gas abatement. Nearly all the talk at the conference had been of CO2, whereas in the EEC, CFC emissions are nearly as important. The latter should be almost completely eliminated by the year 2000. To ignore this point is to paint the situation blacker than it actually is.

Mr Umberto Colombo pointed out that the Commission's research activities have been called into question on a number of occasions during the conference. Much has been said about research, particularly that more was needed. Mr Lannoye made the criticism that research was too long on the same path, although Mr Colombo added that a certain time span was needed for research to bear its fruit. A combination of flexibility and stability is required. Mr Colombo noted that all the institutions which decide the Commission's activities have brought about changes. Pressure comes from different groups at programme definition stage. The final programme is the outcome of the combination of these pressures. A growing attempt is being made to combine energy and environmental aspects, he added. The most tangible evidence of this is the fact that within the DG XII, there is one single Director for the two fields.

Mr. Constance of the European Commission stated that several of the points mentioned during the morning's session were now reflected in the research programmes. The Commission is seeking to combine economic aspects with protection of the environment. Combined cycles and renewable energies are among the priorities.

The Chairman, Mr Colombo, pointed out that Mr Lannoye had been called to task a number of times. Simon Roberts (Friends of the Earth) asked how it was possible to reconcile the drive towards lower prices in the context of an internal energy market with a universal call for a price level high enough to enable investment? Mr Tassart of the ETUC stated that the documents presented four types of domestic appliances incorporating energy saving technologies and asked why they were not more widely distributed on the European market. He also asked how it would be possible to diffuse these measures on a large scale without making things difficult for low income households. Finally, Mr Colombo drew on the experience of his own country, Italy, where there is a lack of optimism as to the possibilities for future energy policy in the area of energy conservation and renewable energies (e.g. biomass).

Mr Lannoye replied to the first question concerning low energy prices: is this a factor which would prevent the emergence of solutions targeting energy supply on renewable energies? He felt that this was a negative factor. Taxes can push up prices, but sudden changes must be avoided, while taking a firm hand. He then moved on to the topic of co-generation, stating that the technology was not new: the obstacle to its use was institutional and economic. Part of the problem is that nuclear power requires costly investments and people consequently attempt to stimulate demand to make their investments pay. This is not rational. Everyone agrees on the principle of co-generation, but no-one is willing to put it into practice. Much more has to be done, he concluded, in the technological sphere.

Mr Bloch (European Petroleum Association) stated that if we want better protection of the environment, we need government intervention via norms and taxation. But he felt that the role of decisions by private companies was being ignored. In the environmental area, the

private sector is beginning to take initiatives which go further than the law. Governments must take steps to encourage such initiatives.

A participant reminded the conference that a scientific consensus existed and stated that at present we are living a kind of experiment, where we emit greenhouse gases without really knowing the effects this will have. On what was said by Mr von Weisacker concerning the fact that in a market economy, taxation can have a major effect, she stated that despite the fact energy is extremely expensive in Japan, they are facing the same problems as Europe. While taxation can play a role, it is not the whole answer. Legislation is also important and this is where the European Community can play a role.

Mr von Weisacker (IPEE) agreed that legislation was important and felt that there was no contradiction between the two approaches. We live in a multicultural Europe and must consequently adapt instruments to the situation. If we look at the economic performance of the four biggest industrial states, the same hierarchy is seen in economic and energy performance prices. It is therefore a fairytale that high energy prices kill an economy. There is no theoretical problem to tradeable permits, it is the practical application and control which pose big problems. Mr von Weisacker suggested that the subject of permits be re-discussed in "climate diplomacy arenas", setting up for example permits based on the number of adults living in the country. Poor countries would consequently have a surplus of permits which they could sell to the richer ones. On the question of taxes, he suggested that the existing counter-productive taxes be replaced by taxes working in the right ecological direction, while being economically beneficial. The basic role of such green taxes would be to give a clear steering signal for technology and consumer behaviour.

Mr Easton (US Energy Department) spoke of the example of the United States, which experimented with different types of regulations before concluding that a command-control approach was less effective than tradeable permits (bubble concept). In the area of greenhouse gases, the suggestion is to assess the relative impact of all these gases and then attempt to cut then as a function of this impact.

Mr Romoli (President of the Economic and Social Committee, Energy Section) stated that with the polluter pays concept, it is the consumer who carries the buck, for costs are recouped through prices. While the concept is a good slogan, attention should be devoted rather to structures. We must combine energy and environment policy with market economics. As regards Eastern Europe, a distinction must be drawn between the different countries. For example, the reunification of the two Germanys will rapidly deal with the pollution problems in the GDR. The main difficulty will be the other countries (Poland, Czechoslovakia): medium-level technology must be transferred to help them solve their pollution problems. Western European engineering firms are currently seeking advanced technologies, but Poland's problems, for example, can be resolved by existing technology, which must consequently be revitalised. We cannot rely on market forces to do the job, Mr Romoli stated. The Commission must consequently give financial incentives, for a balance must rapidly be found between risks and costs.

In response to a question from Mr J. Riggs (US House of Representatives) concerning the amount of toxic gases lost in the USSR via leakage upon firing, **Mr V Bushuev (Energy Committee of the Supreme Soviet)** replied that a distinction must be drawn between three sources of leakage: networks, consumers and production sites. Networks and consumers register a 2% loss, compared with 4% for production sites. Steps are currently being taken to reduce the effects of gas firing to 2%. However, Mr Bushuev stressed that these gases have little impact (2%) on the greenhouse effect.

Several questions and comments were raised at this point in the debate:

1) Given that the price of energy must embrace both production cost and environmental costs, how in this situation can the total cost of nuclear plants be calculated?

2) **Mr Frigola (Permanent Representation of France to the EEC)** noted there were no representatives of the nuclear industry on the panel and that nuclear energy had been discussed only from the viewpoints of safety and waste management.
3) **Mr Levi** felt that the assessment of French energy policy had been too rapid, as had the rejection of nuclear power in favour of renewable energies.
4) **Mr Stevens (Nuclear Energy Agency)** noted that the general public was not ready to adopt all the reduction measures for CO2 and that unacceptable targets should not be adopted.
5) **A participant** remarked that a study has just been published on the comparative costs of coal and nuclear energy in the OECD. It concluded that nuclear power was only economically favourable in five to ten of the OECD countries. He also stated that too many illusions were made to unachievable goals.
6) Is the public well informed about the risks of nuclear power compared with those of other sources? One participant quoted an argument from "The Spectator" whereby if someone lived at equidistant from a nuclear or coal-fired power plant, they would be more likely to die from pollution from the latter. The nuclear industry, however, is forced to spend a great deal more money on waste disposal.

In reply, **Dr. K. Knizia (Chairman of VEW)** stated that it was difficult to measure risk in such a way. In any event, we need both coal and nuclear energy and we must use both in a manner which is safe for the environment. "I am a member of a private company", stated Dr Knizia, "and we have established a combined nuclear-coal process, without either tax incentives or disincentives. Nuclear power is no different a risk from any other", he concluded.

Professor. Colombo stated that the future for the energy world is pluralistic in terms of sources and technology. All of the energy options pose problems, but we cannot do without any of them.

Dr Hans von Bulow explained the Danish policy in this area. The government plans to bring down CO2 by 20% by 2005. This will be achieved by consuming more natural gas, less coal, more renewable energies and no nuclear. Denmark has a good starting point, with the highest CO2 per capita output in Europe. A separate plan will be drawn up for the transport sector.

Mr B. Jones (Australian Embassy, Brussels) stated that to compare fossil fuels with non-fossil fuels was not the answer. If we are to have demand restraint, people must understand the facts. Furthermore, we must convince the developing countries not to follow our path, while offering them tangible solutions.

SESSION 3: GEOPOLITICS AND SUPPLY OF ENERGY

Co-chairmen: The Rt. Hon. D. Howell, M.P., U.K. & Dr. M. Gallego, President, Hidroastur, Madrid

Summary

Known oil resources represent over 40 years of oil supplies, 68 of gas and 100 of coal. Combined with new energies, this should be no danger of an energy crisis.

But many of these supplies are in remote, undeveloped or politically volatile areas. Sudden moves affecting supply or demand could be destabilising. This implies the need for energy policies which can cover possible interruptions and market failures.

The world energy market is slowly moving from a buyer's to seller's market, with the EC becoming more dependent on outside suppliers. More long-term investment is needed and the best way to guarantee that is by ensuring that companies earn enough to make investment an attractive proposition, rather than through subsidies or regulation. Regional imbalances in primary energy sources, environmental protection, taxation and operating conditions must be overcome to ensure fair competition across the community.

The influence of other economic problems on energy policy must also be considered. In Latin America, for example, factors such as external debt loads and certain protectionist barriers to supply have made it difficult for countries to develop a coherent energy policy which takes environmental issues into account. Technology can help, but technical costs must be shared.

One view is that companies will be more successful than governments at developing energy alternatives, provided companies have the financial room to manoeuvre. Availability of financial resources for exploration and development should be considered before burdening certain sectors with fiscal measures aimed at protecting the environment.

The availability and appropriateness of nuclear power is a world-wide issue that must be addressed, especially as industrialised countries step up their capacity and other countries develop theirs. The long-term risks of investment in nuclear or any other energy source must be assumed by society, since short-term uncertainties may mean that energy is not available when needed.

Gas appears to hold promise as a future energy supply. Major gas reserves, especially in the USSR, have not yet been tapped. The EC will need to develop new contracts with new gas exporters to ensure stability of supply. Bringing gas to the market in an orderly manner is one of the major challenges.

Finally, energy policy needs to be debated in the political arena, which implies the need for greater public information.

Panel

Dr. Gallego, President, Hidroastur

European Community will be more dependent from outside because their fossil fuel production will decrease one quarter - about 100 Mtoe from 1990 to 2010, and coal and gas imports will growth significantly. Nevertheless there is no feeling now and no prospect for the near future of a shortage kind of fuel resources crisis, because present plus potential discoveries will extend the oil life horizon to at least 70 years, gas to twice that figure and coal to many times more.

On the other hand there can be an energy availability crisis, especially of electricity, because of the political and financial constraints of acceding to some of the existing fuels and coping with the environmental problems and risks of its use.

Any way the future is going to appear the same up to 2010, because we will have to continue using coal, oil, gas and nuclear as we cannot afford to go without any ofthem, and overreliance on one reduces the stability and flexibility of the system. But the future will be different because security will never exist, neither for the supply nor for the demand side , neither for the utilities nor for the primary energy producers; with coal imports forecast ranging from 100 to 240 Mtoe, gas imports from 160 to 300 Mtoe, oil imports between 420 and only 220 Mtoe and additional electricity requirements differing as much as 170 GW.

In addition the internal energy market will produce a radical change in the structure and organization of the utilities, but an energy policy will also be needed to cope with market failures, specially in relation with the environment and security.

Finally energy can and must be used as a tool for cooperation in promoting the economic development of less developing countries, where continues to exist an energy crisis, but can contribute to decreasing tensions, not only on the world energy balance, but also on the more essential political and social aims to which energy is only a mean.

Mr. Antonius Grotens, President, Gasunie

In the past 25 years in various countries in W-Europe natural gas has taken, in competition with other fuels, between 15 and 30% of the primary energy market.

This success originates not only from the quality of the product itself, but also from the structure of the industry, stable markets, long-term contracts and an extensive transmission network made it possible to invest many hundreds of billion ECU's both in the upstream and downstream side.

For the future we expect that demand for gas will increase to 400 BCM a year in 2010 for W-Europe or even more. Imports from non-EC countries will rise to between 170 and 280 BCM a year in 2010 (1990 about 100 BCM).

Present demand is met from EC-production and imports from non-EC countries (38% in 1989). For the period from 1995 onwards there will be a great need to contract new volumes, a need which will be enhanced by developments in E-Europe with its desire to improve the environmental situation.

To make the production and transport of these large quantities of gas possible, large investments have to be made, which are now estimated at more or less 175 billion ECU's. And in addition the transportation companies will have to enter in take-or-pay contracts with a value of some 650 billion ECU's in addition to the current commitments of some 350 billion ECU's.

This will only be possible in a stable and predictable business climate. One of the most important elements is prolongation of the structure which up till now has been proven successful for the development of the EC-market.

Mr. Rolf Linkohr, European Parliament

The world energy market is slowly moving from a buyer's to a seller's market and the EC is becoming more dependent on outside suppliers. More long-term investment is needed and the best way to guarantee that is by ensuring that companies earn enough to make investment an attractive proposition, rather than through subsidies or regulation.

We need a global vision created from consensus on mutual interests, through increased exchanges with the third world and the US. We must work towards a world-wide network, which would take into account the third world, industrialised countries, debt and the environment to create a real geopolicy.

EC Treaties dealing with energy are no longer relevant and we must bring energy increasingly into the political arena, with issues simplified to be understood by the public. We also need a new division of labour; aluminium and steel could be produced at lower economic and environmental cost than in the EC. On geopolitics and supply, we must ask if population growth is constant or if it could be slowed.

Mr. Alessando Ortis, Vice-President, ENEL

How can economic growth be sustained while preserving the environment and security of supply in the EC? How will energy supplies adjust to changing markets?

We think that the electric supply industry has the potential for a large contribution to economic growth, environmental protection and security of supply. However this potential will be developed in full only within framework of a sound energy policy, harmonized at the European level. In order to be most efficient in its contribution to the above aims the industry needs flexibility in access to all primary energy sources and a long-term approach. On the contrary, misinterpreted concepts of competition, disregarding the factual technical characteristic of electricity, would lead to the choice of short-term and small solutions, then limiting substantially the ability to implement long-term policies. Pushing the electricity sector to massively concentrate its investment choices on techniques which appear the cheapest at the moment could bring about a more volatile and uncertain world energy market. Actually these solutions are captive to natural gas, then drastically reducing the aimed for flexibility in input sources.

Electricity is at crossroads, and we must ask how the utilities will adapt to increased demand , given the uncertainly of future supply. Regional imbalances with regard to primary energy sources and environmental protection must be overcome along with difference in taxation and operating conditions to ensure fair competition. Anyhow we, as electricity energy suppliers, are pursuing a mix of cooperation and competition in order to increase electricity integration. The European electricity stock exchange and the consultation on investments are two major recent initiatives. Others are the World Association of Nuclear Operators and our "code" of environmental protection, a first of its kind in industry.

Mr. Alexei Macarov, (USSR Academy of Science)

The Soviet Union gives priority to energy savings and has developed technical conservation methods which have increased efficiency by 36%. We have the means to double that saving by 2010, but will not use all the methods available because only half are economically viable. The USSR is increasingly replacing oil with gas, and expects to increase gas production from 680 Mtoe (million tonnes of oil equivalent) in 1990 to 950 Mtoe in 2010. There are potential

developments of gas exports beyond the EC and Eastern Europe to the Far East (China, Korea and Japan).

The environmental benefits of gas will mean a reduction in toxic gas emissions (sulphur dioxide and nitrogen oxide) of 40% by 2010 and a reduction in ash. However, we expect a 15% increase in greenhouse gases because the technical methods for stabilisation or reduction are too expensive for implementation. We need intensified international cooperation in the field of technological energy conservation.

Mr. William Ramsay, US Deputy Assistant Secretary of State for Energy Resources and Food

On the question of oil, emphasis must be shifted from the perceived problem of the location of supplies in the Middle East to "economic disposition". Although there are no new large deposits to be discovered, there are still reserves. It is possible to rediversify supply, it was done after the oil crisis in the 70s, by changing the investment climate, and could be done again. Reserves are available and can be brought onto the international market given the right incentives.

On the integration of Eastern Europe's energy systems with those of Western Europe, the problems the West experiences in siting refineries could be solved by upgrading those based in Eastern Europe. This would have benefits for the environment, increase refining facilities for the West and provide much needed foreign currency for the East.

As far as the expansion of East/West gas and electricity networks are concerned, potential technical problems could be overcome in the knowledge that integration would lessen dependence on certain suppliers; the development of new, more flexible systems would provide greater diversity of supply. We should be creative in deciding how the European aggregate market could work, in the interests of efficiency, the maximisation of resources and minimisation of transport costs.

Mr. Garcia Sanchez-Sierra, Latin American Energy Organization, (OLADE)

In the current geopolitical context, most of the world is moving towards the formation of blocs - Europe, the United States and Canada, Japan and the Newly Industrialized Countries of Asia - while the countries of the South are living in a "labyrinth of solitude".

In this international context, the economic and energy development of Latin America and the Caribbean has been negatively influenced by such crucial factors as increased protectionism the part of industrialized countries: Deteriorating, unfair terms of trade, fluctuations on the international oil market, where current prices in constant terms are only one third of 1980.

From the stand-point of the energy sector in the Region's broader economic and development context , the issues of vital concern for Latin America and Caribbean at present includes:

. The energy sector debt, US $ 80 billion, which accounts for 18% of the Region's total foreign debt, and therefore has major implications for both sectoral and overall development efforts in the Latin America and Caribbean countries.
. The search for ways to balance development efforts with growing pressure from the North for environmental protection. The Region must indeed strengthen the concept of environmental management in tapping its energy resources. However, we must not lose sight of the fact that industrialized countries have had the major responsibility for deterioration to date and should thus make a substantial contribution towards covering the higher cost that this will now entail for our Region.
. The Region's declining energy efficiency, due to low growth in industrial demand during recent years, obsolete industrial and vehicle park, and low petroleum prices.

As critically important as these issues are for Latin America and the Caribbean, they are regrettably not a top priority for the countries of the North, where environment has become the key concern. Nonetheless, in light of today's closely interrelated world, developing countries problems cannot be left aside.

As you are all aware, there is a new wave of democracy in the Latin America and Caribbean region; and to defend this democracy, we must improve our standard of living. However, to do so, everyone - in industrialized and developing countries alike - must work together in a global approach.

Mrs. Helga Steeg, Executive Director, International Energy Agency

We have to answer the question of where, how and when resources are going to be developed and by whom. Investment decisions of this kind are the business of the petroleum industry itself and the financial institutions which finance energy investments. If the right investment climate exists, they will be drawn in naturally.

If our economies are burdened by governments imposing punitively heavy environmental taxes, the questions arises will enough investment capital be available for the energy industry to support the expansion of oil and gas production capacity needed world-wide and to cooperate with the emerging economies in Eastern Europe. Therefore we should strike a balance between the need to ensure our economies operate in the most environmentally effective manner, using fiscal incentives, and the need to protect the ability of the same economies to generate the investment income that energy developments require.

On developing countries, I will be provocative and suggest that those with very high population growth rates must try seriously to improve the situation.

As for Mr Linkohr's proposal for a world-wide network, I believe this can come only after consensus has been reached, as any organisation is only as good as its constituent members want it to be.

Mr Uematsu, Director of the NEA

The nuclear electricity generation in the OECD (Organisation for Economic Co-operation and Development) area, which currently makes up about 23 % of the demand, will slightly decline after 1995. While the nuclear power capacity is globally sufficient for the present time, it will need to be increased in the future growing demand. Although the European Community countries have few plans for construction of new nuclear plants, Canada has plants for 10 new units in the coming decade, the US is moving back towards nuclear power, Japan is maintaining a strong commitment to nuclear energy, and other countries, including Taiwan, Korea, China, India, Pakistan and Indonesia, are already relying on nuclear power, or are planning to do so.

Uranium supplies are cheap and will be sufficient until at least 2000. While the currently operating nuclear reactors have achieved high safety levels, there is a desire to move towards cheaper, smaller and simpler reactors. Research in this area should be based on international co-operation, given the importance of using past experience and the need to share the high expenses involved.

Beyond technological and economic consideration, however, we need to enhance public information and openness as a prerequisite for understanding and acceptance. I suggest the NEA as a possible instrument to contribute bridging the communication gap between experts and the public.

Rt. Hon. David Howell, MP, UK

Consumers have made pro-environmental choices by choosing energy efficient goods, showing the important role the public have to play. I do not believe that economic growth and conservation are in conflict, rather that demands for conservation are providing the impetus for economic growth. An example is the new generation of high-tech power plants and developments in electricity transit - notably the efficient transmission from ac to dc systems at low cost.

The new scene is one in which the major dangers to energy supply could come less from primary energy shortages and more from lack of investment in energy transmission and production facilities.Short term uncertainties and financial pressures make the long lead times of major power and gas transmission projects harder and harder to plan and undertake.
Meanwhile we have, of course, to continue shielding ourselves from the inherent volatility of oil prices and the ever-present prospect of short-term oil supply interruptions, (made more likely by growing US imports once again).
So the key question is whether we can get the alternative gas, electricity and conservation investment in place to meet demands effectively - within both the timescale required and within the rapidly growing constraints imposed by environmental concerns.

Finally, Eastern Europe is the area for concentrated efforts in the 90s. While EC policy must centre on environmental issues, massive investment will be needed to update infrastructure, in order to implement the latest energy supply technology.

Discussion

Opening the discussion session, which followed on from the presentations given by the various members of the panel, **Mr. I. Osayimwese, representative of OPEC (Organisation of Petroleum Exporting Countries)** remarked that energy savings constituted an important issue. In geopolitical terms, there are a number of pervasive aspects, such as supply safety and reduction of energy dependence. However, these are political rather than market concepts, he underlined. Geopolitics goes much further than these aspects, according to Mr. Osayimwese, also covering the demand side of the equation. The impression given by the discussions is that this factor was not sufficiently taken into account in the last twenty years.

The Chairman of the Panel called for a reaction from representatives of the coal industry, who had kept relatively quiet during the conference. **Dr. Seeliger (CEPCEO)**, questioned whether the productivity angle of coal had been properly analysed. He did not believe that this was the case, rendering the problem a major one, for dependence will consequently rise. He also stressed that the EEC represents one third of world coal demand. Evolution in Eastern Europe and the Third World will furthermore create supply-side risks, according to Dr. Seeliger. The scenarios in the Report by the "Groupe des Sages" concentrate chiefly on supply diversification, despite the fact that coal reserves form one aspect of supply security and political strategy. Dr. Seeliger concluded by regretting that the Commission has predicted that current coal production will drop by 50% by 2010. and suggests that precautionary measures should be taken to maintain a well-balanced energy mix as a safeguard against unforeseen environmental risks or new perceptions which may mean any energy may have to be ruled out in the future.

A participant speaking from the floor raised the question of safety in mines and attempted to bring the conference "back to earth" by speaking about the human cost outside the EC. It would appear that there are no more indigenous energy reserves in the EEC and that the Community only has a "half guarantee" of supply. Conflicts in the Gulf region destabilise the situation on the supply market. Coal is purchased at low prices - for the working conditions in these countries enable them to achieve low prices - despite the fact that the Community has its own coal, which it does not use.

The representative of the Latin American Energy Organisation, **Mr. G. Sanchez-Sierra**, made a comment on coal subsidies. He remarked that Europeans - in particular Germans - often use different terms for what are in fact subsidies, at least when speaking of themselves. On the question of the safety of miners, he remarked that in Colombia, safety conditions vary considerably from mine to mine.

A representative of the Petroleum Industry Association responded to the presentation made at the beginning of the afternoon by the Vice-Chairman of the ENEL (Entente nationale pour l'énergie électrique), Mr. A. ORTIS, on the reliability of electricity. He stressed that oil and gas were equally reliable. Both these energy sources have enabled an improvement of living conditions : the replacement of wood by butane or diesel oil and the upgrading of communications thanks to oil. This latter sector has now begun to pay closer attention to environmental issues. He concluded that there should be more cooperation with the OPEC countries.

Mr. G. van Hoek, representative of the Association of Electricity Producers, referred to document 3B (page 5), which raised the question of reduced adaptation of electricity producers to the environment. He believed that steps must be taken to ensure that this situation did not occur. Uncertainties will cost consumers dear.

A representative of the European Trade Union Confederation (ETUC) asked Mr. R. Linkohr, Member of the European Parliament, what European political circles think of the import into the EEC of South African coal? Mr. Linkohr replied that his political grouping in the European Parliament has always been in favour of the application of economic sanctions against South Africa as a weapon against the government's policy of Apartheid.

In this connection, he declared that Mr. Nelson Mandela, leader of the African National Congress (ANC) had accepted an invitation from the President of the European Parliament, Mr. Enrique Baron, and will visit the Parliament in Strasbourg on June 13. However, economic pressure does not always have the hoped for results. If the same yardstick was to be used for other countries, we would have to cut off relations with many. Touching upon steel production, Mr. Linkohr mentioned the case of Venezuela, where German and Italian companies set up very modern plant, but Europeans then refused to buy the Venezuelan steel produced there. One of the lessons which can be drawn from these examples is that an international division of labour would also have economic and social advantages.

A representative of the European Environment Bureau (EEB) asked Mr. Linkohr a question on ecological concerns and the International Energy Agency (IEA). Mr. Linkohr pointed out that the creation of the Agency had been the Western response to the creation and strategy of the OPEC and stated that he personally thought it had been "a good idea". But other challenges have arisen in the interim, such as that of environmental protection, and it is difficult to say why the IEA has not reacted more to these problems. International bodies dealing with these aspects must be created or reinforced to tackle the ecological challenges, he concluded.

The Executive Director of the IEA, **Mrs. H. Steeg**, stated that from the organisation's viewpoint there were a number of relevant analyses already conducted, two of which she referred to on energy and environment topics, which had been undertaken in collaboration with IEA's Member countries

In reply to a question as to whether the United Nations favours a global and multidisciplinary approach in the energy sector, the **UN representative** stated that this was indeed the case. He revealed that the Organisation is preparing a conference on this topic which will take place in 1992 in Brazil. The conference will cover all the topics raised by the Panel, he maintained. He extended an invitation to the authors of the "Rapport des Sages" to take part in discussions.

A representative of Friends of the Earth emphasised that all those active in the area of energy supply should read the report distributed during the morning on the climate. He maintained that the effects of energy production on climatic changes meant that production would have to be cut to a certain extent, to defuse the play-off between supply and demand and thus protect the environment.

Mr. Jean Tassar (CFDT, France) put a question to Mrs. H. Steeg on competitiveness prospects for production prices in KW/hour, asking whether the IEA had studied this matter. Mrs. Steeg felt that at present there was not sufficient information available to be able to give an exact answer to this very technical question, although the Agency is in contact with certain bodies, such as the ENEL. Its comparisons of production costs vary according to the hypotheses: in some cases it is nuclear and in others coal which have a better ratio.
Mr. G. Sanchez-Sierra from the Latin American Energy Organisation came back to the subject of deforestation. He suggested that kerosene production could help temper this phenomenon. Wood consumption for cooking purposes only has secondary impact on deforestation in Latin America, he stated, which results chiefly from social pressure for the extension of farm land.

CONCLUDING REMARKS

C.S. Maniatopoulos, Director General, Directorate-General XVII

At the end of the discussion, the Director General of the DG XVII of the European Commission, **Mr. C.S.Maniatopoulos**, strove to draw lessons from the two days of debates. He expressly stipulated that he was not attempting to produce "conclusions or a summary of the work" but to put across what he saw to be the main messages. His first introductory remark concerned the nature of participation in the conference. Mr. Maniatopoulos emphasised that the conference had been extremely fortunate "to enjoy the presence of very high level political officials, leaders of European industry, representatives of our people and of the press". It was interesting to note that during the debates, no reference had been made to scenario 2 in the report by the "Groupe des Sages", i.e. the "how things could go wrong". This reflects awareness that the world is changing and that this presents challenges and risks, but that uncontrollable tensions are not expected. There must be "smooth" movement towards the future, with analysis of how, rather then whether European industry is going to be restructured. This raises the question of prices, taxation, environmental protection and so on. We must act quickly but not abruptly, taking the path of "evolution not revolution". Mr. Maniatopoulos expressed his agreement with one of the panel participants, who stated that "energy is not an end in itself": all the interests entering into the equation must be analysed and once they have been examined, the final choice made.

On the question of the development of energy and the resultant pollution, Mr. Maniatopoulos underlined that "all changes must be paid for in one way or another". The cost must be minimised, but the development cannot be stopped and we cannot go into reverse. "Competitiveness is a requirement", he added, "it is one of the prerequisites for survival in a world where Europe is not alone". Although we use more energy than in the past, we use it better.

Mr. Maniatopoulos raised the point of taxation and prices, indirectly but clearly related to the previous question. He stressed that the notion of "progressiveness" put forward by one of the panels was interesting. Along with the notion of gentle change, it constitutes a "political choice which must be made". The question is to know how evolution will be mastered, for growth is both inevitable and desirable.

Mr. Maniatopoulos then gave several responses to the work of the different panels. "We need an European energy policy", he declared. "This is vital for our economies and for our standard of living, even if it is something which will be difficult to achieve. I hope that we will have the courage, as in the United States, to speak openly of energy". All kinds of energy have a role to play in the future, he emphasised. It is unrealistic to think that we do not need coal, but we must think in terms of "clean coal", as we have done for nuclear energy.

Gas is an energy of the future, Mr. Maniatopoulos then declared. It is a pity however that there is reticence to change structures and that the internal market in energy is seen as posing a threat to current energy structures. Industry must jump at the opportunity offered by gas.

As for renewables, they will, unfortunately, continue to play a limited role in the foreseeable future. Information for the general public is essential. Good effective decisions cannot be taken without democratic control. The closed attitude of the European energy industry in recent decades has not facilitated the creation of a European policy, according to Mr. Maniatopoulos. Clear and lasting signals must be given to the market and to industry.

Touching upon the topic of energy demand security, Mr. Maniatopoulos stated that this concept was "interesting", but emphasised that he disagreed with this point. The concept would be a "barrier to progress". "There is no evolution without risks", he stated. Why should the producer not also take risks? Moreover, market confidence reigns for as long as there is evolution or progress. The notion is consequently "meaningless". it is interesting to note that European industry has also called for such demand security for its services, and consequently its market and monopoly. "I find this bad, it is a sign of rigidity", commented Mr. Maniatopoulos, adding that it would be a form of "protectionism". While recognising that the creation of a European energy policy would be an uphill task, he concluded that the messages received from the work of the conference would indicate priority elements for this policy.

Energy for a new century:

The European Perspective

Major Themes in Energy Revisited

Technical Annex

a report prepared by
the Directorate-General for Energy
Commission of the European Communities

Contents

1. INTRODUCTION

Any energy forecast is necessarily based on quantitative analysis. The document "Major Themes in Energy Revisited" presents the summary of the whole analysis. This annex contains the main assumptions and results for each scenarios.

The methodological aspects including tools and models are summarized in chapter 2 while chapter 3 shows the characterization of the scenarios: Demography, economy, energy prices.

The global context is in chapter 4 where a summary of World-wide assumptions and results (energy, atmospheric pollutants) is shown for the main OECD countries as well as Eastern European countries and South Mediterranean basin.

Chapter 5 contains summary results for each Community Member State with a special focus by form of energy. It also contains a summary of the main effects on energy demand of higher energy prices to consumers (scenario 4).
Chapter 6 shows a sensitivity analysis on the fuel mix for electricity generation in scenario 3

Detailed results by Member State are available in working documents 1, 2 and 3.

2. METHODOLOGY

The identification of the major issues facing the energy sector in the future was done with the help of national energy balance forecast.

The four scenarios were developed on the basis of demographic, economic, social and technological assumptions. In all cases, demand-side forecast dominated our analysis. No supply constraints were considered. We can therefore say that the study is mainly a "bottom-up" approach.

The "Conventional Wisdom" scenario was first developed by a detailed analysis using the MEDE and EFOM models. The results were then discussed with the different Member States and modified accordingly so as to incorporate many comments and suggestions.

The other three scenarios were developed with a more flexible approach. In these cases , and because energy demand is the focal point, MEDEE was always used but supply was mainly obtained by the MSSSE spreadsheet model.

In the case of scenario 4, because of the need to identify the impact of higher energy prices to all users, price elasticities derived from MIDAS model were used.

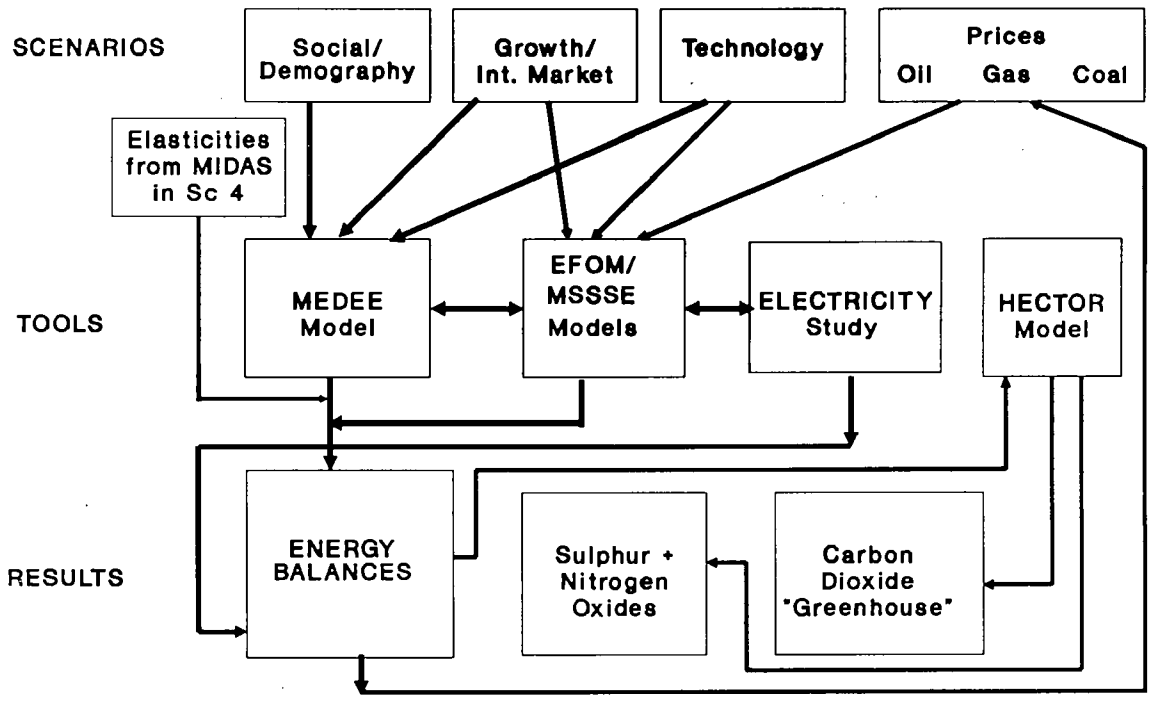
In all scenarios particular attention was paid to the electricity sector and its investment needs.

The energy balances associated with each scenario were then inputted to the HECTOR model to calculate air polluting emissions (SO2, NOX and CO2).

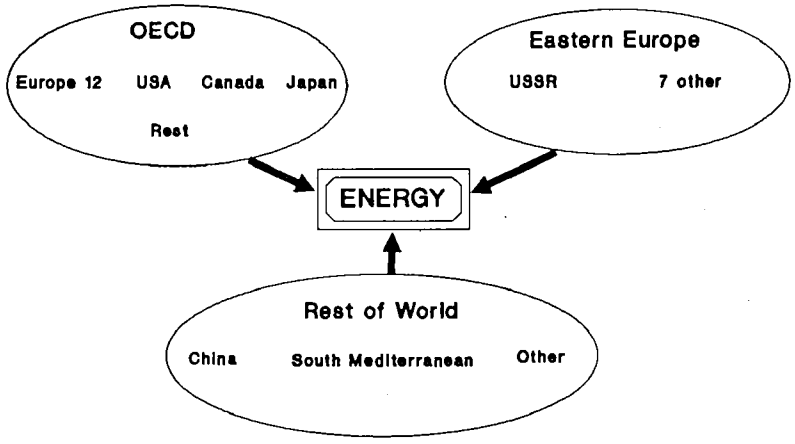
Certain feedback analysis were also done. This is the case, for example, of oil and coal demand forecasts and their impact on international prices.

The "Conventional Wisdom" scenario was also analysed in a world-wide perspective. Special focus has been put on energy-related issues concerning Eastern European countries as well as OECD Member countries.

Work scheme for EUROPE 12



World-wide approach



3. SCENARIO DEFINITION

Scenario 1 - «Conventional Wisdom»

This scenario is based on steady if unspectacular economic growth, with the gradual development of existing policies and ways of thinking about issues. Technology will continue to improve and the effects on end use and on production could be important resulting in improved efficiencies. The distinguishing feature is the lack of special concern with energy policy; with market forces driving the system within existing frameworks.

Definition:

1. International situation

- **Energy prices (1987 US dollars):**
  Oil USD 17.5/bbl in 1995; USD 20/bbl in 2000 and USD 30/bbl in 2010;
  Gas indexed to oil up to 2000 and to coal thereafter;
  Coal USD 49/tce in 1995; USD 50/tce in 2000 and USD 60/tce in 2010.

- **Economic outlook, GDP:**
  World at 3.2% average annual growth from 1990 to 2010;
  CPEs at 2.7% average annual growth from 1990 to 2010;
  LDCs at 4.0% average annual growth from 1990 to 2010;
  OECD at 2.8% average annual growth from 1990 to 2010.

2. European Community

- **Internal market**: Moderate, but positive macroeconomic effect. The economic outlook up to 1993 is similar to that indicated in the report "Europe in 1993" prepared by BIPE et al (2.6 % annual GDP growth rate).

- **GDP**: 2.7% average annual growth from 1990 to 2010 (that for 1968-88 averaged 2.8 %).

- **Sectors**:
  Industry some industrial growth; stability of energy-intensive branches;
  Tertiary strong growth of services;
  Domestic 2.5% growth in private consumption from 1990 to 2010.

3. Energy-related aspects

- **Resources**: Assumes that over the next 20 years there are no physical resource limitations.

- **Technology**: Further penetration of new (although existing) industrial processes (e.g. electric furnace, continuous casting); penetration of more efficient industrial equipment (10% improvement); efficiency of domestic thermal uses improving by 10%; renewal of equipment at end of normal life time; penetration of electric appliances at a faster rate thus improving efficiency.

- **Behaviour**: Industrial energy demand following economic climate; wealthier people facing relatively low prices leading to reversible behaviour (e.g. car mileage; higher space heating) up to 1995 and more rational behaviour thereafter.

4. Policy aspects

- **Energy internal market**: Following most of current views in Member States and uncertainties about final decisions of the Council, there is no explicit assumption of a complete internal market in energy, such as in the fields of tax harmonisation and electricity and gas trade; some convergence of both pre-tax fuel and investment costs between Member States is anticipated.

- **Environment**: Application of Community legislation; this is not expected to significantly constrain the energy demand and supply system (balance and fuel mix).

- **Energy**: No special concern on energy, allowing market forces to drive the whole system within the existing policy framework.

Scenario 2 - «Driving Into Tensions»

Objective :

To demonstrate that high economic growth without appropriate policy measures and only based on market mechanisms will drive the system into a situation where supply capacities are under pressure (supply gaps and price shocks) and polluting emissions will attain high levels.

Definition :

1. International situation

- **Energy prices (1987 US dollars):**
  Oil USD 20/bbl in 1995; USD 26.5/bbl in 2000 and USD 40/bbl in 2010.
  Gas slight decoupling with oil up to 2000 and indexed to coal thereafter.
  Coal USD 55/tce in 1995; USD 65/tce in 2000 and USD 70/tce in 2010.

- **Economic outlook, GDP:**
  World at 4.0% average annual growth from 1990 to 2000 and 2.8 % from 2000 to 2010;
  CPEs at 3.0% average annual growth from 1990 to 2000 and 2.5 % from 2000 to 2010;
  LDCs at 4.5% average annual growth from 1990 to 2000 and 3.5 % from 2000 to 2010;
  OECD at 3.5% average annual growth from 1990 to 2000 and 2.6 % from 2000 to 2010.

2. European Community

- **Internal market**: Important macroeconomic effect leading to about 1 % higher GDP growth rate than in Scenario 1. However, this increase in the growth rate is not only the result of a successful internal market but also of a better international situation. On the other hand, due to high energy prices (driven by higher energy demand levels) the economic situation deteriorates after 2000 with a fall of economic growth to a rate slightly below of that of Scenario 1.
- **GDP** : 3.5% average annual growth from 1990 to 2000, and 2.5 % from 2000 to 2010.
- **Sectors:**
  Industry relaunch of energy-intensive industries (chemicals, steel, non-metalic) up to 2000 and stability after; rest of industries (specially equipment goods) with more growth;
  Tertiary similar growth rates as for industry;
  Domestic 3.0% average annual growth until 2000, 2% from 2000 to 2010.

3. Energy-related aspects

- **Technology**: Same as in Scenario 1 but faster penetration due to more new capacity requirements; more opportunities for innovation and new products.
- **Behaviour**: From 1990 to 2000 "no concern" approach leading to a partial loss of theoretical gains brought by technology, after 2000 as in Scenario 1 due to prices. No energy management especially in transport up to 2000.

4. Policy aspects

- **Energy internal market**: Given the global philosophy of the scenario (important economic impact), a more integrated energy market is assumed :
  - fiscal harmonisation (details yet to be defined);
  - full convergence of pre-tax fuel prices;
  - liberalisation of electricity and gas trade which results in a rationalisation of the respective supply systems;
  - convergence of investment costs as result of public procurement directive and free capital movements and access.
- **Environment**: Application of Community legislation; this could lead to a serious constraint on the energy demand and supply system (balance and fuel mix) given the system's very high levels of emissions.
- **Energy**: No special concern on energy, allowing market forces to drive the whole system within the existing policy framework (return to high prices will tend to slow down demand).

Scenario 3 - «Sustaining High Economic Growth»

Objective :

To demonstrate that sustained high economic growth is not in conflict with strict environmental standards and that both objectives can be achieved within a secure energy future through mastering both energy consumption (more efficiency via technological innovation and improved consumer behaviour, such as through traffic management) and more efficient means of production.

Definition :

1. International situation

- **Energy prices (1987 US dollars):**
  Oil USD 20/bbl in 1995; USD 25 in 2000; USD 20/bbl in 2010;
  Gas same as Scenario 2 but more decoupling;
  Coal USD 50/tce in1995; USD 60/tce in 2000 and USD 50/tce in 2010.
- **Economic outlook, GDP:**
  World at 4.0% average annual growth from 1990 to 2000 and 3.5% from 2000 to 2010;
  CPEs at 3.0% average annual growth from 1990 to 2000 and 2.7% from 2000 to 2010;
  LDCs at 4.5% average annual growth from 1990 to 2000 and 4.0% from 2000 to 2010;
  OECD at 3.5% average annual growth from 1990 to 2000 and 3.0% from 2000 to 2010.

2. European Community

- **Internal market**: Important macroeconomic effect leading to about 1 % higher GDP growth rate than in Scenario 1. However, this increase in the growth rate is not only the result of a successful internal market but also of a better international situation. Because a 3.5 % per year GDP growth rate could lead to some tensions there is a slight slow down after 2000 to 3 % per year.
- **GDP** : 3.5% average annual growth from 1990 to 2000 and 3.0% from 2000 to 2010.
- **Sectors:**
  Industry same as Scenario 2 until 1995; between 1995 and 2010 decline of energy-intensive branches and sustained growth of others (mainly equipment goods and specialised chemicals);
  Tertiary same as Scenario 2 until 1995; between 1995 and 2010 tertiary continues to grow (compensating the slow down in industry);
  Domestic 3.0% average annual growth until 2000; 2.5% from 2000 to 2010.

3. Energy-related aspects

- **Technology**: Until 1992 as in Scenario 2; due to policy decisions taken as of 1992, strong innovation in equipment and high capital turn-over leading to more economic and energy efficiency.
- **Behaviour**: Until 1992 as in Scenario 2; due to policy decisions taken as of 1992 as well as new available technologies (more efficient equipment) and better infrastructures (more and better roads and traffic management), consumer behaviour will tend towards more rational behaviour nothwithstanding higher incomes.

4. Policy aspects

- **Energy internal market**: Given the global philosophy of the scenario (important economic impact), a more integrated energy market is assumed :
  - fiscal harmonisation (details yet to be defined);
  - full convergence of pre-tax fuel prices;
  - liberalisation of electricity and gas trade which results in a rationalisation of the respective supply systems;
  - convergence of investment costs as result of public procurement directive and free capital movements and access.

  In addition, there is full implementation of a common energy policy which sustains high economic growth.
- **Environment**: Application of Community legislation until 1992; due to policy decisions taken as of 1992 much stricter environmental standards will be implemented thus restraining the possibilities for a merely market-oriented expansion of the energy demand and supply system (balance and fuel mix).
- **Energy**: After 1992 special focus on energy policy with emphasis on:
  - stricter environmental regulations;
  - stricter and mandatory technological gains as well as encouragement of rational use;
  - diversification of fuels avoiding oil but more use of gas, relaunch of nuclear after 2000, new technologies on end use and production.

Scenario 4 - «High Prices»

Objective:

To demonstrate the effect of a moderate economic growth (as in scenario 1) combined with stricter environmental objectives, particularly CO2 emissions, and through mastering both energy consumption (demand management of scenario 3 type plus CO2 taxes on fossil fuels) and more efficient means of production (as in Scenario 3).

Definition:

1.International situation

▪**Energy prices (1987 US dollars):**
Oil US$17.5/bbl in 1995, US$20/bbl in 2000 and US$30/bbl in 2010;
Gas indexed to oil up to 2000 and to coal thereafter;
Coal US$49/tce in 1995; US$50/tce in 2000 and US$60/tce in 2010.

▪**Economic outlook, GDP:**
World at 3.2% average annual growth from 1990 to 2010;
CPEs at 2.7% average annual growth from 1990 to 2010;
LDCs at 4.0% average annual growth from 1990 to 2010;
OECD at 2.8% average annual growth from 1990 to 2010.

2.European Community

▪**Internal market:** Moderate but positive macroeconomic effect; the economic outlook is the same as in Scenario 1.

▪**GDP:** 2.7% average annual growth from 1990 to 2010.

▪**Sectors:**
Industry Slowdown of the activity due to higher energy prices.
Tertiary Compensating growth until 1995, afterwards same as scenario 1.

3.Energy-related aspects

▪**Resources:** As in Scenario1.

▪**Technology:** Until 1992 as in Scenario 1;due to policy decisions taken as of 1992,strong innovation in equipment and high capital turn-over (as in Scenario 3) leading to more economic and energy efficiency.

▪**Behaviour:** As in Scenario 3 but reinforced via higher fuel price due to special taxes (see below under environment).

4.Policy aspects

▪**Energy internal market:** As in Scenario 1.

▪**Environment:** As in Scenario 3 plus a carbon tax imposed on all fossil fuels.

▪**Energy:** As in Scenario 3 but with nuclear capacity estimated at 115 GW by 2010 (105 GW in 1990).

3.1 International Assumptions

Table 3.1.1 Macroeconomic Outlook

Annual GDP growth rate

%/year

Scenarios	80 to 87	87 to 90	1990 to 2000			2000 to 2010		
			1=4	2	3	1=4	2	3
Europe 12	1.8	3.4	2.7	3.5	3.5	2.7	2.5	3.0
OECD	2.4	3.5	2.8	3.5	3.5	2.8	2.6	3.0
USSR and other Eastern European Countries	1.8	0.5	1.7			2.6		
LDCs	3.0	4.1	4.0	4.5	4.5	4.0	3.5	4.0
World	2.7	3.1	2.9			3.0		

Source: IMF, OECD, SOEC, DGII and DGXVII A2 estimates.

Table 3.1.2 Fuel Prices (1) ($87)

Crude oil

Unit	$/bbl	$/bbl	$/bbl			$/toe		
Scenarios	1985	1990	1995	2000	2010	1995	2000	2010
Scenario 1 and 4	29.2	15.5	17.5	20.0	30.0	126.9	145.0	217.5
Scenario 2			20.0	26.5	40.0	145.0	192.1	290.0
Scenario 3				25.0	20.0		181.2	145.0

Steam coal

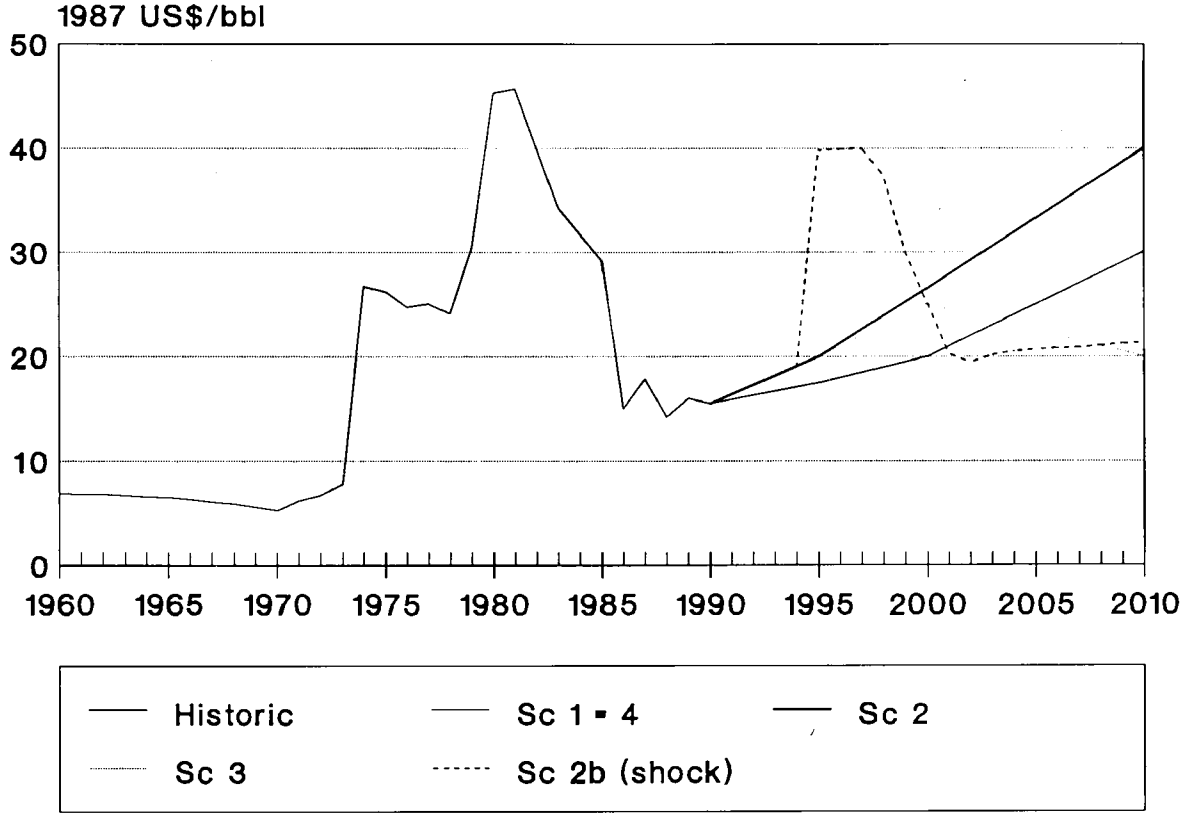
Unit	$/tce	$/tce	$/tce			$/toe		
Scenarios	1985	1990	1995	2000	2010	1995	2000	2010
Scenario 1 and 4	48.8	44.6	49.0	50.0	60.0	70.0	71.4	85.7
Scenario 2			55.0	65.0	70.0	78.6	92.9	100.0
Scenario 3			50.0	60.0	50.0	71.4	85.7	71.4

Natural Gas Prices

Unit	$/MBTU	$/MBTU	$/MBTU			$/toe		
Scenarios	1985	1990	1995	2000	2010	1995	2000	2010
Scenario 1 and 4	4.1	2.0	2.5	2.8	3.5	100.2	109.8	139.8
Scenario 2			2.7	4.0	4.1	106.4	156.9	162.9
Scenario 3			2.6	3.2	2.8	104.7	126.6	110.0

(1) Weighted CIF average for Europe 12
Source: SOEC data, DGXVII A2 estimates

OIL PRICES


1987 US$/bbl
50
40
30
20
10
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Historic
Sc 1 - 4
Sc 2
Sc 3
Sc 2b (shock)

3.2 Demographic Assumptions

Table 3.2.1 **A relatively stable population**
(all scenarios)

million inhabitants	1980	1985	1987	1990	1995	2000	2005	2010	1987-2010 per year
Belgium	9.85	9.86	9.87	9.73	9.78	9.62	9.49	9.37	-0.2%
Denmark	5.12	5.11	5.13	5.14	5.16	5.16	5.11	5.06	-0.1%
France	53.88	55.17	55.63	56.10	57.10	57.90	58.35	58.80	0.2%
Germany	61.57	61.02	61.20	62.00	61.55	61.05	59.68	58.30	-0.2%
Greece	9.64	9.93	9.99	10.08	10.11	10.35	10.50	10.65	0.3%
Ireland	3.40	3.58	3.54	3.54	3.60	3.67	3.71	3.75	0.3%
Italy	56.43	57.14	57.34	57.33	57.76	57.96	58.13	58.30	0.1%
Luxembourg	0.36	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.0%
Netherlands	14.15	14.49	14.67	14.93	15.28	15.70	15.90	16.10	0.4%
Portugal	9.77	10.16	10.25	10.34	10.45	10.57	10.90	11.22	0.4%
Spain	37.39	38.60	38.88	39.30	40.10	40.50	40.85	41.20	0.3%
United kingdom	56.31	56.35	56.93	56.90	57.40	57.90	58.05	58.20	0.1%
Europe 12	317.87	321.78	323.80	325.76	328.66	330.75	331.04	331.32	0.1%

Table 3.2.2 **Household size declines**
(all scenarios)

persons per household	1980	1985	1987	1990	1995	2000	2005	2010	1987-2010 per year
Belgium	2.9	2.8	2.8	2.7	2.6	2.5	2.5	2.4	-0.6%
Denmark	2.4	2.4	2.3	2.3	2.3	2.2	2.2	2.2	-0.3%
France	2.8	2.7	2.7	2.6	2.5	2.5	2.4	2.4	-0.5%
Germany	2.5	2.3	2.3	2.3	2.2	2.2	2.2	2.2	-0.2%
Greece	3.3	3.2	3.1	3.0	2.9	2.8	2.7	2.7	-0.6%
Ireland	3.9	3.8	3.7	3.5	3.5	3.4	3.3	3.2	-0.7%
Italy	3.1	3.0	2.9	2.8	2.6	2.5	2.5	2.5	-0.7%
Luxembourg	3.0	2.8	2.8	2.6	2.6	2.5	2.4	2.5	-0.5%
Netherlands	2.7	2.6	2.6	2.6	2.5	2.5	2.4	2.4	-0.4%
Portugal	3.3	3.2	3.2	3.1	3.0	2.9	2.8	2.8	-0.7%
Spain	3.7	3.4	3.4	3.4	3.3	3.1	2.9	2.8	-0.8%
United kingdom	2.8	2.6	2.6	2.6	2.5	2.5	2.4	2.4	-0.5%
Europe 12	2.9	2.7	2.7	2.6	2.6	2.5	2.5	2.4	-0.5%

Source : SOEC Demographic statistics, DG XVII A2 estimates.

3.3 Economic Assumptions

Table 3.3.1 **GDP by Member State : Conventional Wisdom**
(idem for scenario 4)

billion ECU	1987 current prices and exchange rates	% per year in volume 1987-1990	1990-1995	1995-2000	2000-2010	1987-2010
Belgium	120.4	3.7%	2.8%	2.8%	2.8%	2.9%
Denmark	87.9	1.4%	2.3%	2.8%	2.8%	2.5%
France	764.1	3.3%	2.6%	2.5%	2.6%	2.7%
Germany	969.5	3.7%	2.7%	2.8%	2.8%	2.9%
Greece	41.1	3.0%	2.5%	3.0%	3.0%	2.9%
Ireland	25.5	4.5%	3.0%	2.9%	2.7%	3.0%
Italy	659.2	3.5%	2.9%	2.6%	2.5%	2.7%
Luxembourg	5.2	4.3%	2.8%	3.0%	2.8%	3.0%
Netherlands	184.9	3.2%	2.2%	2.7%	2.8%	2.7%
Portugal	31.9	4.4%	4.4%	4.4%	4.2%	4.3%
Spain	251.3	4.6%	3.4%	3.2%	3.1%	3.4%
United kingdom	580.1	2.8%	2.6%	2.4%	2.4%	2.5%
Europe 12	3721.1	3.4%	2.7%	2.7%	2.7%	2.8%

Table 3.3.2 **The others scenarios:** Faster Growth scenarios 2 and 3.
Slowdown after 2000 in scenario 2 - Sustainable in scenario 3

GDP volume	% per year	1990-1995	1995-2000	2000-2010	1987-2010
Belgium	sc . 2	3.2%	3.4%	2.5%	3.0%
	sc . 3	-	-	2.9%	3.2%
Denmark	sc . 2	3.0%	3.2%	2.5%	2.6%
	sc . 3	-	-	2.7%	2.7%
France	sc . 2	3.1%	3.5%	2.5%	2.9%
	sc . 3	-	-	2.9%	3.1%
Germany	sc . 2	3.4%	3.5%	2.5%	3.1%
	sc . 3	-	-	2.8%	3.2%
Greece	sc . 2	4.2%	4.9%	2.8%	3.6%
	sc . 3	-	-	3.5%	3.9%
Ireland	sc . 2	5.8%	4.9%	2.9%	4.2%
	sc . 3	-	-	3.8%	4.6%
Italy	sc . 2	3.5%	3.5%	2.5%	3.1%
	sc . 3	-	-	2.9%	3.2%
Luxembourg	sc . 2	3.1%	3.5%	2.5%	3.1%
	sc . 3	-	-	2.9%	3.3%
Netherlands	sc . 2	3.1%	3.0%	2.5%	2.8%
	sc . 3	-	-	2.9%	3.0%
Portugal	sc . 2	6.2%	6.1%	3.5%	4.8%
	sc . 3	-	-	4.1%	5.0%
Spain	sc . 2	6.9%	5.1%	3.0%	4.5%
	sc . 3	-	-	4.0%	4.9%
United kingdom	sc . 2	3.2%	3.5%	2.5%	2.9%
	sc . 3	-	-	2.8%	3.0%
Europe 12	sc . 2	3.6%	3.6%	2.6%	3.1%
	sc . 3	-	-	3.0%	3.3%

Sources : SOEC National Accounts, Economic forecasts 1990 DG II, DG XVII estimates

3.4 Industrial Sector Assumptions

Table 3.4.1 Value added in the industrial sector : The Conventional Wisdom.

billion ECU	1985 current prices an exchange rates	% per year in volume 1985-1990	1990-1995	1995-2000	2000-2010	1985-2010
Belgium	21.6	1.9%	2.1%	2.1%	2.1%	2.1%
Denmark	12.7	1.5%	2.7%	2.8%	3.2%	2.7%
France	142.8	2.3%	2.0%	2.0%	2.0%	2.1%
Germany	240.4	2.3%	2.2%	2.2%	2.1%	2.2%
Greece	7.3	1.8%	2.3%	3.2%	3.1%	2.7%
Ireland	6.9	3.7%	4.0%	3.2%	3.0%	3.4%
Italy	132.1	2.9%	2.3%	2.1%	2.0%	2.3%
Luxembourg	1.4	3.6%	2.8%	2.8%	1.8%	2.6%
Netherlands	27.8	1.9%	2.1%	2.9%	3.3%	2.7%
Portugal	8.1	3.6%	3.7%	3.7%	3.1%	3.4%
Spain	53.3	3.5%	3.5%	2.7%	2.3%	2.9%
United kingdo	135.8	2.2%	2.0%	1.9%	1.6%	1.9%
Europe 12	790.2	3.4%	2.7%	2.7%	2.7%	2.8%

Table 3.4.2 The other scenarios : An industrial revival up to 1995 (except scenario 4) followed by a slowdown in activity by the end of the period.

V.A industry	% per year	Conv. wisd	Scenario 2	Scenario 3	Scenario 4
Belgium	1990-1995	2.1%	3.0%	3.0%	1.5%
	1995-2010	2.1%	2.1%	1.9%	1.8%
Denmark	1990-1995	2.7%	3.1%	3.1%	1.4%
	1995-2010	3.1%	2.2%	2.0%	2.3%
France	1990-1995	2.0%	2.8%	2.8%	1.3%
	1995-2010	2.0%	2.1%	1.9%	1.6%
Germany	1990-1995	2.2%	2.8%	2.8%	1.0%
	1995-2010	2.1%	2.0%	1.8%	1.7%
Greece	1990-1995	2.3%	4.8%	4.8%	2.1%
	1995-2010	3.1%	3.4%	3.7%	2.9%
Ireland	1990-1995	4.0%	5.9%	5.9%	2.1%
	1995-2010	3.1%	3.4%	3.9%	2.6%
Italy	1990-1995	2.3%	3.0%	3.0%	1.4%
	1995-2010	2.0%	2.1%	1.9%	1.5%
Luxembourg	1990-1995	2.8%	3.0%	3.0%	1.6%
	1995-2010	2.1%	2.3%	2.0%	1.8%
Netherlands	1990-1995	2.1%	2.8%	2.8%	0.8%
	1995-2010	3.2%	2.3%	2.0%	2.0%
Portugal	1990-1995	3.7%	6.1%	6.1%	3.2%
	1995-2010	3.3%	3.4%	3.6%	3.1%
Spain	1990-1995	3.5%	6.6%	6.6%	2.0%
	1995-2010	2.4%	3.4%	3.8%	2.8%
United kingdom	1990-1995	2.0%	3.0%	3.0%	1.4%
	1995-2010	1.7%	2.1%	2.0%	1.5%
Europe 12	1990-1995	2.7%	3.2%	3.2%	1.3%
	1995-2010	2.7%	2.2%	2.1%	1.8%

Sources : SOEC National Accounts detailed by sector, DG XVII estimates

Table 3.4.3 **Crude steel production in the Conventional Wisdom scenario.**
Smooth in global activity.
Stabilization of production in major countries (Europe 4).

million tonnes	1980	1985	1988	1990	1995	2000	2010
Belgium	12.3	10.7	11.2	11.8	12.2	12.2	12.2
Denmark	0.7	0.5	0.7	0.6	0.6	0.6	0.6
France	23.2	18.6	18.7	18.9	19.1	19.3	19.7
Germany	43.8	40.5	41.0	39.9	40.2	40.4	40.8
Greece	0.9	1.0	1.0	1.0	1.1	1.1	1.3
Ireland	0.0	0.2	0.3	0.3	0.3	0.3	0.3
Italy	26.5	23.9	23.8	24.8	24.2	23.6	23.1
Luxembourg	4.6	4.0	3.7	3.7	3.8	3.8	3.8
Netherlands	5.3	5.5	5.5	5.7	5.9	6.0	6.1
Portugal	0.6	0.7	0.8	0.8	0.9	0.9	0.9
Spain	12.6	14.2	11.6	15.4	15.7	17.0	17.9
United Kingdom	11.3	15.8	19.0	16.6	17.0	17.4	17.4
Europe 12	141.8	135.6	137.3	139.5	140.8	142.6	144.1

Table 3.4.4 **The other scenarios :** More steel products in the scenario 2.
Lower production in scenario 3 & 4 than in Conventional Wisdom.

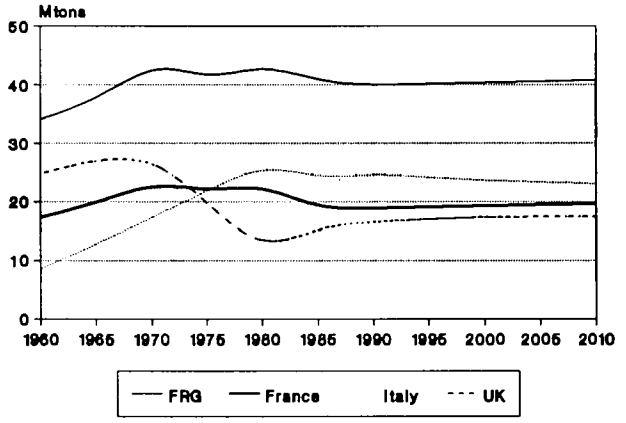
million tonnes		Scenario 2	Scenario 3	Scenario 4
Belgium	1995	12.2	-	11.0
	2010	12.3	10.9	10.9
Denmark	1995	0.6	-	0.5
	2010	0.6	0.5	0.5
France	1995	19.5	-	18.0
	2010	19.6	17.1	17.1
Germany	1995	41.5	-	37.9
	2010	40.7	35.1	35.1
Greece	1995	1.1	-	1.1
	2010	1.2	1.2	1.2
Ireland	1995	0.3	-	0.3
	2010	0.3	0.3	0.3
Italy	1995	25.0	-	22.8
	2010	24.7	21.2	21.2
Luxembourg	1995	3.9	-	3.7
	2010	3.9	3.8	3.8
Netherlands	1995	5.9	-	5.5
	2010	6.0	5.4	5.4
Portugal	1995	0.9	-	0.9
	2010	0.9	0.9	0.9
Spain	1995	16.2	-	15.0
	2010	17.5	17.4	17.4
United Kingdom	1995	17.4	-	16.1
	2010	17.5	15.6	15.6
Europe 12	1995	144.5	144.5	132.7
	2010	145.1	129.5	129.5

Sources : SOEC Iron & steel , DG XVII estimates

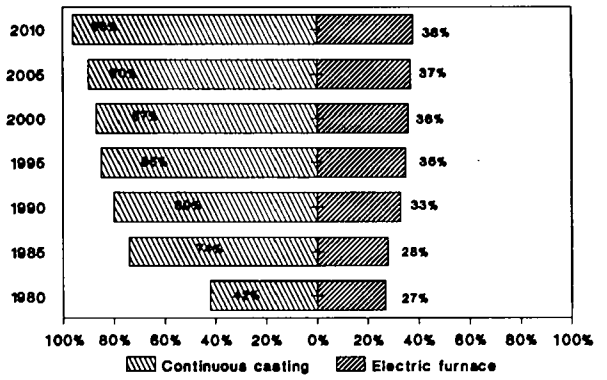
CRUDE STEEL IN EUROPE

Conventional Wisdom

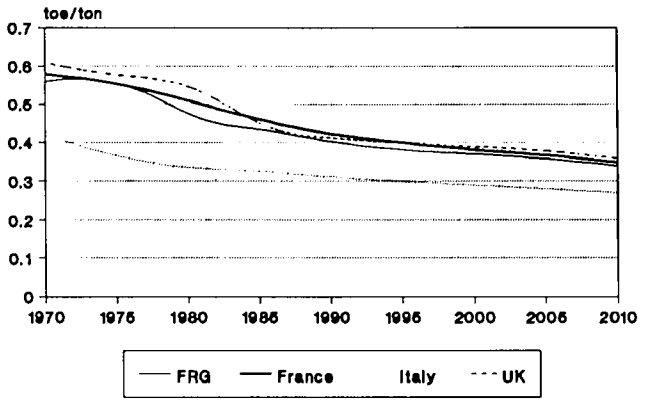
Towards flat production growth



Penetration of more efficient technics



But decreasing energy consumption overall.



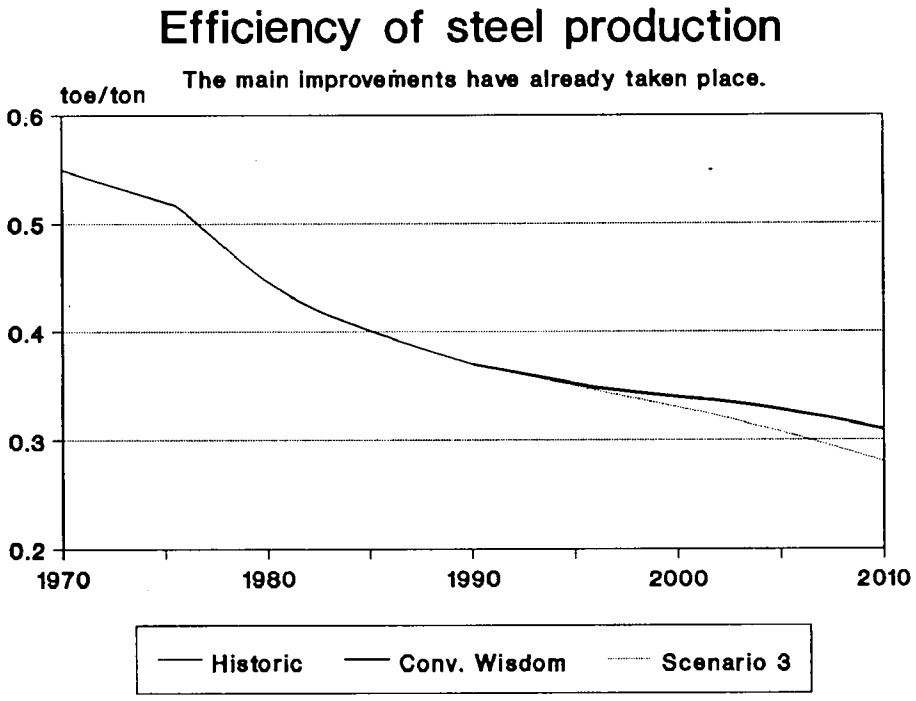


Table 3.4.5 **Specific Energy Consumption for Crude Steel Production**

(Energy Efficiency Assumptions)

The national mix of technical processes explains an important part of the ranges between the countries

toe/ton		1980	1985	1987	1990	1995	2000	2010
Belgium	sc. 1	0.43	0.40	0.40	0.39	0.38	0.37	0.36
	sc. 3	-	-	-	-	-	0.36	0.30
Denmark	sc. 1	0.27	0.25	0.25	0.24	0.23	0.23	0.22
	sc. 3	-	-	-	-	-	0.23	0.21
France	sc. 1	0.51	0.46	0.45	0.42	0.40	0.38	0.35
	sc. 3	-	-	-	-	-	0.36	0.29
Germany	sc. 1	0.45	0.44	0.43	0.40	0.38	0.37	0.34
	sc. 3	-	-	-	-	-	0.36	0.29
Greece	sc. 1	0.57	0.29	0.29	0.29	0.28	0.28	0.27
	sc. 3	-	-	-	-	-	0.28	0.26
Ireland	sc. 1		0.20	0.20	0.19	0.18	0.18	0.17
	sc. 3	-	-	-	-	-	0.18	0.17
Italy	sc. 1	0.33	0.33	0.32	0.31	0.30	0.29	0.27
	sc. 3	-	-	-	-	-	0.26	0.24
Luxembourg	sc. 1	0.44	0.36	0.36	0.36	0.35	0.35	0.33
	sc. 3	-	-	-	-	-	0.34	0.32
Netherlands	sc. 1	0.40	0.40	0.40	0.39	0.37	0.37	0.37
	sc. 3	-	-	-	-	-	0.36	0.30
Portugal	sc. 1	0.52	0.40	0.39	0.37	0.34	0.32	0.30
	sc. 3	-	-	-	-	-	0.31	0.27
Spain	sc. 1	0.32	0.32	0.31	0.30	0.28	0.26	0.24
	sc. 3	-	-	-	-	-	0.25	0.22
United Kingdom	sc. 1	0.58	0.43	0.42	0.41	0.40	0.39	0.36
	sc. 3	-	-	-	-	-	0.37	0.31
Europe 12	sc. 1	0.43	0.40	0.39	0.37	0.35	0.34	0.31
	sc. 3	-	-	-	-	-	0.33	0.28

Source : DG XVII estimates from SOEC statistics

Table 3.4.6 Cement Production in the Conventional Wisdom Scenario.
Smooth growth of activity similar to the other energy intensive dutries.

million tonnes	1980	1985	1987	1990	1995	2000	2010
Belgium	7.5	5.7	5.9	6.2	6.6	7.0	7.7
Denmark	1.9	2.1	1.8	1.7	1.8	1.9	2.1
France	29.1	22.2	23.6	23.3	23.3	23.3	23.8
Germany	33.1	29.0	29.0	30.7	32.6	33.4	35.1
Greece	12.7	13.5	12.5	15.2	16.8	18.1	20.9
Ireland	1.9	1.4	1.5	1.6	1.7	1.9	2.2
Italy	41.9	38.5	39.1	39.5	40.5	40.5	42.6
Luxembourg	0.3	0.3	0.4	0.3	0.3	0.3	0.3
Netherlands	3.7	3.0	3.1	3.3	3.4	3.5	3.5
Portugal	5.8	5.5	5.9	6.8	7.1	7.1	7.1
Spain	28.0	27.0	25.7	30.4	31.9	33.6	37.1
United kingdom	14.8	13.4	14.2	14.3	15.0	15.8	17.4
Europe 12	180.7	161.6	162.6	173.3	181.0	186.4	199.8

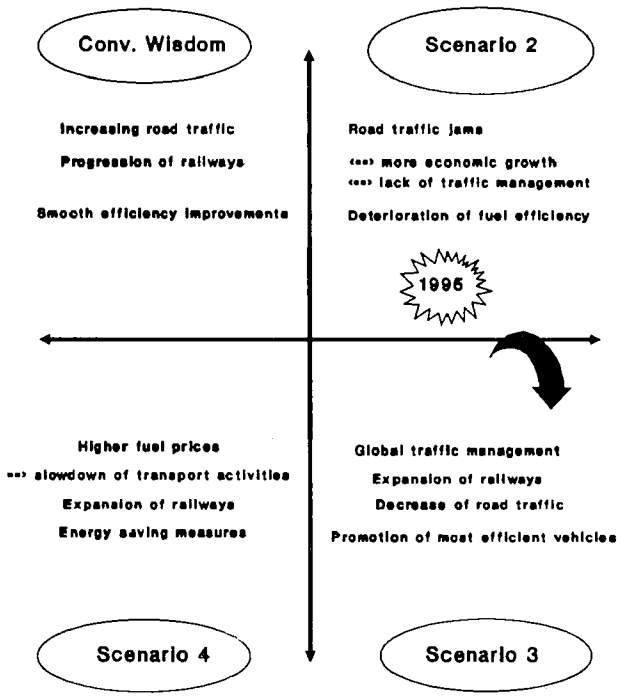
Table 3.4.7 The other scenarios : Higher production in the scenario 2.
Lower production in scenarios 3 & 4 than in the Conventional Wisdom.

miilion tonnes		Scenario 2	Scenario 3	Scenario 4
Belgium	1995	6.8	-	6.5
	2010	7.3	6.7	6.7
Denmark	1995	1.8	-	1.6
	2010	2.0	1.7	1.7
France	1995	24.5	-	22.0
	2010	25.1	20.3	20.3
Germany	1995	33.2	-	30.7
	2010	34.9	29.4	29.4
Greece	1995	17.2	-	16.7
	2010	19.0	19.8	19.8
Ireland	1995	1.8	-	1.7
	2010	2.0	2.1	1.9
Italy	1995	41.5	-	38.5
	2010	42.6	38.0	38.0
Luxembourg	1995	0.4	-	0.3
	2010	0.4	0.3	0.3
Netherlands	1995	3.5	-	3.1
	2010	3.7	3.1	3.1
Portugal	1995	7.4	-	6.9
	2010	7.8	7.2	7.2
Spain	1995	34.4	-	30.5
	2010	37.4	35.6	35.6
United Kingdom	1995	15.5	-	14.5
	2010	16.7	15.5	15.5
Europe 12	1995	188.0	188.0	173.0
	2010	198.7	179.6	179.6

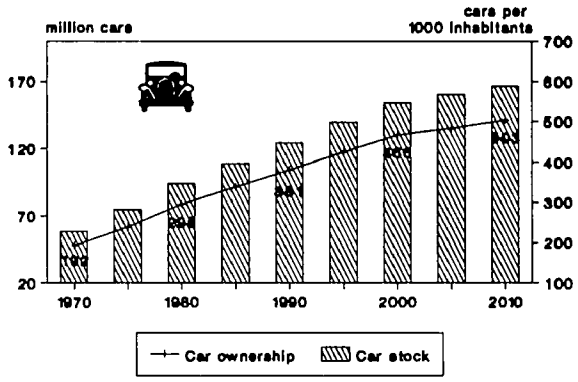
Sources : SOEC Industrial productions, DG XVII estimates

3.5 Transport Sector Assumptions

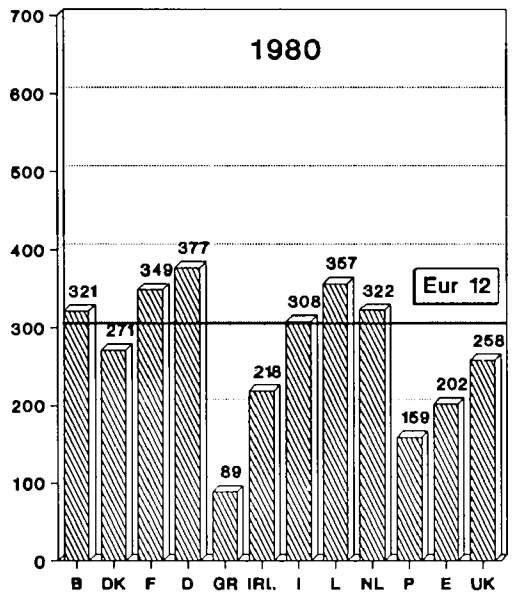
Scenarios up to 2010



Private Car



Car Ownership: Difference diminish but at higher level



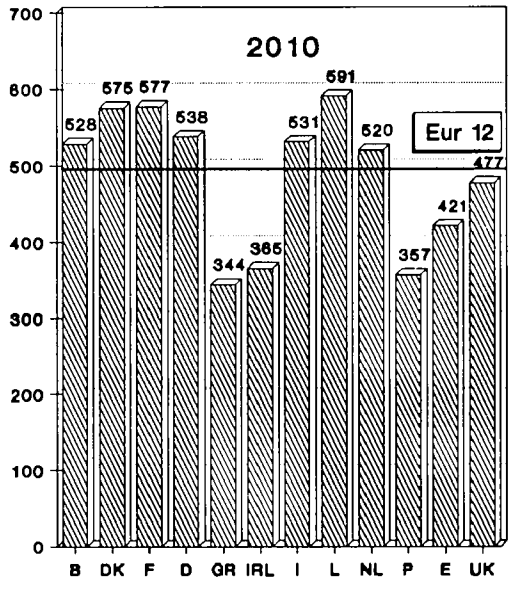


Table 3.5.1 **Trends In The Private Car Market** Conventional Wisdom

1.The stock of cars will increase rapidly up to 1995, but growth will moderate over the longer term.

million cars	1980	1985	1987	1990	1995	2000	2010
Belgium	3.2	3.3	3.5	3.8	4.2	4.7	5.0
Denmark	1.4	1.5	1.5	1.6	1.9	2.2	2.9
France	18.8	20.9	22.4	24.9	28.6	32.2	33.9
Germany	23.2	25.9	26.9	28.6	29.7	30.6	31.4
Greece	0.9	1.2	1.4	1.7	2.5	3.5	3.7
Ireland	0.7	0.8	0.8	0.8	0.9	1.0	1.4
Italy	17.4	22.4	23.0	23.9	26.5	28.8	30.9
Luxembourg	0.1	0.2	0.2	0.2	0.2	0.2	0.2
Netherlands	4.6	5.1	5.4	5.9	6.8	7.8	8.4
Portugal	1.6	1.7	1.9	2.3	3.1	3.6	4.0
Spain	7.6	9.3	10.0	11.2	12.9	15.3	17.4
United kingdom	14.5	16.7	17.7	19.4	22.2	24.3	27.7
Europe 12	93.8	108.8	114.7	124.2	139.6	154.0	166.8

2. Diesel cars will penetrate the market up to 1995 - stabilization or decrease thereafter.

% car stock	1980	1985	1987	1990	1995	2000	2010
Belgium	6.0%	12.6%	15.1%	19.9%	20.1%	17.8%	14.9%
Denmark	3.6%	4.0%	5.1%	7.5%	10.2%	10.1%	10.0%
France	4.3%	8.5%	9.9%	12.4%	15.0%	15.0%	15.0%
Germany	4.9%	9.1%	9.9%	11.3%	12.0%	12.0%	12.0%
Greece	4.7%	4.9%	5.1%	5.3%	5.2%	4.9%	4.9%
Ireland	2.7%	5.3%	5.6%	6.2%	7.8%	7.8%	8.0%
Italy	2.8%	7.8%	10.3%	15.5%	17.1%	14.0%	10.0%
Luxembourg	6.0%	12.6%	15.1%	19.9%	20.1%	17.8%	14.9%
Netherlands	3.1%	5.0%	6.0%	8.0%	8.2%	8.5%	8.9%
Portugal	5.2%	10.9%	11.0%	11.1%	9.3%	9.0%	10.0%
Spain	4.2%	6.0%	7.3%	9.9%	10.0%	10.0%	10.0%
United kingdom	0.0%	1.0%	2.0%	4.0%	6.6%	7.5%	8.0%
Europe 12	3.5%	7.0%	2.0%	11.0%	12.4%	11.8%	11.0%

3. New registrations will lead to a high turnover of the car stock

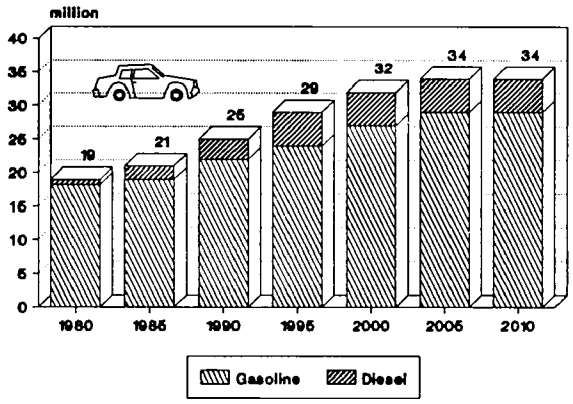
1000 per year	1980	1985	1987	1990	1995	2000	2010
Belgium	430	388	420	400	510	430	280
Denmark	74	157	124	150	200	210	255
France	1907	1766	2105	2340	3150	3275	3225
Germany	2426	2379	2900	2900	3190	3050	3135
Greece	34	105	110	145	315	355	340
Ireland	90	60	60	70	79	82	110
Italy	1640	1800	1920	2250	2960	2800	3085
Luxembourg	25	29	33	34	34	32	30
Netherlands	450	506	580	580	615	705	726
Portugal	75	115	135	195	245	240	325
Spain	574	595	927	940	1330	1400	1500
United kingdom	1570	1804	1963	1900	2450	2320	2615
Europe 12	9295	9704	11277	11904	15078	14899	15626

Source : SOEC Transport & Communications yearbook, DG XVII estimates

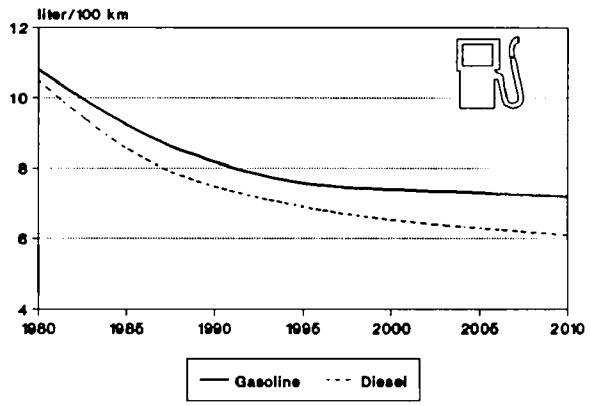
CAR MARKET INDICATORS

(French Example)

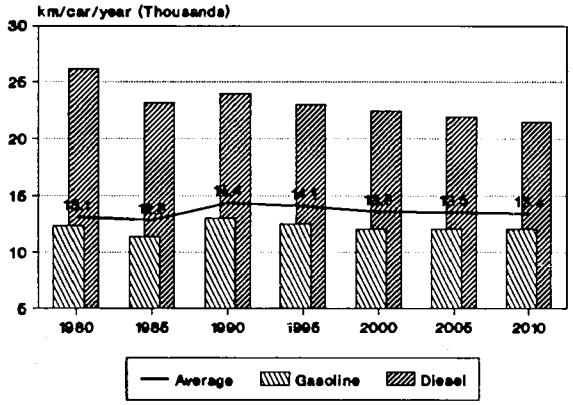
More private cars



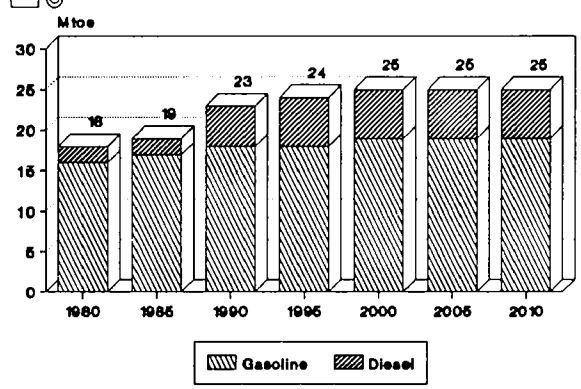
But with less specific fuel consumption



And less annual mileage by car



: Towards stabilization of total fuel consumption



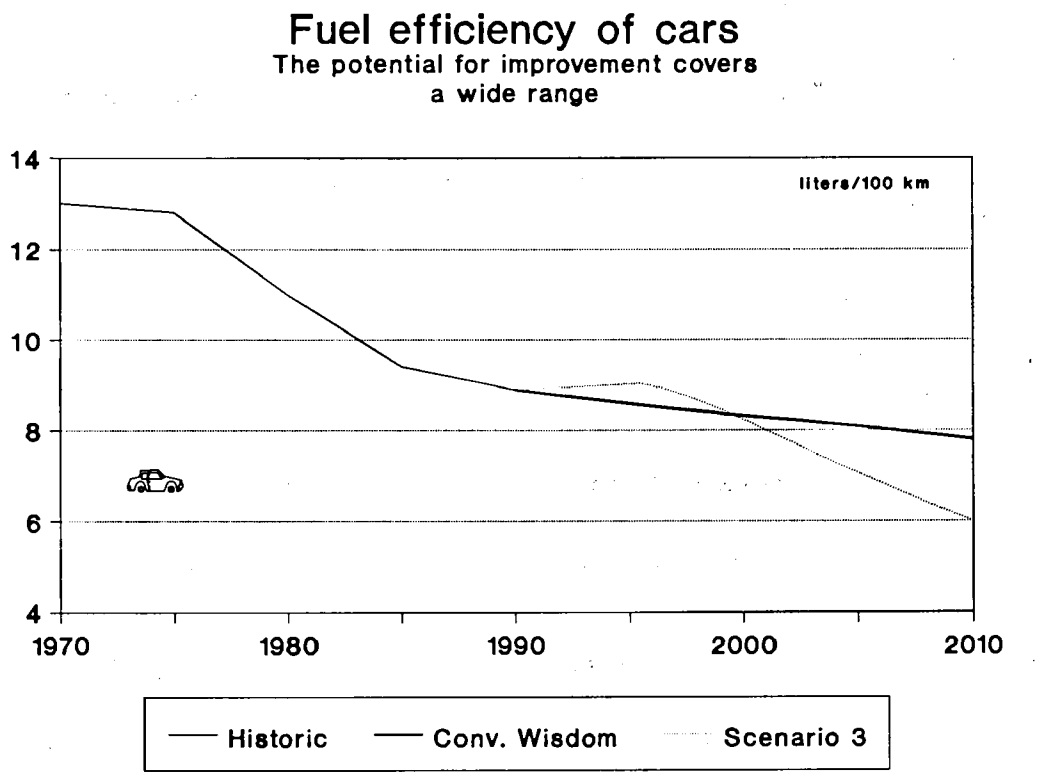


Table 3.5.2 **Specific fuel consumption of cars** (Average conventional value)

Scenario 3 presents strong improvements in fuel efficiency after a deterioration in the earlier 90's

l/100 km		1980	1985	1987	1990	1995	2000	2010
Belgium	sc. 1	12.4	9.9	9.7	8.7	8.7	8.5	8.0
	sc. 3	-	-	-	-	9.0	8.3	6.1
Denmark	sc. 1	10.7	9.4	9.4	9.0	8.7	8.3	7.6
	sc. 3	-	-	-	-	9.4	7.9	5.6
France	sc. 1	10.8	9.0	8.8	8.0	7.4	7.3	7.0
	sc. 3	-	-	-	-	8.1	7.0	5.2
Germany	sc. 1	12.1	11.2	11.1	11.0	10.6	10.0	8.9
	sc. 3	-	-	-	-	11.6	10.1	6.7
Greece	sc. 1	11.2	9.3	9.3	9.0	8.7	8.3	7.7
	sc. 3	-	-	-	-	9.5	8.1	6.6
Ireland	sc. 1	10.5	9.1	9.0	8.6	8.5	8.3	7.7
	sc. 3	-	-	-	-	9.4	8.1	5.8
Italy	sc. 1	9.5	8.4	8.4	8.1	7.7	7.6	7.0
	sc. 3	-	-	-	-	8.3	7.3	5.2
Luxembourg	sc. 1	12.4	9.9	9.6	8.7	8.7	8.5	8.0
	sc. 3	-	-	-	-	9.2	8.3	6.2
Netherlands	sc. 1	10.5	9.3	9.2	8.9	8.7	8.4	7.9
	sc. 3	-	-	-	-	9.1	8.5	6.0
Portugal	sc. 1	9.5	8.7	8.7	8.3	8.0	7.7	7.4
	sc. 3	-	-	-	-	8.7	8.0	6.3
Spain	sc. 1	10.0	8.9	8.9	8.9	8.5	8.1	7.5
	sc. 3	-	-	-	-	9.4	7.9	6.2
United Kingdom	sc. 1	12.8	10.5	10.4	10.1	9.9	9.6	9.2
	sc. 3	-	-	-	-	10.6	9.4	6.7
Europe 12	sc. 1	11.0	9.4	9.3	8.9	8.6	8.3	7.8
	sc. 3	-	-	-	-	9.3	8.2	6.0

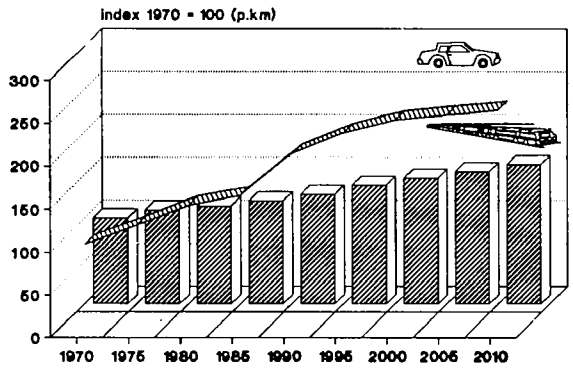
Sources : DGXVII estimates from SOEC statistics.

Road and Railways Transports

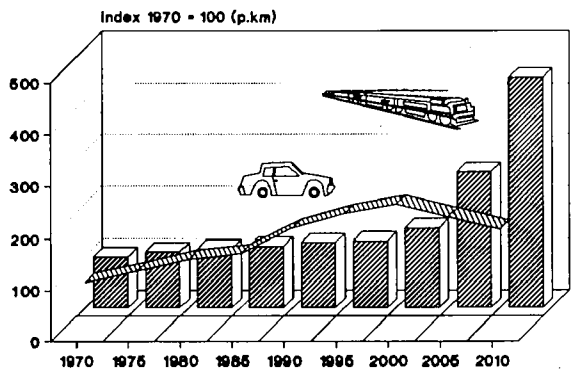
(EUROPE 12)

PASSENGERS

The Conventional Wisdom
Expansion of cars but growth of railways

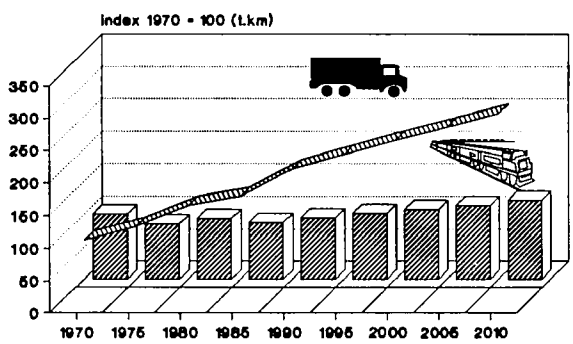


The Sustained High Growth Scenario
Expansion of railways, decline of cars



FREIGHT

The Conventional Wisdom
The hegemony of the road is becoming more pronounced...



...BUT the railways are growing

The Sustained High Growth Scenario
A new future for the railways

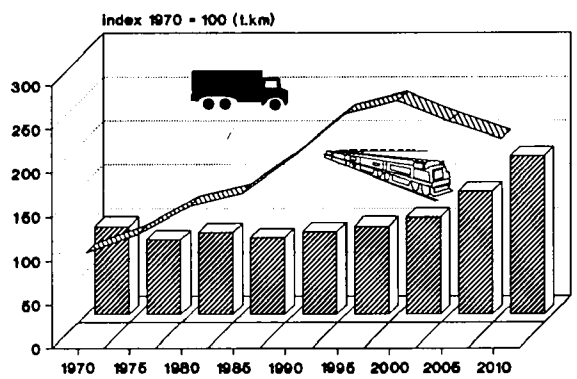


Table 3.5.3 **Passengers Traffic :** Main modal splits.

1.Traffic associated with private cars will grow significantly in the Conventional Wisdom scenario. Restriction in the use of private cars is expected in scenario 3.

billion p-km		1980	1985	1987	1990	1995	2000	2010
Belgium	sc. 1	61.5	80.0	85.7	104.0	117.6	119.8	124.6
	sc. 3	-	-	-	-	118.3	124.9	91.0
Denmark	sc. 1	36.5	41.7	44.0	47.7	56.2	64.7	79.5
	sc. 3	-	-	-	-	55.9	63.8	53.4
France	sc. 1	452.5	494.4	549.9	645.1	725.3	786.6	819.9
	sc. 3	-	-	-	-	737.9	804.5	600.9
Germany	sc. 1	535.0	563.8	610.2	687.1	699.1	690.8	683.5
	sc. 3	-	-	-	-	710.1	710.1	525.6
Greece	sc. 1	17.3	27.5	33.1	43.6	63.2	82.2	83.2
	sc. 3	-	-	-	-	63.5	80.0	73.5
Ireland	sc. 1	22.5	25.4	27.1	29.9	31.9	35.4	46.1
	sc. 3	-	-	-	-	33.6	40.2	43.9
Italy	sc. 1	280.0	326.2	373.0	456.0	513.0	531.3	540.0
	sc. 3	-	-	-	-	518.6	544.6	419.9
Luxembourg	sc. 1	3.0	4.4	4.7	5.7	6.4	6.5	6.7
	sc. 3	-	-	-	-	6.5	6.8	4.9
Netherlands	sc. 1	113.7	135.5	145.4	161.5	177.9	186.3	185.0
	sc. 3	-	-	-	-	180.7	191.6	157.1
Portugal	sc. 1	21.6	33.0	39.1	50.5	66.9	72.5	77.7
	sc. 3	-	-	-	-	67.8	73.0	70.3
Spain	sc. 1	119.3	162.0	183.1	220.0	276.6	334.2	380.7
	sc. 3	-	-	-	-	282.8	347.8	346.5
United Kingdom	sc. 1	355.0	410.0	465.0	570.8	646.4	687.4	739.2
	sc. 3	-	-	-	-	648.2	710.2	582.1
Europe 12	sc. 1	2017.9	2303.9	2560.2	3021.9	3380.5	3597.7	3766.1
	sc. 3	-	-	-	-	3423.9	3697.5	2969.1

2. Railway traffic : An important expansion in the scenario 3 after 2000.

billion p-km		1980	1985	1987	1990	1995	2000	2010
Belgium	sc. 1	8.6	8.1	8.1	8.1	8.3	8.6	9.3
	sc. 3	-	-	-	-	7.5	9.0	27.0
Denmark	sc. 1	4.3	4.6	4.6	4.7	4.9	5.2	5.5
	sc. 3	-	-	-	-	4.8	5.5	17.7
France	sc. 1	54.7	62.0	63.9	67.0	73.1	79.2	90.8
	sc. 3	-	-	-	-	70.0	87.4	237.8
Germany	sc. 1	40.5	42.7	41.9	40.7	42.4	43.2	44.1
	sc. 3	-	-	-	-	40.0	45.0	161.9
Greece	sc. 1	1.5	1.8	1.8	2.0	2.5	3.1	3.7
	sc. 3	-	-	-	-	2.5	4.0	6.1
Ireland	sc. 1	1.1	1.1	1.2	1.3	1.5	1.5	1.7
	sc. 3	-	-	-	-	1.5	1.6	4.4
Italy	sc. 1	46.3	43.7	46.4	50.8	55.8	60.7	71.8
	sc. 3	-	-	-	-	52.2	61.1	153.0
Luxembourg	sc. 1	0.3	0.3	0.3	0.3	0.3	0.3	0.3
	sc. 3	-	-	-	-	0.3	0.3	0.3
Netherlands	sc. 1	8.9	9.0	9.2	9.5	10.3	11.1	12.2
	sc. 3	-	-	-	-	9.3	11.5	29.2
Portugal	sc. 1	6.1	5.7	5.8	5.9	6.1	6.4	7.5
	sc. 3	-	-	-	-	6.0	7.1	15.3
Spain	sc. 1	14.8	17.0	17.1	17.2	18.1	18.6	19.5
	sc. 3	-	-	-	-	18.0	20.0	58.4
United Kingdom	sc. 1	37.1	36.4	37.8	40.0	43.0	45.2	48.9
	sc. 3	-	-	-	-	40.0	46.0	148.3
Europe 12	sc. 1	224.2	232.3	238.1	247.5	266.3	283.1	315.2
	sc. 3	-	-	-	-	252.1	298.6	859.4

Sources : SOEC transport & Communications yearbook, DG XVII estimates

Table 3.5.4 **Freight Transport :** Main modal splits.

1. The hegemony of the road is becoming more marked within the Conventional Wisdom, but the market is declining after 2000 in scenario 3.

billion tons-km		1980	1985	1987	1990	1995	2000	2010
Belgium	sc. 1	10.4	14.0	16.0	18.8	20.5	22.0	23.9
	sc. 3	-	-	-	-	22.7	23.4	17.9
Denmark	sc. 1	6.1	8.8	10.0	12.6	13.5	14.5	19.0
	sc. 3	-	-	-	-	14.9	15.3	12.3
France	sc. 1	103.9	89.1	95.8	106.8	112.1	117.9	130.4
	sc. 3	-	-	-	-	126.3	125.4	97.8
Germany	sc. 1	124.4	132.3	136.2	142.3	160.0	171.5	180.6
	sc. 3	-	-	-	-	175.7	176.1	121.8
Greece	sc. 1	7.2	8.8	9.5	10.7	13.4	17.3	27.9
	sc. 3	-	-	-	-	14.9	18.8	25.7
Ireland	sc. 1	4.7	5.5	5.9	6.5	7.5	8.2	10.7
	sc. 3	-	-	-	-	8.5	9.1	9.8
Italy	sc. 1	119.6	144.1	155.4	174.1	196.6	213.3	234.2
	sc. 3	-	-	-	-	213.1	226.9	178.3
Luxembourg	sc. 1	0.3	0.2	0.3	0.3	0.3	0.4	0.4
	sc. 3	-	-	-	-	0.4	0.4	0.3
Netherlands	sc. 1	17.4	19.0	19.7	20.7	22.9	24.6	27.8
	sc. 3	-	-	-	-	25.2	26.0	21.1
Portugal	sc. 1	8.1	9.2	9.7	10.5	12.3	14.6	21.4
	sc. 3	-	-	-	-	14.1	16.6	17.3
Spain	sc. 1	85.0	110.0	121.9	142.3	166.1	189.4	266.5
	sc. 3	-	-	-	-	188.3	214.8	223.3
United Kingdom	sc. 1	92.4	102.1	121.9	158.9	169.3	181.1	196.1
	sc. 3	-	-	-	-	189.1	195.6	153.6
Europe 12	sc. 1	579.5	643.1	702.3	804.5	894.5	974.8	1138.9
	sc. 3	-	-	-	-	992.8	1048.0	879.1

2. Railway traffic in scenario 3 : A new market is coming .

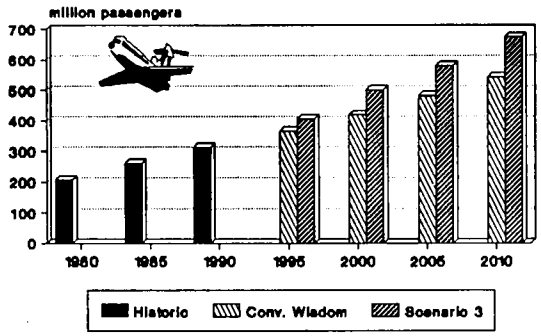
billion tons-km		1980	1985	1987	1990	1995	2000	2010
Belgium	sc. 1	8.0	8.3	8.0	8.1	8.6	9.0	10.6
	sc. 3	-	-	-	-	8.6	9.3	13.6
Denmark	sc. 1	1.6	1.7	1.9	2.2	2.4	2.5	3.3
	sc. 3	-	-	-	-	2.4	2.7	5.1
France	sc. 1	66.4	55.8	57.8	61.1	64.1	67.5	74.5
	sc. 3	-	-	-	-	64.1	68.5	91.3
Germany	sc. 1	63.8	63.0	66.1	71.0	75.5	80.1	89.7
	sc. 3	-	-	-	-	75.5	84.1	112.9
Greece	sc. 1	0.8	0.7	0.8	0.8	0.8	0.8	0.9
	sc. 3	-	-	-	-	0.8	0.9	2.3
Ireland	sc. 1	0.6	0.6	0.6	0.7	0.8	0.8	0.9
	sc. 3	-	-	-	-	0.5	0.8	2.0
Italy	sc. 1	18.7	18.4	19.0	20.0	22.1	23.8	27.6
	sc. 3	-	-	-	-	22.1	24.3	55.1
Luxembourg	sc. 1	0.7	0.6	0.6	0.6	0.6	0.8	0.8
	sc. 3	-	-	-	-	0.6	0.8	0.8
Netherlands	sc. 1	3.5	3.3	3.3	3.7	4.0	4.2	5.5
	sc. 3	-	-	-	-	4.0	4.4	8.9
Portugal	sc. 1	1.0	1.3	1.3	1.5	1.8	2.1	3.1
	sc. 3	-	-	-	-	1.2	2.2	6.9
Spain	sc. 1	11.2	12.6	12.7	13.6	14.5	15.4	17.0
	sc. 3	-	-	-	-	14.5	16.6	44.1
United Kingdom	sc. 1	17.6	17.2	18.0	14.6	15.7	16.9	19.6
	sc. 3	-	-	-	-	15.7	17.5	37.5
Europe 12	sc. 1	194.0	183.4	190.1	197.9	210.9	223.8	253.5
	sc. 3	-	-	-	-	209.9	232.0	380.3

Sources : SOEC transport & Communications yearbook, DG XVII estimates

Airway Transport

(EUROPE12)

An expanding mode of transport
(all scenarios)



Nevertheless jet fuel demand growth will slowdown
- Size of planes and load factors are raising
- Improving fuel efficiency trend is continuing

Table 3.5.5 **AIRWAY PASSENGERS TRAFFIC**

million passengers		1980	1985	1987	1990	1995	2000	2010
Belgium	sc. 1	5.4	6.0	6.3	6.7	7.9	9.1	12.1
	sc. 3	-	-	-	-	8.3	10.1	13.8
Denmark	sc. 1	9.1	9.9	10.9	12.6	15.4	17.7	23.4
	sc. 3	-	-	-	-	16.9	20.1	26.4
France	sc. 1	23.8	32.6	34.8	38.3	44.3	50.6	65.4
	sc. 3	-	-	-	-	46.9	57.0	76.6
Germany	sc. 1	46.6	53.2	54.9	57.5	66.0	75.2	98.0
	sc. 3	-	-	-	-	70.4	84.5	112.3
Greece	sc. 1	9.9	10.9	11.2	11.7	13.3	15.5	20.8
	sc. 3	-	-	-	-	15.5	20.2	29.0
Ireland	sc. 1	3.1	3.6	4.3	5.5	7.1	8.1	10.0
	sc. 3	-	-	-	-	8.6	10.8	14.1
Italy	sc. 1	12.5	15.0	15.8	17.1	19.8	22.3	27.8
	sc. 3	-	-	-	-	21.0	24.9	32.4
Luxembourg	sc. 1	0.6	0.8	0.8	1.0	1.2	1.4	1.8
	sc. 3	-	-	-	-	1.3	1.5	2.0
Netherlands	sc. 1	11.1	14.9	17.2	21.3	24.5	27.8	33.9
	sc. 3	-	-	-	-	26.7	31.3	39.2
Portugal	sc. 1	3.9	5.1	5.6	6.4	8.0	9.9	13.8
	sc. 3	-	-	-	-	9.3	13.0	19.9
Spain	sc. 1	31.7	43.6	47.4	53.7	64.9	75.6	101.6
	sc. 3	-	-	-	-	80.6	104.6	149.9
United Kingdom	sc. 1	49.4	66.0	71.4	80.3	94.4	106.8	134.6
	sc. 3	-	-	-	-	100.9	123.0	159.5
Europe 12	sc. 1	207.1	261.6	280.5	312.1	366.8	420.0	543.2
	sc. 3	-	-	-	-	406.2	501.2	675.3

Sources : SOEC transport & Communications yearbook, DG XVII estimates

3.6 Residential and Tertiary Sector Assumptions

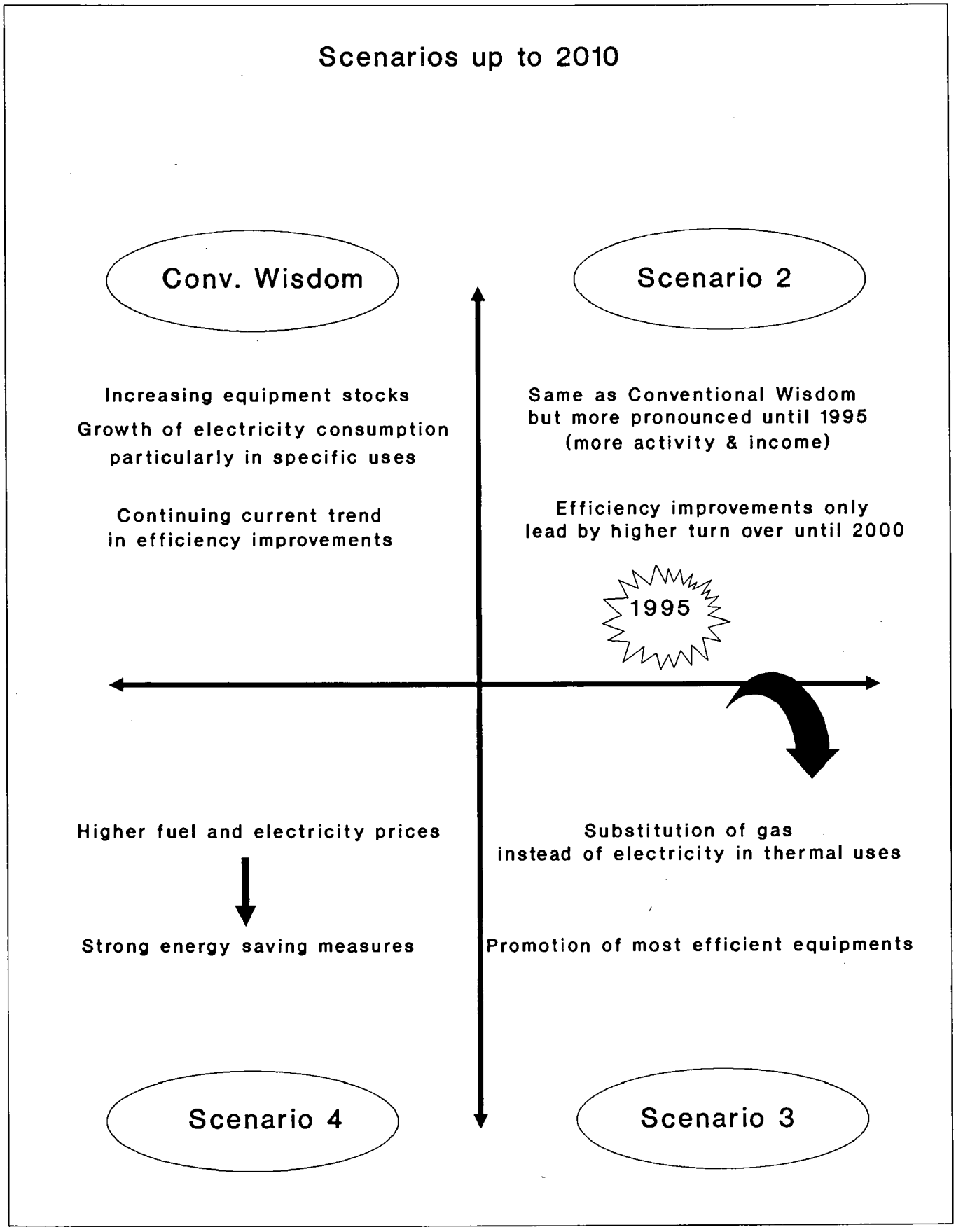


Table 3.6.1 ABOUT HOUSING : The Conventional Wisdom

1. The number of households is growing

million households	1980	1985	1987	1990	1995	2000	2010	1987-2010 per year
Belgium	3.4	3.6	3.6	3.6	3.7	3.8	3.9	0.4%
Denmark	2.1	2.2	2.2	2.3	2.3	2.3	2.3	0.2%
France	19.1	20.4	20.9	21.6	22.7	23.6	24.8	0.7%
Germany	25.1	26.5	26.9	27.6	27.6	27.5	26.6	-0.1%
Greece	2.9	3.1	3.2	3.3	3.5	3.8	3.9	0.9%
Ireland	0.9	0.9	1.0	1.0	1.0	1.1	1.2	1.0%
Italy	18.2	19.1	19.9	20.8	22.2	23.2	23.8	0.8%
Luxembourg	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.6%
Netherlands	5.2	5.5	5.6	5.7	6.1	6.4	6.7	0.8%
Portugal	3.0	3.1	3.2	3.3	3.5	3.6	4.1	1.1%
Spain	10.1	11.4	11.5	11.7	12.2	13.1	14.7	1.1%
United kingdom	20.3	21.3	21.8	21.9	22.9	23.6	24.6	0.5%
Europe 12	110.4	117.1	119.9	123.0	127.8	132.1	136.8	0.6%

2. New construction of dwellings is adjusted to reflect the demography and economic trends

1000 per year	1970	1980	1985	1987	1990	1995	2000	2010
Belgium	46	26	26	26	26	33	31	31
Denmark	50	24	24	22	20	20	19	19
France	457	378	340	345	330	320	340	350
Germany	480	350	340	340	335	300	300	250
Greece	114	110	90	90	90	90	85	80
Ireland	39	27	24	23	20	20	20	20
Italy	376	180	170	185	210	220	250	250
Luxembourg	1.6	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Netherlands	117	125	115	115	115	105	100	85
Portugal	26	33	31	33	35	40	40	50
Spain	308	330	230	250	300	250	250	200
United kingdom	361	175	180	188	200	195	180	170
Europe 12	2376	1759	1571	1618	1682	1594	1616	1506

Source : SOEC Family budgets, DG XVII estimates

Table 3.6.2 INDICATORS FOR ELECTRICAL APPLIANCES (e.g washing-machines)

1. Washing-machine ownership is raising...

% households	1980	1985	1987	1990	1995	2000	2010
Belgium	80%	84%	87%	92%	93%	95%	100%
Denmark	54%	61%	65%	71%	79%	88%	100%
France	79%	84%	86%	89%	91%	95%	100%
Germany	81%	84%	86%	90%	92%	95%	100%
Greece	41%	53%	56%	61%	70%	83%	95%
Ireland	55%	80%	82%	86%	90%	95%	100%
Italy	75%	78%	81%	87%	91%	95%	100%
Luxembourg	84%	88%	91%	96%	98%	100%	100%
Netherlands	90%	94%	94%	95%	95%	100%	100%
Portugal	25%	40%	44%	51%	66%	79%	95%
Spain	65%	75%	77%	81%	90%	93%	100%
United kingdom	76%	85%	87%	91%	92%	95%	100%
Europe 12	74%	80%	83%	87%	90%	94%	100%

2. Specific electricity consumption is decreasing in all scenarios, especially in scenario 3

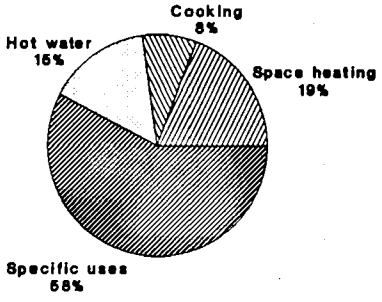
kwh/appliance per year		1980	1985	1987	1990	1995	2000	2010
Belgium	sc. 1	300	283	280	275	267	250	240
	sc. 3	-	-	-	-	267	210	200
Denmark	sc. 1	400	400	380	350	320	250	235
	sc. 3	-	-	-	-	320	235	200
France	sc. 1	280	275	272	265	260	255	250
	sc. 3	-	-	-	-	260	210	200
Germany	sc. 1	350	265	260	250	245	240	235
	sc. 3	-	-	-	-	245	210	200
Greece	sc. 1	330	330	326	320	310	300	290
	sc. 3	-	-	-	-	310	250	200
Ireland	sc. 1	330	330	325	320	310	300	290
	sc. 3	-	-	-	-	310	250	200
Italy	sc. 1	450	440	435	420	390	370	320
	sc. 3	-	-	-	-	390	270	200
Luxembourg	sc. 1	300	283	280	275	267	250	240
	sc. 3	-	-	-	-	267	210	200
Netherlands	sc. 1	295	290	280	265	245	240	235
	sc. 3	-	-	-	-	245	210	200
Portugal	sc. 1	450	450	440	430	410	390	350
	sc. 3	-	-	-	-	410	300	200
Spain	sc. 1	480	460	450	430	415	400	350
	sc. 3	-	-	-	-	415	290	200
United Kingdom	sc. 1	415	400	395	385	350	320	260
	sc. 3	-	-	-	-	350	250	200
Europe 12	sc. 1	373	346	340	331	316	302	275
	sc. 3	-	-	-	-	316	250	200

Source : SOEC Family budgets, UNIPEDE statistics, DG XVII estimates

Electricity Prospect in the Household Sector.

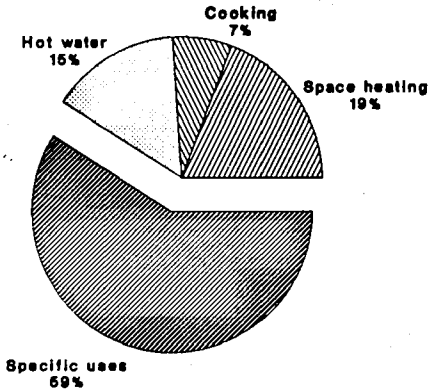
EUROPE 12 CONSUMPTION
(Conventional Wisdom)

392 Twh



1985

633 Twh

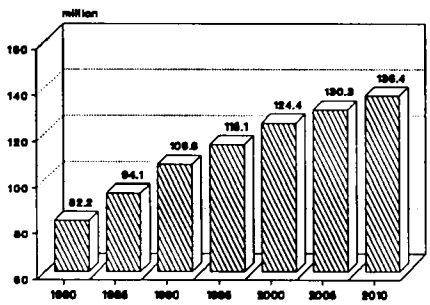


2010

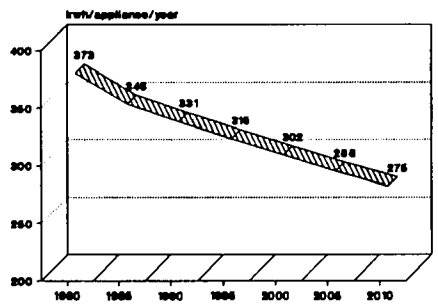
refrigerator-freezer
washing machine
dish washer
TV
...

Example: Washing-Machine Indicators

More washing-machines



With less specific energy consumption



Leading to stable electricity consumption

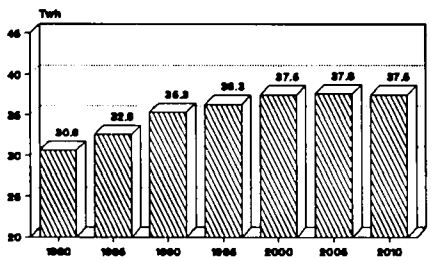


Table 3.6.3 Value added in the service sector: Conventional Wisdom

billion ECU	1985 current prices and exchange rates	% per year in volume 1985-1990	1990-1995	1995-2000	2000-2010	1985-2010
Belgium	65.5	4.7%	3.2%	3.2%	3.2%	3.5%
Denmark	45.1	0.9%	2.5%	3.0%	3.0%	2.5%
France	416.2	3.6%	3.0%	3.0%	3.0%	3.1%
Germany	462.7	3.3%	3.2%	3.0%	3.0%	3.1%
Greece	21.0	2.4%	2.8%	3.0%	3.0%	2.8%
Ireland	11.6	2.3%	3.0%	3.2%	3.0%	2.9%
Italy	331.6	3.5%	3.5%	3.3%	3.0%	3.3%
Luxembourg	3.4	3.7%	3.0%	3.2%	3.9%	3.5%
Netherlands	96.0	3.0%	2.5%	3.0%	3.0%	2.9%
Portugal	15.3	4.7%	5.1%	5.1%	4.9%	4.9%
Spain	131.0	4.8%	4.2%	3.6%	3.5%	3.9%
United kingdom	340.2	3.8%	3.4%	3.1%	2.8%	3.2%
Europe 12	1939.6	3.5%	3.2%	3.1%	3.0%	3.2%

Table 3.6.4 The other scenarios : Scenario 3 was the most services oriented growth. A relative slowdown is expected in scenario 2 after 1995

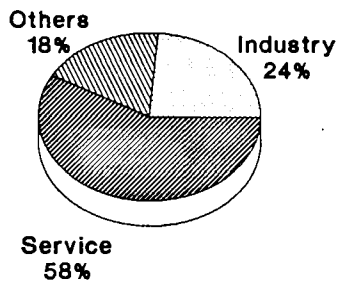
V.A services	% per year	Conv. wisd	scenario 2	scenario 3	scenario 4
Belgium	1990-1995	3.2%	3.2%	3.2%	3.9%
	1995-2010	3.2%	3.0%	3.3%	3.1%
Denmark	1990-1995	2.5%	3.2%	3.2%	3.5%
	1995-2010	3.0%	3.0%	3.0%	2.9%
France	1990-1995	3.0%	3.6%	3.6%	4.1%
	1995-2010	3.0%	3.0%	3.6%	2.9%
Germany	1990-1995	3.2%	4.0%	4.0%	4.3%
	1995-2010	3.0%	3.1%	3.3%	3.0%
Greece	1990-1995	2.8%	4.3%	4.3%	4.1%
	1995-2010	3.0%	3.7%	4.1%	3.0%
Ireland	1990-1995	3.0%	5.9%	5.9%	4.1%
	1995-2010	3.1%	3.8%	4.6%	3.1%
Italy	1990-1995	3.5%	4.1%	4.1%	4.6%
	1995-2010	3.1%	3.1%	3.8%	3.1%
Luxembourg	1990-1995	3.0%	3.2%	3.2%	3.5%
	1995-2010	3.7%	3.0%	3.5%	3.6%
Netherlands	1990-1995	2.5%	3.2%	3.2%	3.2%
	1995-2010	3.0%	2.9%	3.2%	3.0%
Portugal	1990-1995	5.1%	6.3%	6.3%	5.5%
	1995-2010	5.0%	4.8%	5.4%	5.0%
Spain	1990-1995	4.2%	7.2%	7.2%	4.7%
	1995-2010	3.5%	4.2%	5.1%	3.7%
United kingdom	1990-1995	3.4%	3.5%	3.5%	3.9%
	1995-2010	2.9%	3.3%	3.6%	2.9%
Europe 12	1990-1995	3.2%	4.0%	4.0%	4.2%
	1995-2010	3.0%	3.2%	3.7%	3.1%

Sources : SOEC national accounts detailed by sector, DG XVII estimates

Service Sector Prospect

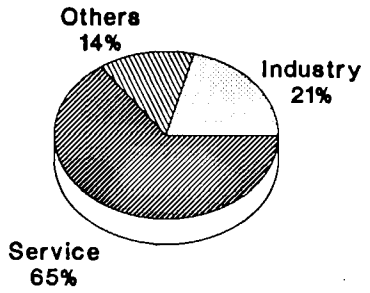
In all scenarios the service sector grows faster than GDP
A growing share for services up to 2010

Structural Change
(EUROPE 12)



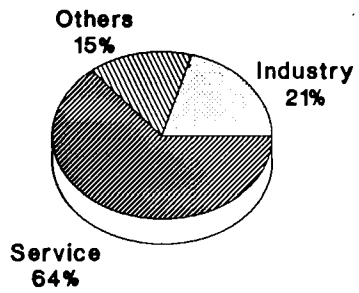
1985

GDP: 3333 billion ecu 1985



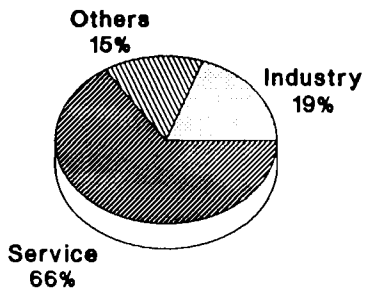
2010

Conventional Wisdom
GDP: 6563 billion ecu 1985



2010

Driving Into Tensions
GDP: 7095 billion ecu 1985



2010

Sustaining High Economic Growth
GDP: 7393 billion ecu 1985

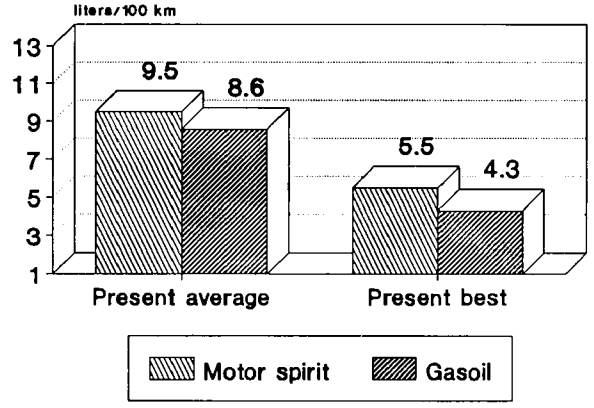
3.7 Energy Efficiency

Potential Realistically Attainable

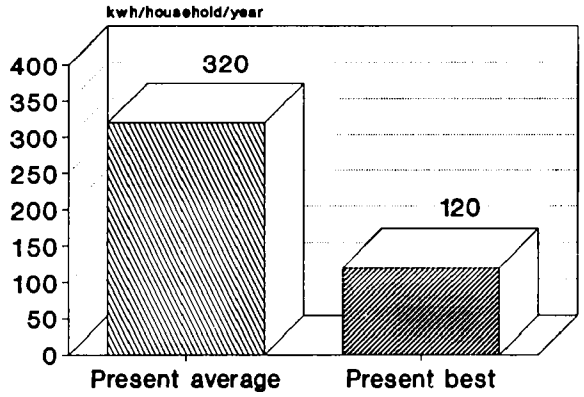
Major improvements in the energy efficiency can be still obtained. The range of equipments is wide according to the specific consumption.

A large diffusion of the most efficient technics at current economical conditions will save very significantly the energy for the same end-use on the long term: the half of the fuel consumption for car driving, a third of the electricity for lighting...

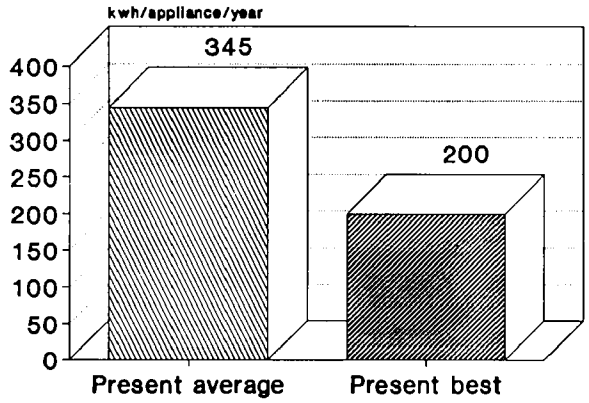
Private cars



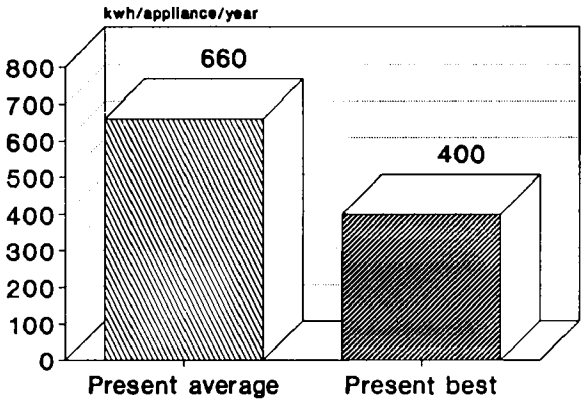
Domestic lighting



Washing machine



Freezer



Source: Les équipements de maîtrise de l'énergie (EXPLICIT)

ENERGY INTERNAL MARKET

UP TO 2010

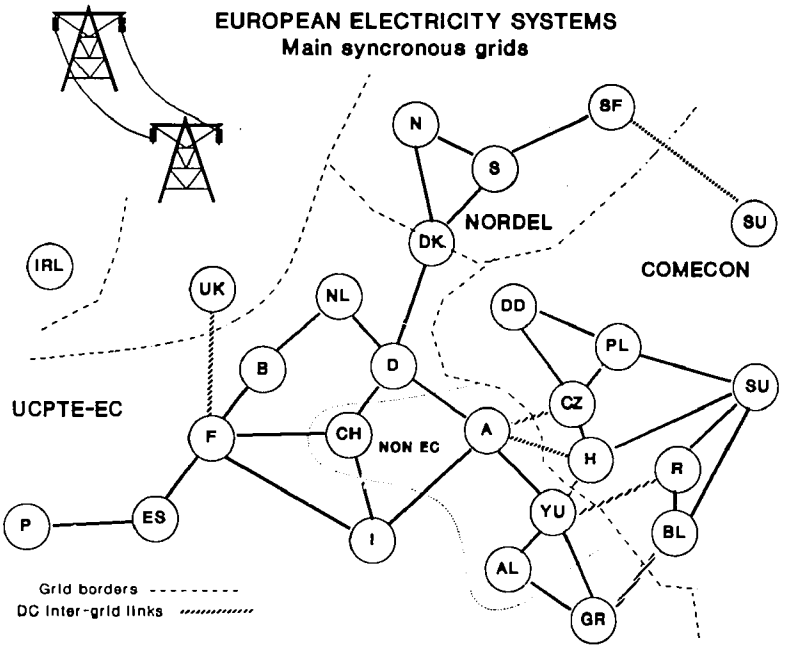
Electricity Network Integration

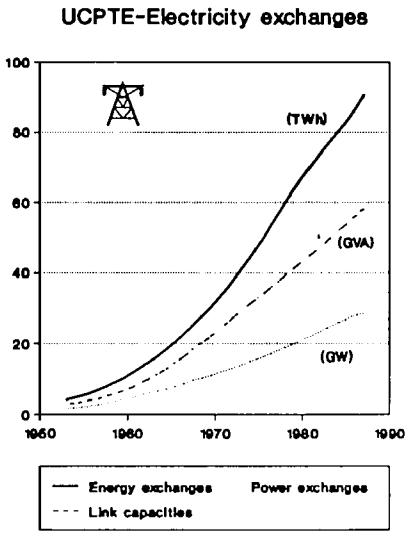
. Old practice but ?

. Benefits ?

Fiscal Harmonisation

INTEGRATION IS AN OLD PRACTICE FOR THE UTILITIES, but is its potential fully exploited?





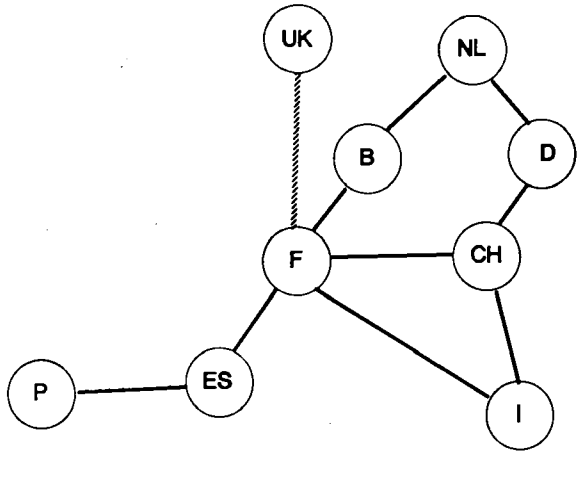
ASSESSING BENEFITS OF HIGHER LEVELS OF INTEGRATION

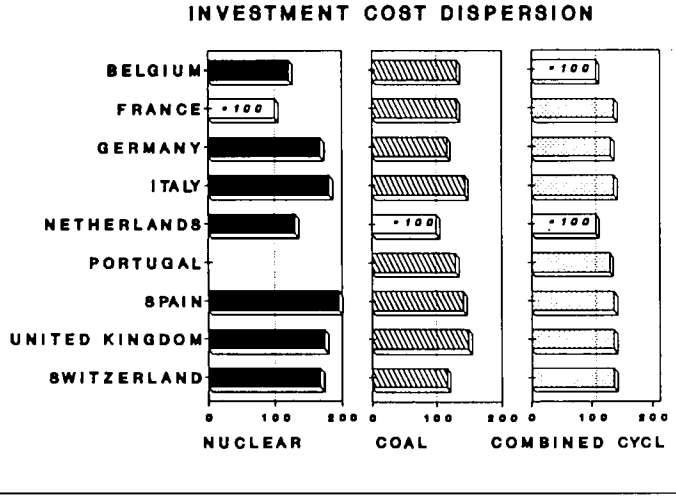
	LIMITED	MAXIMUM
Transmission Capacities	Existing + Country planned	Existing + Country planned + Required additions
Generation Mix	Individual National Policies	Blanket Policies for 9 Countries as a whole
	Low level of Nuclear development in the Countries	Possibility of Higher level of Nuclear development in France

IN THE INTERNAL MARKET FRAMEWORK

GENERAL ASSUMPTIONS

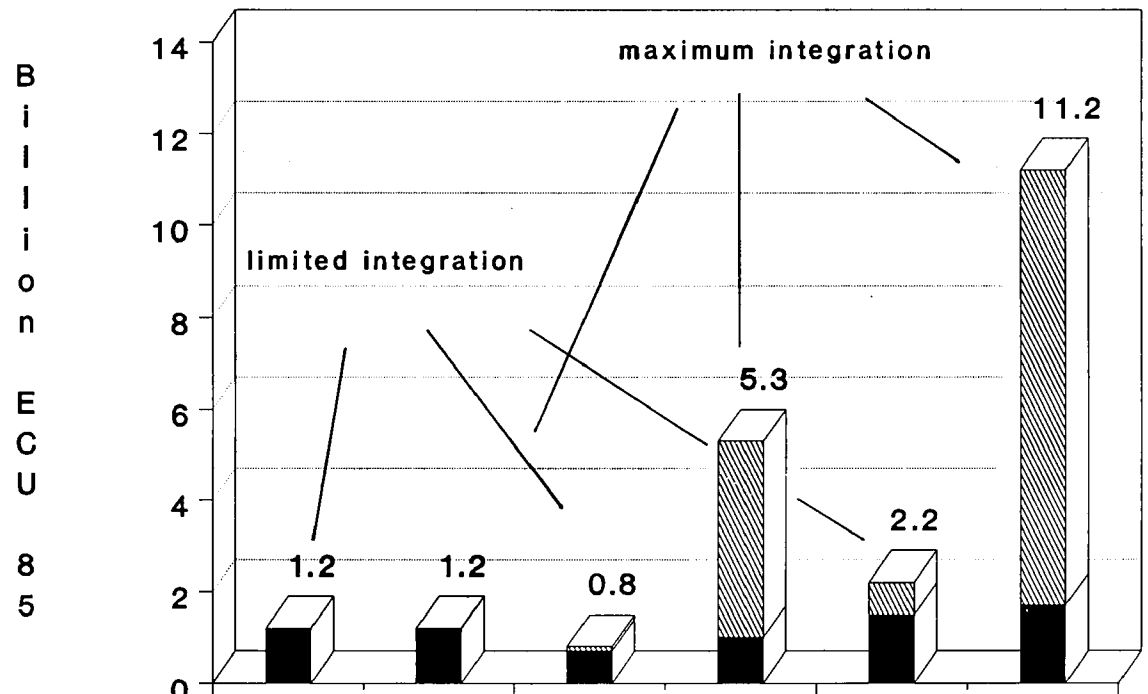
Electricity Systems	8 EC countries + Switzerland public networks
Electricity Demand	"Conventional Wisdom" scenario growth rate
Fuel Costs	Full prices harmonization on CIF basis other than gas
	Differences in national transportation costs
	No differences in taxation
Investments	No harmonization of total costs
	No harmonization of planning policy
Power Units Characteristics	No differences in efficiency
	No differences in availability





Potential benefits exist even in respect of present integration

Assessed benefits of larger integration
(annuities)



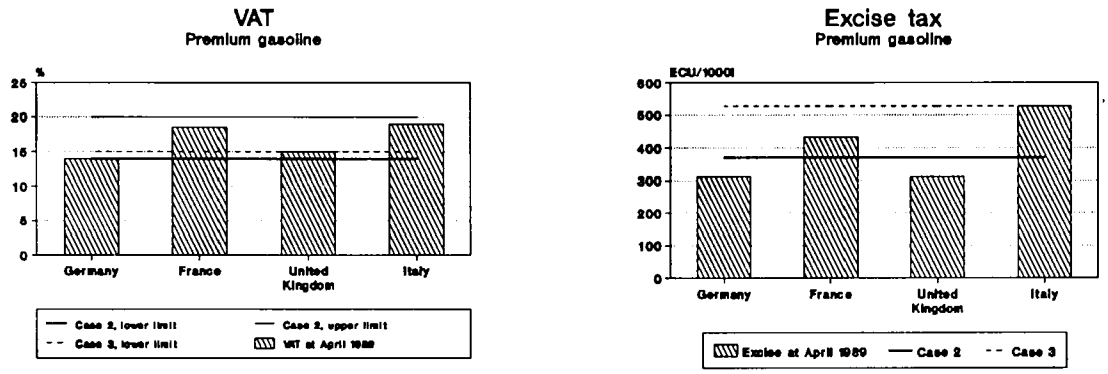
	short term		medium term		long term	
investments	0	0	0.1	4.3	0.7	9.5
fuel	1.2	1.2	0.7	1.0	1.5	1.7

fuel investments

The gains of present integration are assessed as 1 billion ECU '85 each year.

IMPACT OF TAX HARMONIZATION

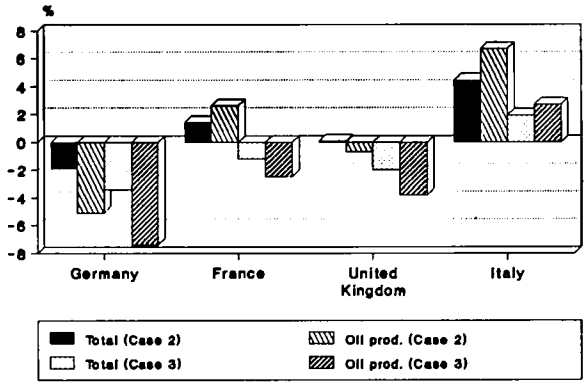
National VAT and excise duties toward harmonized rates



Impact of harmonization on final energy demand

% of difference from Case 1

	Case 2	Case
GERMANY	- 1.9 %	- 3.4
• Oil prod	- 5.1 %	- 7.4
FRANCE	+ 1.4 %	- 1.2
• Oil prod.	+ 2.6 %	- 2.5
U.K.	+ 0.1 %	- 2.0
• Oil prod.	- 0.7 %	- 3.8
ITALY	+ 4.4 %	+ 1.9
• Oil prod.	+ 6.7 %	+ 2.7
AVERAGE	+ 0.6 %	- 1.5
• Oil prod.	+ 0.1 %	- 3.4



NOTE:

Case 1: No harmonization, the national taxation systems continue as in the past.
Case 2: Strict harmonization of VAT rates and excise dutie
Case 3: Harmonization of VAT rates and excise duties, with a single VAT rate for all fuels (normal rate, 15% minimum), alignment of the excise duties on motor fuels at highest level, alignment of excise duties on heating gasoil in an average brcket, alignment of the excise duties on heavy fuel oil at lowest level.

The analysis was carried out using the results of the simulation of these three cases by the MIDAS model, over period 1988-2000.

4. INTERNATIONAL SITUATION

4.1 World Energy Outlook

This section presents the main results of the world energy outlook under the "conventional wisdom" scenario, up to 2010. For the purposes of this analysis the world has been divided in the following zones:

1. Europe-12 (EUR-12)
2. USA
3. Canada
4. Japan
5. Rest of the OECD (ROECD: Austria, Finland, Iceland, Norway, Sweden, Switzerland, Turkey, Australia, New Zealand)
6. Eastern Europe (Albania, Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, Romania, Yugoslavia)
7. USSR
8. China
9. Rest of the World (ROW)

Historical data used come from a variety of sources: SOEC, IEA, UN, BP and PlanEcon.

The following conventions have been used to harmonize statistical information from different sources:

a. Bunkers are included in primary energy consumption.
b. Hydro-electricity is treated in a fuel-equivalent basis, using a theoretical generation efficiency of 38.5%.
c. Geothermal energy used for electricity generation is included in hydro figures.
d. Nuclear energy production and primary consumption outside the European Community is calculated using a theoretical generation efficiency of 34%, equal to the EUR-12 average.
e. Net electricity imports are ignored, with the exception of EUR-12 and the ROECD.
f. Stock variations are included in the net import figures.
g. Renewable and non-commercial fuels are based on IEA data for the USA, Canada and the non-OECD zones. "Other fuels" of the SOEC balance sheet for EUR-12 are also included.

Therefore, the EUR-12 figures in this chapter are slightly different from those shown in the rest of this document.

More details are available in the working documents 14 (World Energy Outlook) and 13 (Energy Outlook of the USSR and Eastern Europe).

TABLE 4.1.1 World Energy Outlook, 1987-2010: GDP/GNP Assumptions.

Countries	1987 (billion US $)	Average annual growth of GDP (in %)					
		1980-87	1987-90	1990-95	1995-2000	2000-05	2005-10
1.Europe-12	4305	1.8	3.4	2.7	2.7	2.7	2.7
2.USA	4525	2.7	3.1	2.5	2.5	2.5	2.5
3.Canada	415	3.0	3.5	2.8	2.8	2.8	2.8
4.Japan	2390	3.8	4.9	3.8	3.8	3.8	3.8
5.Rest of OECD	950	1.8	2.8	2.8	2.8	2.8	2.8
TOTAL OECD	12585	2.4	3.5	2.8	2.8	2.8	2.8
6.Eastern Europe	630	1.4	1.2	1.4	2.1	2.5	2.6
7.USSR	1660	2.0	0.2	1.2	2.1	2.6	2.6
8.China	300	9.6	8.0	6.0	5.5	5.0	5.0
9.Rest of the World	2450	3.0	4.1	4.0	4.0	4.0	4.0
TOTAL WORLD	17625	2.7	3.1	2.8	2.9	3.0	3.0

Sources: SOEC, OECD, IMF, World Bank, DG XVII/A2 estimates

TABLE 4.1.2 World Energy Outlook 1987-2010: Primary Energy Consumption Mtoe

	1980	1985	1987	1990	1995	2000	2005	2010
SOLID FUELS								
1.Europe-12	238	239	231	235	246	275	298	322
2.USA	383	446	459	485	525	554	633	717
3.Canada	23	29	33	35	35	44	51	58
4.Japan	56	74	69	78	84	89	95	98
5.Rest of OECD	46	53	74	91	101	111	125	138
TOTAL OECD	755	841	867	924	992	1073	1203	1332
6.Eastern Europe	247	264	271	270	284	303	321	335
7.USSR	307	295	309	313	297	281	277	264
8.China	309	414	448	500	574	652	722	802
9.Rest of the World	179	234	262	315	422	547	707	890
WORLD	1797	2048	2157	2322	2569	2854	3230	3622
OIL								
1.Europe-12	580	489	508	548	572	560	542	524
2.USA	794	722	763	794	844	881	895	897
3.Canada	88	69	71	77	81	84	84	84
4.Japan	238	203	206	230	236	229	219	212
5.Rest of OECD	119	106	112	111	115	113	109	106
TOTAL OECD	1818	1589	1659	1757	1848	1866	1849	1822
6.Eastern Europe	115	104	108	111	124	139	154	171
7.USSR	449	444	446	443	434	425	422	423
8.China	90	94	109	127	156	188	218	253
9.Rest of the World	584	645	687	781	911	1027	1129	1224
WORLD	3055	2876	3007	3219	3474	3645	3773	3893
NATURAL GAS								
1.Europe-12	171	185	198	213	233	249	263	277
2.USA	507	449	437	479	528	589	614	635
3.Canada	49	45	41	54	60	67	75	85
4.Japan	23	36	36	48	59	67	78	88
5.Rest of OECD	20	23	26	31	39	45	52	59
TOTAL OECD	771	738	738	824	919	1017	1082	1144
6.Eastern Europe	67	76	80	78	97	122	152	184
7.USSR	317	466	519	584	740	904	1085	1291
8.China	12	12	13	14	16	18	20	22
9.Rest of the World	119	169	190	232	306	397	516	661
WORLD	1285	1460	1541	1732	2078	2459	2855	3302
NUCLEAR								
1.Europe-12	44	124	136	161	180	196	220	252
2.USA	67	103	122	147	151	154	160	161
3.Canada	10	15	20	22	29	30	33	34
4.Japan	21	40	48	51	70	90	109	127
5.Rest of OECD	12	25	28	29	29	29	20	14
TOTAL OECD	154	308	353	410	458	499	542	587
6.Eastern Europe	6	12	16	21	26	32	39	45
7.USSR	19	42	48	60	75	90	105	120
8.China	0	0	0	0	3	5	6	9
9.Rest of the World	4	17	23	27	31	47	56	62
WORLD	182	378	440	517	592	672	748	823
HYDRO, GEOTHERMAL,etc								
1.Europe-12	44	43	44	47	50	53	54	55
2.USA	63	66	59	69	70	83	91	104
3.Canada	56	68	71	70	81	87	94	100
4.Japan	21	20	18	25	26	30	32	34
5.Rest of OECD	52	59	63	59	64	69	75	81
TOTAL OECD	236	255	255	270	291	322	346	373
6.Eastern Europe	13	12	12	12	13	14	14	15
7.USSR	47	53	54	60	66	77	90	100
8.China	13	21	22	31	43	60	76	98
9.Rest of the World	88	114	120	130	158	192	234	271
WORLD	397	454	462	503	571	664	761	857
TOTAL CONVENTIONAL								
1.Europe-12	1076	1079	1116	1201	1281	1333	1376	1429
2.USA	1825	1786	1841	1974	2119	2261	2393	2513
3.Canada	225	226	236	258	286	312	336	360
4.Japan	358	373	377	431	474	505	534	559
5.Rest of OECD	249	267	304	321	349	367	382	398
TOTAL OECD	3734	3730	3874	4186	4508	4777	5021	5256
6.Eastern Europe	447	468	484	492	544	609	679	749
7.USSR	1139	1300	1375	1459	1612	1776	1980	2198
8.China	423	540	593	673	792	923	1044	1183
9.Rest of the World	974	1178	1282	1483	1827	2210	2642	3107
WORLD	6717	7217	7608	8292	9283	10295	11366	12496
RENEWABLES AND NON-COMMERCIAL								
1.Europe-12	2	2	2	2	3	4	5	6
2.USA	56	67	75	76	83	89	94	100
3.Canada	8	8	7	7	7	8	8	8
4.Japan	0	0	0	0	0	0	0	0
5.Rest of OECD	0	0	0	0	0	0	0	0
TOTAL OECD	65	77	84	85	93	100	107	115
6.Eastern Europe	4	4	4	4	4	4	3	3
7.USSR	48	41	39	37	33	32	30	28
8.China	37	42	44	47	52	58	84	70
9.Rest of the World	306	338	344	355	377	400	424	451
WORLD	461	502	515	529	559	593	629	667
TOTAL ENERGY								
1.Europe-12	1078	1081	1118	1203	1283	1336	1381	1436
2.USA	1881	1852	1916	2050	2202	2349	2487	2613
3.Canada	233	234	243	266	293	319	344	368
4.Japan	358	373	377	431	474	505	534	559
5.Rest of OECD	249	267	304	321	349	367	382	398
TOTAL OECD	3799	3807	3957	4271	4601	4877	5128	5374
6.Eastern Europe	451	472	489	496	548	613	683	752
7.USSR	1187	1341	1414	1496	1645	1808	2010	2226
8.China	460	583	637	720	845	980	1107	1253
9.Rest of the World	1280	1516	1626	1838	2203	2610	3067	3558
WORLD	7178	7719	8122	8821	9842	10887	11995	13163

TABLE 4.1.3 World Energy Outlook, 1987-2010: Primary Energy Production

Mtoe	1987				1995				2000				2010			
	Soilds	Oil	Nat.Gas	TOTAL	Soilds	Oil	Nat.Gas	TOTAL	Soilds	Oil	Nat.Gas	TOTAL	Soilds	Oil	Nat.Gas	TOTAL
1.Europe-12	166	151	129	627	143	125	137	636	122	112	135	621	105	103	119	640
2.USA	502	471	422	1651	600	404	460	1768	660	380	500	1865	880	350	490	2085
3.Canada	40	80	71	288	55	89	115	377	65	94	127	411	80	69	140	432
4.Japan	8	1	2	77	5	1	2	104	5	0	2	127	0	0	2	162
5.Rest of OECD	109	77	44	323	140	95	60	390	180	63	70	413	260	27	80	464
TOTAL OECD	826	780	668	2965	943	715	774	3275	1032	649	834	3437	1325	549	831	3782
6.Eastern Europe	272	17	44	366	260	11	35	348	240	10	25	324	200	10	10	283
7.USSR	326	626	586	1679	330	598	850	1952	340	578	1060	2176	360	553	1560	2721
8.China	454	136	13	669	620	186	16	920	700	218	19	1059	900	283	24	1383
9.Rest of the World	264	1426	276	2453	410	1963	405	3343	540	2190	520	3889	840	2497	875	4995
WORLD	2142	2986	1587	8132	2563	3474	2080	9838	2852	3645	2458	10885	3625	3893	3300	13164

Notes: (1) Total includes fossil fuels, hydro, nuclear and non-commercial

TABLE 3.1.4 World Energy Outlook, 1987-2010: Net Energy Imports

Mtoe	1987				1995				2000				2010			
	Soilds	Oil	Nat.Gas	TOTAL	Soilds	Oil	Nat.Gas	TOTAL	Soilds	Oil	Nat.Gas	TOTAL	Soilds	Oil	Nat.Gas	TOTAL
1.Europe-12	65	356	69	491	103	446	96	647	152	448	114	716	217	421	157	797
2.USA	-42	292	15	265	-75	440	68	433	-106	501	89	484	-164	547	145	528
3.Canada	-7	-9	-30	-46	-20	-8	-55	-83	-21	-10	-60	-91	-22	14	-55	-63
4.Japan	61	205	35	301	79	235	57	371	84	229	65	378	98	212	86	396
5.Rest of OECD	-35	35	-18	-19	-39	20	-21	-42	-69	50	-25	-46	-122	79	-21	-66
TOTAL OECD	42	879	71	992	48	1133	145	1326	40	1218	183	1441	7	1273	312	1592
6.Eastern Europe	-2	89	36	123	24	113	62	199	63	129	97	289	135	161	174	470
7.USSR	-17	-180	-67	-264	-33	-164	-108	-305	-59	-153	-156	-368	-96	-131	-269	-496
8.China	-6	-27	0	-33	-46	-30	0	-76	-49	-30	0	-79	-98	-30	-1	-129
9.Rest of the World	-2	-739	-86	-827	7	-1052	-99	-1144	5	-1164	-124	-1283	52	-1273	-216	-1437
WORLD	15	22	-46	-9	0	0	0	0	0	0	0	0	0	0	0	0

Notes:
(1) Negative numbers indicate net exports
(2) 1987 figures include stock variations and statistical errors
(3) Total figures for EUR-12 and ROECD include net electricity exchanges

TABLE 4.1.5 World Energy Outlook, 1987-2010: World Final Energy Demand

Mtoe	1980	1985	1987	1990	1995	2000	2005	2010
Solids	850	922	912	982	1041	1101	1164	1226
Oil	2373	2324	2450	2638	2854	3018	3165	3292
Gas	817	895	947	1090	1268	1431	1594	1773
Electricity	592	703	759	836	982	1149	1335	1537
Heat	153	179	185	179	185	198	212	224
Others	459	500	512	527	555	587	623	659
TOTAL	5243	5523	5764	6252	6884	7484	8091	8710

%	1980	1985	1987	1990	1995	2000	2005	2010
Solids	16.2	16.7	15.8	15.7	15.1	14.7	14.4	14.1
Oil	45.3	42.1	42.5	42.2	41.5	40.3	39.1	37.8
Gas	15.6	16.2	16.4	17.4	18.4	19.1	19.7	20.4
Electricity	11.3	12.7	13.2	13.4	14.3	15.4	16.5	17.6
Heat	2.9	3.2	3.2	2.9	2.7	2.6	2.6	2.6
Others	8.8	9.1	8.9	8.4	8.1	7.8	7.7	7.6
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 4.1.6 World Energy Outlook, 1987-2010: World Electricity

A. ELECTRICITY GROSS PRODUCTION

TWh	1980	1985	1987	1990	1995	2000	2005	2010
1.Europe-12	1403	1573	1659	1801	2039	2242	2426	2635
2.USA	2427	2622	2733	3016	3446	3889	4336	4811
3.Canada	373	459	496	549	625	710	801	894
4.Japan	576	672	719	817	935	1061	1189	1320
5.Rest of OECD	458	578	625	670	746	817	884	956
TOTAL OECD	5238	5903	6232	6852	7791	8719	9637	10616
6.Eastern Europe	483	551	577	592	661	748	847	938
7.USSR	1294	1544	1664	1681	1832	2075	2359	2648
8.China	301	411	497	602	761	944	1149	1398
9.Rest of the World	1000	1432	1610	1906	2598	3477	4566	5773
WORLD	8316	9841	10580	11633	13643	15963	18557	21372
of which:								
Hydro etc	1802	2067	2104	2286	2592	3012	3444	3879
in %	21.7	21.0	19.9	19.7	19.0	18.9	18.6	18.2
Nuclear	714	1492	1739	2023	2317	2630	2935	3217
in %	8.6	15.2	16.4	17.4	17.0	16.5	15.8	15.1
Thermal	5800	6282	6736	7324	8734	10321	12178	14276
in %	69.7	63.8	63.7	63.0	64.0	64.7	65.6	66.8

B. INPUTS TO THERMAL POWER STATIONS

Mtoe	1980	1985	1987	1990	1995	2000	2005	2010
Solids	882	1042	1116	1212	1398	1621	1930	2256
Oil	410	321	320	330	356	355	327	312
Gas	279	369	398	435	588	789	1004	1252
Others	2	2	2	2	4	5	6	7
TOTAL	1572	1734	1837	1979	2346	2770	3268	3828
Electricity produced	499	540	579	630	751	888	1047	1228
Efficiency-in %	31.7	31.2	31.5	31.8	32.0	32.0	32.1	32.1

%	1980	1985	1987	1990	1995	2000	2005	2010
Solids	56.1	60.1	60.8	61.2	59.6	58.5	59.1	58.9
Oil	26.1	18.5	17.4	16.7	15.2	12.8	10.0	8.2
Gas	17.7	21.3	21.7	22.0	25.1	28.5	30.7	32.7
Others	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 4.1.7 World Energy Outlook, 1987-2010: CO2 Emissions

A. PRIMARY ENERGY DEMAND

Mtoe	1987	1995	in % 1987-95	2000	in % 1995-2000	2010	in % 2000-10	in % 1987-2010
1.Europe-12	1118	1283	1.7	1336	0.8	1436	0.7	1.1
2.USA	1916	2202	1.8	2349	1.3	2613	1.1	1.4
3.Canada	243	293	2.4	319	1.7	368	1.4	1.8
4.Japan	377	474	2.9	505	1.3	559	1.0	1.7
5.Rest of OECD	304	349	1.7	367	1.0	398	0.8	1.2
TOTAL OECD	3957	4601	1.9	4877	1.2	5374	1.0	1.3
6.Eastern Europe	489	548	1.4	613	2.3	752	2.1	1.9
7.USSR	1414	1645	1.9	1808	1.9	2226	2.1	2.0
8.China	637	845	3.6	980	3.0	1253	2.5	3.0
9.Rest of the World	1626	2203	3.9	2610	3.4	3558	3.1	3.5
WORLD	8122	9842	2.4	10887	2.0	13163	1.9	2.1
Part of EUROPE-12 in Total World in %	13.8	13.0		12.3		10.9		

B. CO2 EMISSIONS

Million tonnes of C	1987	1995	in % 1987-95	2000	in % 1995-2000	2010	in % 2000-10	in % 1987-2010
1.Europe-12	767	854	1.4	886	0.7	930	0.5	0.8
2.USA	1395	1599	1.7	1711	1.4	1949	1.3	1.5
3.Canada	121	143	2.1	160	2.3	189	1.7	2.0
4.Japan	258	312	2.4	319	0.4	332	0.4	1.1
5.Rest of OECD	184	224	2.5	238	1.2	273	1.4	1.7
TOTAL OECD	2725	3132	1.8	3314	1.1	3673	1.0	1.3
6.Eastern Europe	437	479	1.2	529	2.0	635	1.8	1.6
7.USSR	1075	1185	1.2	1265	1.3	1501	1.7	1.5
8.China	631	815	3.3	932	2.7	1162	2.2	2.7
9.Rest of the World	1245	1706	4.0	2022	3.5	2801	3.3	3.6
WORLD	6113	7317	2.3	8062	2.0	9772	1.9	2.1
of which:								
1.Solid Fuels	2416	2879	2.2	3197	2.1	4056	2.4	2.3
2.Oil	2225	2569	1.8	2695	1.0	2876	0.6	1.1
3.Natural Gas	1014	1372	3.8	1642	3.7	2247	3.2	3.5
4.Non-commercial	458	497	1.0	527	1.2	593	1.2	1.1
Part of EUROPE-12 in Total World in %	12.5	11.7		11.0		9.5		

C. CO2 INTENSITY

Kg of C/Toe	1987	1995	in % 1987-95	2000	in % 1995-2000	2010	in % 2000-10	in % 1987-2010
1.Europe-12	686	665	-0.4	663	-0.1	648	-0.2	-0.3
2.USA	728	726	0.0	728	0.1	746	0.2	0.1
3.Canada	498	488	-0.3	501	0.5	513	0.2	0.1
4.Japan	684	658	-0.5	632	-0.8	594	-0.6	-0.6
5.Rest of OECD	606	643	0.7	649	0.2	686	0.6	0.5
TOTAL OECD	689	681	-0.1	680	0.0	684	0.1	0.0
6.Eastern Europe	894	874	-0.3	863	-0.3	844	-0.2	-0.3
7.USSR	761	720	-0.7	700	-0.6	674	-0.4	-0.5
8.China	991	965	-0.3	951	-0.3	927	-0.3	-0.3
9.Rest of the World	766	774	0.1	775	0.0	787	0.2	0.1
WORLD	753	743	-0.2	741	-0.1	742	0.0	-0.1

CO2 Emission factors:	kg C/GJ	Kg CO2/GJ
Solid Fuels	26.7	98
Oil	19.6	72
Natural Gas	13.6	50
Non-commercial	21.3	78

Table 4.1.8 **ENERGY IN THE MEDITERRANEAN BASIN**

Fastest growth of energy demand in the non european countries

	Population (million)	GDP / cap ($US)	Energy Demand (Mtoe)					
			Total primary			Final electricity		
					% p. a.			% p. a.
	1987	1987	1987	2010	1987-2010	1987	2010	1987-2010
Spain	38.9	5625	73.7	111.4	1.8%	9.4	16.5	2.5%
France	55.6	11950	201.4	286.0	1.5%	23.7	41.3	2.4%
Italy	57.3	10000	139.8	182.5	1.2%	16.2	28.3	2.5%
Greece	10.0	3580	18.1	36.1	3.0%	2.2	5.4	4.1%
[1] EUROPE 4	161.8	9223	433.1	615.9	1.5%	51.4	91.5	2.5%
Morocco	23.3	610	5.8	14.0	3.9%	0.6	2.0	5.6%
Algeria	23.2	2832	21.1	56.7	4.4%	0.9	4.7	7.7%
Tunisia	7.6	1180	3.8	7.6	3.1%	0.4	1.5	6.1%
Libya	4.1	5460	9.6	29.8	5.0%	1.2	6.5	7.5%
Egypt	50.7	700	27.5	82.0	4.9%	2.4	13.4	7.8%
[2] N. AFRICA	108.9	1346	67.8	190.1	4.6%	5.4	28.1	7.4%
Malta	0.4	3800	0.5	0.8	2.3%	0.1	0.2	3.8%
Yugoslavia	23.4	2480	52.3	83.0	2.0%	5.6	13.6	3.9%
Albania	3.1	870	3.3	5.4	2.1%	0.2	0.6	3.8%
Turkey	51.4	1240	46.7	140.1	4.9%	3.0	24.3	9.5%
Cyprus	0.7	5190	1.4	2.6	2.8%	0.1	0.3	4.0%
Syria	11.2	1640	9.7	24.8	4.2%	0.5	2.2	6.8%
Lebanon	2.8	na	2.8	7.0	4.1%	0.4	1.7	6.5%
Israel	4.4	6800	8.9	16.9	2.8%	1.3	3.3	4.1%
[3] OTHER	97.3	1878	125.6	280.4	3.6%	11.2	46.2	6.3%
TOTAL [1+2+3]	368.0	4951	626.5	1086.4	2.4%	68.1	165.7	3.9%

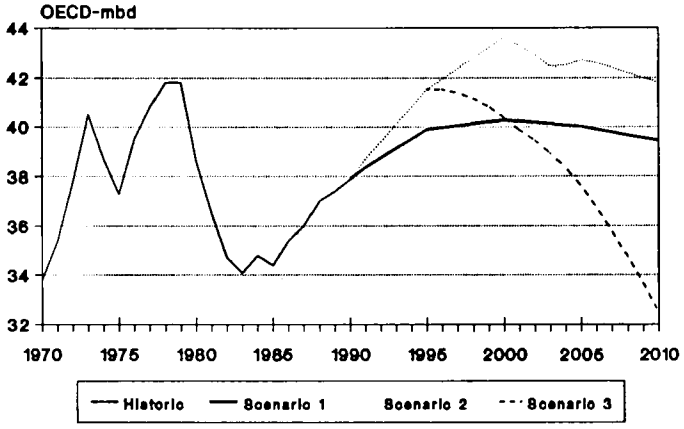
	Population (million)	GDP/cap ($US)	Total primary demand (Mtoe)			Final electricity (Mtoe)		
					% p. a.			% p. a.
For memory:	1987	1987	1987	2010	1987-2010	1987	2010	1987-2010
EUROPE 12	323.8	10000	1062	1368	1.1%	120	192	2.1%
MED in % EUR 12	114%	-	59%	79%		57%	86%	

	ENERGY DEMAND PER CAPITA			
	Electricity		Total primary demand	
koe / inhabitant	1987	2010	1987	2010
EUROPE 4	318	541	2676	3646
N. AFRICA	50	157	623	1060
OTHER	115	338	1291	2054
TOTAL MED	185	342	1702	2241

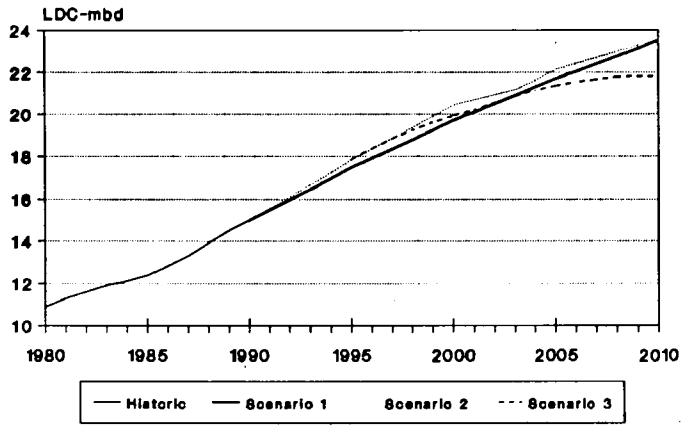
Sources: SOEC, World Bank, United Nations, Planecon, DG XVII estimates
Primary energy demand based on SOEC conversion factors

4.2 World Oil Market

OECD OIL DEMAND



LDC OIL DEMAND



CALL ON OPEC CRUDE

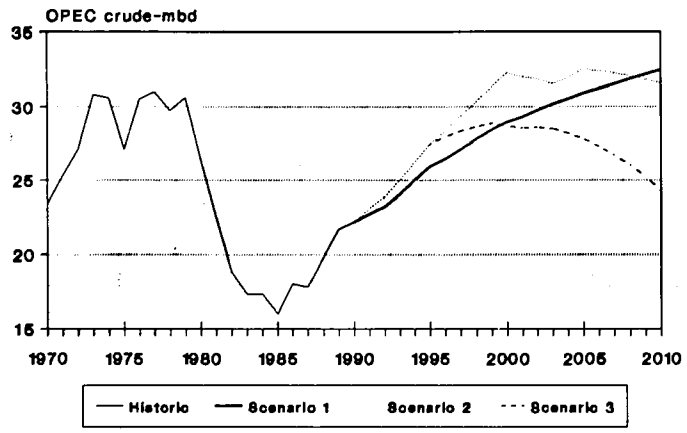


Table 4.2.1

Oil Supply and Demand

Summary of 3 scenarios

Mbd	1973	1979	1985	1989	1990	1995 Sc. 1	1995 Sc. 2/3	2000 Sc. 1	2000 Sc. 2	2000 Sc. 3	2010 Sc. 1	2010 Sc. 2	2010 Sc. 3
CONSUMPTION													
OECD	40.5	41.8	34.4	37.4	37.9	39.9	41.5	40.3	43.6	40.4	39.5	41.8	32.5
LDCs	7.5	10.6	12.4	14.5	15.0	17.5	17.9	19.7	20.4	19.9	23.5	23.6	21.8
TOTAL	48.0	52.4	46.8	51.9	52.9	57.4	59.4	60.0	64.0	60.3	63.0	65.4	54.3
SUPPLY													
OECD	13.9	14.7	17.0	16.0	16.3	15.4	15.8	14.0	14.6	14.5	11.8	13.8	11.8
LDC	3.3	5.2	8.6	9.6	9.9	11.5	11.5	12.9	12.9	12.9	15.2	15.9	14.6
Processing gains	0.6	0.8	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.2	1.3	1.4	1.4
CPEs-Net exports	0.4	1.2	1.9	2.1	2.0	1.5	1.5	1.0	1.0	1.0	0.0	0.5	0.0
TOTAL NON OPEC	18.2	21.9	28.6	28.8	29.3	29.6	30.0	29.1	29.7	29.6	28.3	31.6	27.8
OPEC	31.2	31.5	17.5	23.6	24.1	27.8	29.4	30.9	34.3	30.7	34.7	33.8	26.5
(of which: Crude)	30.8	30.6	16.0	21.7	22.2	25.9	27.5	28.9	32.3	28.8	32.5	31.6	24.3
TOTAL	49.4	53.4	46.1	52.4	53.4	57.4	59.4	60.0	64.0	60.3	63.0	65.4	54.3
Stock changes	1.4	1.0	-0.7	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

% p. a.	1973	1979	1985	1989	1990	1995 Sc. 1	1995 Sc. 2/3	2000 Sc. 1	2000 Sc. 2	2000 Sc. 3	2010 Sc. 1	2010 Sc. 2	2010 Sc. 3
CONSUMPTION													
OECD		0.5	-3.2	2.1	1.3	1.0	1.8	0.2	1.0	-0.5	-0.2	-0.4	-2.2
LDCs		5.9	2.6	4.0	3.4	3.1	3.6	2.4	2.6	2.1	1.8	1.5	0.9
TOTAL		1.5	-1.9	2.6	1.9	1.6	2.3	0.9	1.5	0.3	0.5	0.2	-1.0
SUPPLY													
NON OPEC		3.1	4.5	0.2	1.7	0.2	0.5	-0.3	-0.2	-0.3	-0.3	0.6	-0.6
OPEC		0.2	-9.3	7.8	2.1	2.9	4.1	2.1	3.1	0.9	1.2	-0.1	-1.5
(of which: Crude)		-0.1	-10.2	7.9	2.3	3.1	4.4	2.2	3.3	0.9	1.2	-0.2	-1.7
TOTAL		1.3	-2.4	3.3	1.9	1.5	2.2	0.9	1.5	0.3	0.5	0.2	-1.0

5. FINAL RESULTS OF SCENARIOS 1 TO 4.

5.1 Energy Balances at Europe 12 level

Table 5.1.1 TOTAL PRIMARY ENERGY REQUIREMENT - SCENARIO 1

MTOE	1980	1985	1987	1990	1995	2000	2010
1. Indigeneous Production	482.64	592.48	604.53	617.99	607.94	591.40	609.28
of which :							
- Solids	197.45	172.58	168.94	158.33	143.36	122.35	105.34
- Oil	92.89	150.85	150.90	147.10	125.18	111.93	103.30
- Natural Gas	129.17	127.11	129.00	131.21	136.82	135.26	119.36
- Nuclear	44.01	123.62	136.25	160.56	179.58	196.06	251.51
- Hydro & Geotherm.	17.47	16.65	17.28	18.81	20.21	22.00	23.42
- Others & Renew.	1.66	1.67	2.16	1.98	2.79	3.80	6.35
2. Net Imports	591.95	456.54	489.08	558.80	646.96	715.43	796.39
of which :							
- Solids	52.45	62.14	59.55	76.83	102.79	152.19	216.94
- Oil	495.84	333.86	356.53	398.62	446.38	447.51	420.96
- Natural Gas	42.26	59.35	71.41	81.42	95.86	114.05	157.30
- Electricity	1.39	1.19	1.59	1.93	1.93	1.68	1.19
3.Inland Energy Consumption	1023.29	1026.73	1062.25	1148.33	1226.29	1278.07	1376.59
of which :							
- Solids	238.52	238.33	230.15	235.16	246.15	274.54	322.28
- Oil	551.32	462.66	476.58	517.26	542.95	530.68	495.18
- Natural Gas	171.01	184.71	198.23	212.63	232.68	249.31	276.66
- Nuclear	44.01	123.62	136.25	160.56	179.58	196.06	251.51
- Others	18.44	17.42	21.04	22.72	24.93	27.48	30.96
4. Electr. Generation Input	306.60	349.88	367.30	407.75	461.18	508.09	597.42
of which :							
- Solids	140.25	140.32	146.37	155.93	170.81	203.01	250.75
- Oil	71.06	39.45	36.34	43.57	55.29	46.54	20.98
- Gas	32.16	28.18	28.89	27.01	33.19	37.94	47.15
- Nuclear	44.01	123.62	136.25	160.56	179.58	196.06	251.51
- Hydro & Geotherm.	17.47	16.65	17.28	18.81	20.21	22.00	23.42
- Others & Renew.	1.66	1.66	2.16	1.87	2.10	2.54	3.61
5. Final Energy Consumption	697.28	676.48	701.63	752.77	792.32	813.52	849.82
of which :							
- Industry	249.51	213.06	213.84	226.18	235.60	242.37	261.85
- Transport	170.41	181.53	198.81	222.42	237.24	245.72	253.77
- Tertiary-Domestic	277.36	281.89	288.97	304.17	319.48	325.43	334.20
%	1980	1985	1987	1990	1995	2000	2010
Share of oil in inland energy consumption	53.88	45.06	44.87	45.04	44.28	41.52	35.97
Share of coal and nuclear in electr. production	60.10	75.44	76.95	77.62	75.98	78.54	84.07
Supply dependance on imports	57.85	44.47	46.04	48.66	52.76	55.98	57.85

Table 5.1.2 TOTAL PRIMARY ENERGY REQUIREMENT - SCENARIO 2

MTOE	1980	1985	1987	1990	1995	2000	2010
1. Indigeneous Production	482.64	592.48	604.53	617.99	627.27	626.95	656.81
of which :							
- Solids	197.45	172.58	168.94	158.33	143.86	123.55	107.84
- Oil	92.89	150.85	150.90	147.10	132.33	126.44	119.02
- Natural Gas	129.17	127.11	129.00	131.21	140.51	140.60	132.55
- Nuclear	44.01	123.62	136.25	160.56	187.35	209.87	266.60
- Hydro & Geotherm.	17.47	16.65	17.28	18.81	20.34	22.55	24.32
- Others & Renew.	1.66	1.67	2.16	1.98	2.88	3.94	6.48
2. Net Imports	591.95	456.54	489.08	558.80	709.77	821.15	874.28
of which :							
- Solids	52.45	62.14	59.55	76.83	116.61	181.71	239.24
- Oil	495.84	333.86	356.53	398.62	479.14	498.68	459.01
- Natural Gas	42.26	59.35	71.41	81.42	112.01	139.01	174.82
- Electricity	1.39	1.19	1.59	1.93	2.01	1.74	1.21
3.Inland Energy Consumption	1023.29	1026.73	1062.25	1148.33	1308.43	1419.35	1502.01
of which :							
- Solids	238.52	238.33	230.15	235.16	260.47	305.26	347.08
- Oil	551.32	462.66	476.58	517.26	582.87	596.36	548.95
- Natural Gas	171.01	184.71	198.23	212.63	252.52	279.61	307.37
- Nuclear	44.01	123.62	136.25	160.56	187.35	209.87	266.60
- Others	18.44	17.42	21.04	22.72	25.23	28.23	32.01
4. Electr. Generation Input	306.60	349.88	367.30	407.75	489.52	560.74	646.33
of which :							
- Solids	140.25	140.32	146.37	155.93	182.53	230.14	272.82
- Oil	71.06	39.45	36.34	43.57	58.21	49.35	23.86
- Gas	32.16	28.18	28.89	27.01	38.90	46.15	54.99
- Nuclear	44.01	123.62	136.25	160.56	187.35	209.87	266.60
- Hydro & Geotherm.	17.47	16.65	17.28	18.81	20.34	22.55	24.32
- Others & Renew.	1.66	1.66	2.16	1.87	2.19	2.68	3.74
5. Final Energy Consumption	697.28	676.48	701.63	752.77	848.95	907.83	934.58
of which :							
- Industry	249.51	213.06	213.84	226.18	247.96	258.61	271.29
- Transport	170.41	181.53	198.81	222.42	263.57	296.82	300.93
- Tertiary-Domestic	277.36	281.89	288.97	304.17	337.42	352.40	362.36
%	1980	1985	1987	1990	1995	2000	2010
Share of oil in inland energy consumption	53.88	45.06	44.87	45.04	44.55	42.02	36.55
Share of coal and nuclear in electr. production	60.10	75.44	76.95	77.62	75.56	78.47	83.46
Supply dependance on imports	57.85	44.47	46.04	48.66	54.25	57.85	58.21

Table 5.1.3 **TOTAL PRIMARY ENERGY REQUIREMENT - SCENARIO 3**

MTOE	1980	1985	1987	1990	1995	2000	2010
1. Indigeneous Production	482.64	592.48	604.53	617.99	627.27	609.91	646.10
of which :							
- Solids	197.45	172.58	168.94	158.33	143.86	123.14	105.00
- Oil	92.89	150.85	150.90	147.10	132.33	122.64	113.15
- Natural Gas	129.17	127.11	129.00	131.21	140.51	139.79	126.46
- Nuclear	44.01	123.62	136.25	160.56	187.35	197.80	268.37
- Hydro & Geotherm.	17.47	16.65	17.28	18.81	20.34	22.33	23.74
- Others & Renew.	1.66	1.67	2.16	1.98	2.88	4.21	9.38
2. Net Imports	591.95	456.54	489.08	558.80	709.77	737.47	561.92
of which :							
- Solids	52.45	62.14	59.55	76.83	116.61	146.40	114.97
- Oil	495.84	333.86	356.53	398.62	479.14	451.34	270.85
- Natural Gas	42.26	59.35	71.41	81.42	112.01	138.71	177.24
- Electricity	1.39	1.19	1.59	1.93	2.01	1.02	-1.14
3.Inland Energy Consumption	1023.29	1026.73	1062.25	1148.33	1308.43	1318.40	1178.94
of which :							
- Solids	238.52	238.33	230.15	235.16	260.47	269.54	219.97
- Oil	551.32	462.66	476.58	517.26	582.87	545.02	354.92
- Natural Gas	171.01	184.71	198.23	212.63	252.52	278.50	303.70
- Nuclear	44.01	123.62	136.25	160.56	187.35	197.80	268.37
- Others	18.44	17.42	21.04	22.72	25.23	27.56	31.98
4. Electr. Generation Input	306.60	349.88	367.30	407.75	489.52	520.66	550.99
of which :							
- Solids	140.25	140.32	146.37	155.93	182.53	202.07	168.85
- Oil	71.06	39.45	36.34	43.57	58.21	45.67	18.94
- Gas	32.16	28.18	28.89	27.01	38.90	50.24	67.46
- Nuclear	44.01	123.62	136.25	160.56	187.35	197.80	268.37
- Hydro & Geotherm.	17.47	16.65	17.28	18.81	20.34	22.33	23.74
- Others & Renew.	1.66	1.66	2.16	1.87	2.19	2.55	3.64
5. Final Energy Consumption	697.28	676.48	701.63	752.77	848.95	846.46	712.49
of which :							
- Industry	249.51	213.06	213.84	226.18	247.96	248.44	229.02
- Transport	170.41	181.53	198.81	222.42	263.57	255.15	164.88
- Tertiary-Domestic	277.36	281.89	288.97	304.17	337.42	342.87	318.59

%	1980	1985	1987	1990	1995	2000	2010
Share of oil in inland energy consumption	53.88	45.06	44.87	45.04	44.55	41.34	30.11
Share of coal and nuclear in electr. production	60.10	75.44	76.95	77.62	75.56	76.80	79.35
Supply dependance on imports	57.85	44.47	46.04	48.66	54.25	55.94	47.66

Table 5.1.4 **TOTAL PRIMARY ENERGY REQUIREMENT - SCENARIO 4**

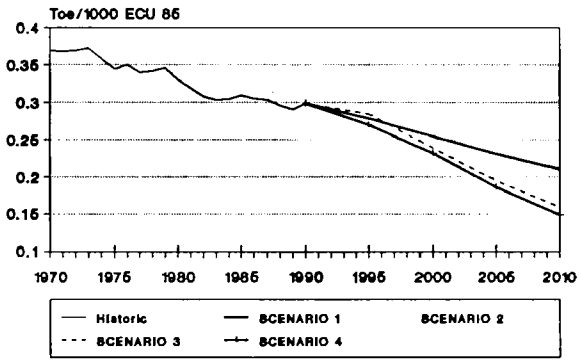
MTOE	1980	1985	1987	1990	1995	2000	2010
1. Indigeneous Production	482.64	592.48	604.53	617.99	608.20	587.29	549.03
of which :							
- Solids	197.45	172.58	168.94	158.33	143.36	122.35	101.94
- Oil	92.89	150.85	150.90	147.10	125.10	111.81	102.83
- Natural Gas	129.17	127.11	129.00	131.21	136.78	135.14	119.36
- Nuclear	44.01	123.62	136.25	160.56	179.58	191.57	192.14
- Hydro & Geotherm.	17.47	16.65	17.28	18.81	20.21	22.00	23.42
- Others & Renew.	1.66	1.67	2.16	1.98	3.17	4.42	9.34
2. Net Imports	591.95	456.54	489.08	558.80	610.41	610.61	455.64
of which :							
- Solids	52.45	62.14	59.55	76.83	89.75	112.59	106.23
- Oil	495.84	333.86	356.53	398.62	429.93	396.24	219.56
- Natural Gas	42.26	59.35	71.41	81.42	88.81	100.14	128.81
- Electricity	1.39	1.19	1.59	1.93	1.93	1.64	1.04
3.Inland Energy Consumption	1023.29	1026.73	1062.25	1148.33	1190.01	1168.94	975.59
of which :							
- Solids	238.52	238.33	230.15	235.16	233.11	234.94	208.17
- Oil	551.32	462.66	476.58	517.26	526.42	479.09	293.31
- Natural Gas	171.01	184.71	198.23	212.63	225.59	235.28	248.17
- Nuclear	44.01	123.62	136.25	160.56	179.58	191.57	192.14
- Others	18.44	17.42	21.04	22.72	25.31	28.06	33.80
4. Electr. Generation Input	306.60	349.88	367.30	407.75	456.63	473.48	459.54
of which :							
- Solids	140.25	140.32	146.37	155.93	167.40	176.93	169.36
- Oil	71.06	39.45	36.34	43.57	53.08	41.38	19.50
- Gas	32.16	28.18	28.89	27.01	34.06	38.76	51.11
- Nuclear	44.01	123.62	136.25	160.56	179.58	191.57	192.14
- Hydro & Geotherm.	17.47	16.65	17.28	18.81	20.21	22.00	23.42
- Others & Renew.	1.66	1.66	2.16	1.87	2.30	2.84	4.01
5. Final Energy Consumption	697.28	676.48	701.63	752.77	759.70	729.47	574.59
of which :							
- Industry	249.51	213.06	213.84	226.18	220.70	218.73	191.02
- Transport	170.41	181.53	198.81	222.42	230.41	218.12	124.04
- Tertiary-Domestic	277.36	281.89	288.97	304.17	308.59	292.62	259.53
%	1980	1985	1987	1990	1995	2000	2010
Share of oil in inland energy consumption	53.88	45.06	44.87	45.04	44.24	40.98	30.06
Share of coal and nuclear in electr. production	60.10	75.44	76.95	77.62	75.99	77.83	78.67
Supply dependance on imports	57.85	44.47	46.04	48.66	51.29	52.24	46.76

MAIN ENERGY INDICATORS
(EUROPE 12)

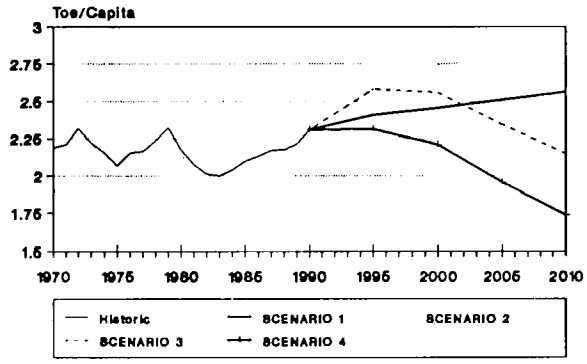
Intensities fall fastest in scenario 3 and scenario 4

Per capita total consumption falls in scenario 3 and scenario 4

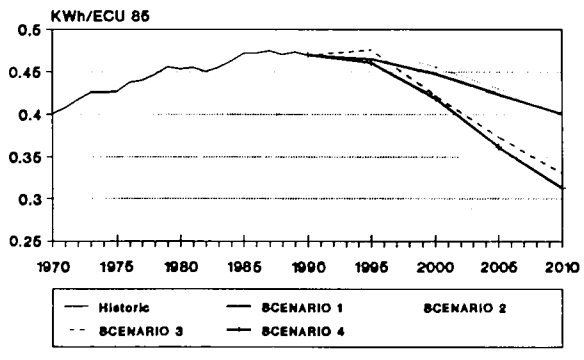
Total Primary Energy / GDP



Total Final Consumption / Capita



Electricity Consumption / GDP



Electricity Consumption / Capita

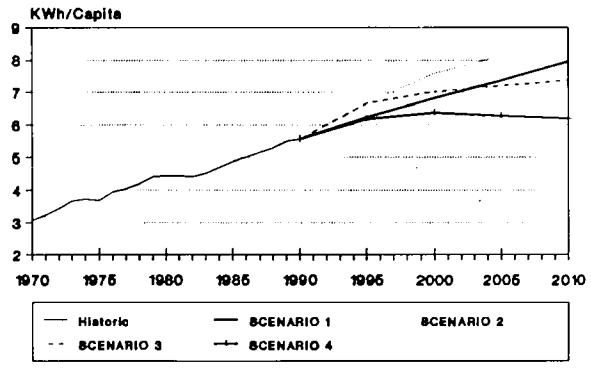


Table 5.1.5 **MAIN ECONOMIC AND ENERGY INDICATORS**

TIME	TFC/GDP Toe/Thousand ECU	TPER/GDP Toe/Thousand ECU	TFC/POP Toe/capita	TPER/POP Toe/capita	ELECT./GDP KWh/ECU	ELECT/POP MWh/capita
1960	0.261	0.343	1.363	1.792	0.312	1.632
1961	0.257	0.337	1.397	1.835	0.318	1.731
1962	0.264	0.345	1.491	1.948	0.330	1.863
1963	0.274	0.355	1.601	2.073	0.343	2.003
1964	0.266	0.349	1.632	2.140	0.349	2.138
1965	0.267	0.349	1.691	2.209	0.359	2.273
1966	0.265	0.344	1.732	2.246	0.367	2.396
1967	0.268	0.347	1.796	2.324	0.374	2.501
1968	0.274	0.353	1.921	2.468	0.383	2.684
1969	0.280	0.360	2.062	2.648	0.395	2.904
1970	0.286	0.369	2.191	2.825	0.401	3.071
1971	0.281	0.368	2.214	2.896	0.408	3.215
1972	0.284	0.369	2.319	3.018	0.418	3.415
1973	0.259	0.372	2.226	3.200	0.426	3.663
1974	0.247	0.359	2.157	3.132	0.426	3.717
1975	0.241	0.344	2.071	2.958	0.427	3.673
1976	0.240	0.350	2.156	3.147	0.438	3.938
1977	0.236	0.340	2.163	3.122	0.440	4.035
1978	0.237	0.341	2.236	3.214	0.447	4.206
1979	0.240	0.346	2.324	3.352	0.456	4.413
1980	0.223	0.330	2.179	3.224	0.454	4.436
1981	0.213	0.319	2.078	3.106	0.455	4.431
1982	0.206	0.308	2.015	3.013	0.451	4.418
1983	0.202	0.303	2.003	3.009	0.455	4.518
1984	0.201	0.304	2.041	3.085	0.463	4.693
1985	0.203	0.309	2.101	3.198	0.472	4.887
1986	0.201	0.305	2.135	3.233	0.472	4.998
1987	0.200	0.303	2.174	3.284	0.475	5.150
1988	0.194	0.296	2.176	3.311	0.471	5.279
1989	0.191	0.290	2.216	3.365	0.474	5.490
1990	0.195	0.298	2.311	3.525	0.470	5.563
1995						
Sc. 1	0.179	0.277	2.410	3.720	0.465	6.241
Sc. 2	0.184	0.283	2.583	3.970	0.476	6.674
Sc. 3	0.184	0.284	2.583	3.972	0.476	6.674
Sc. 4	0.172	0.269	2.315	3.610	0.461	6.186
2000						
Sc. 1	0.161	0.253	2.459	3.850	0.448	6.819
Sc. 2	0.165	0.257	2.744	4.277	0.456	7.590
Sc. 3	0.154	0.239	2.559	3.972	0.422	7.025
Sc. 4	0.145	0.231	2.210	3.520	0.419	6.383
2005						
Sc. 1	0.145	0.230	2.512	3.992	0.424	7.363
Sc. 2	0.147	0.233	2.782	4.395	0.430	8.128
Sc. 3	0.122	0.195	2.346	3.751	0.373	7.200
Sc. 4	0.113	0.185	1.960	3.210	0.362	6.290
2010						
Sc. 1	0.129	0.209	2.565	4.139	0.401	7.951
Sc. 2	0.132	0.211	2.821	4.517	0.406	8.704
Sc. 3	0.096	0.159	2.151	3.542	0.331	7.379
Sc. 4	0.088	0.148	1.738	2.928	0.313	6.199

5.2 Electricity Sector

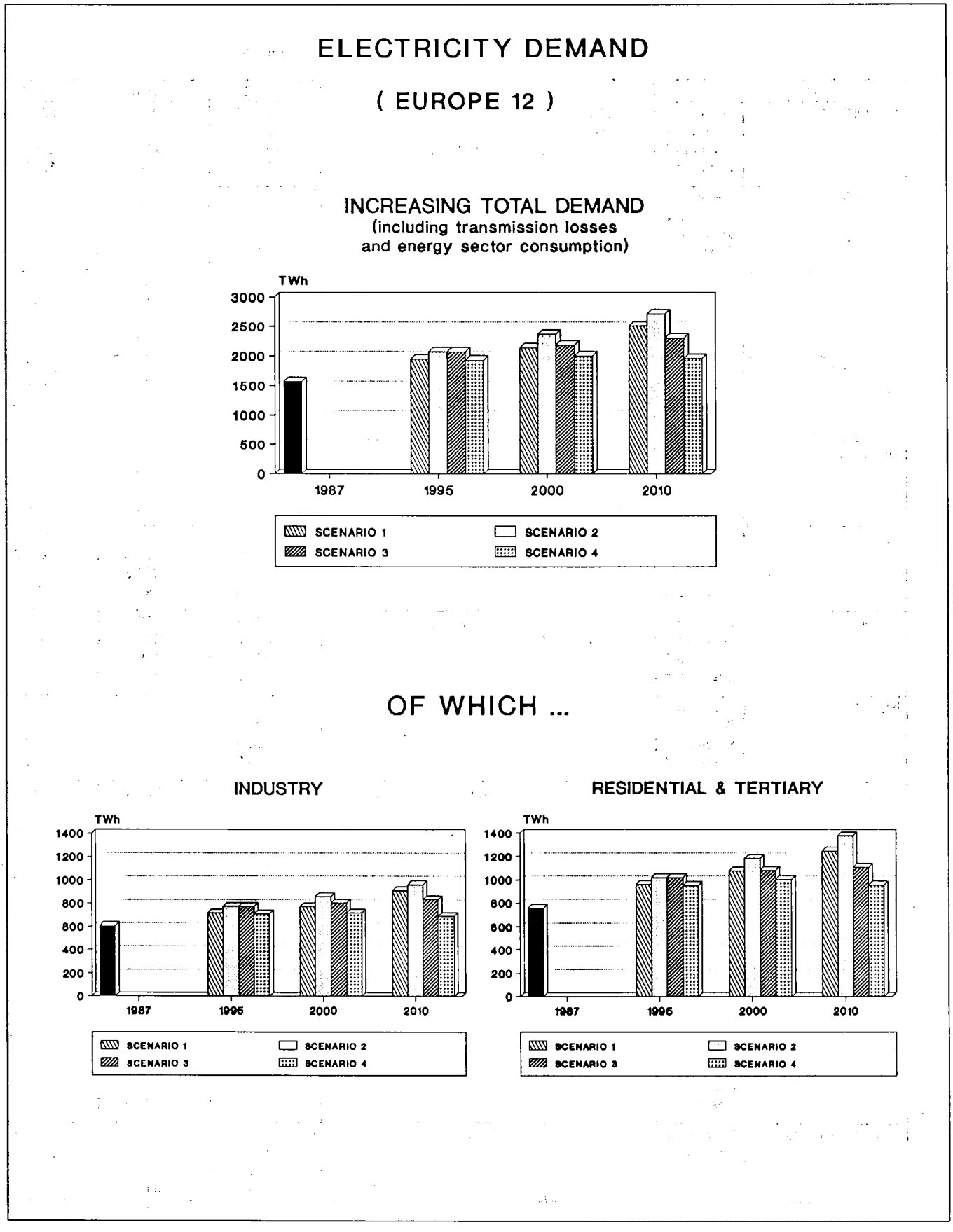


Table 5.2.1 **EUROPE 12 : TOTAL ELECTRICITY DEMAND**

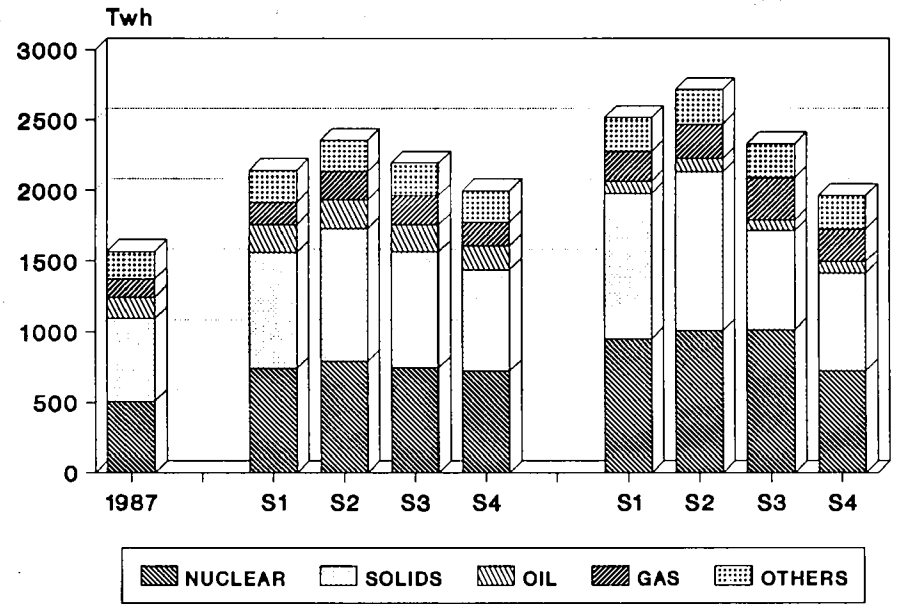
including transmission losses and energy sector consumption

Twh		1987	1990	1995	2000	2005	2010
EUROPE 12	Scenario 1	1569.4	1719.8	1942.8	2139.5	2314.9	2507.4
	Scenario 2	1569.4	1719.8	2068.1	2358.8	2526.9	2709.3
	Scenario 3	1569.4	1719.8	2068.1	2184.1	2238.5	2296.2
	Scenario 4	1569.4	1719.8	1924.6	1998.0	1974.2	1952.5
BELGIUM	Scenario 1	56.5	61.8	71.2	81.4	89.7	98.9
	Scenario 2			74.2	88.9	96.7	105.2
	Scenario 3			74.2	79.2	81.5	84.0
	Scenario 4			70.4	77.0	73.5	70.1
DENMARK	Scenario 1	29.9	30.9	34.6	38.1	41.4	45.1
	Scenario 2			36.1	41.2	44.9	49.0
	Scenario 3			36.1	37.9	37.4	37.0
	Scenario 4			34.3	35.1	34.7	34.2
GERMANY	Scenario 1	393.2	427.6	462.6	480.5	498.7	517.6
	Scenario 2			490.2	523.5	536.0	548.8
	Scenario 3			490.2	504.8	496.8	489.0
	Scenario 4			459.0	448.5	439.4	430.5
GREECE	Scenario 1	28.5	32.7	39.0	48.1	57.8	69.6
	Scenario 2			44.3	60.5	70.2	81.6
	Scenario 3			44.3	51.0	55.8	61.0
	Scenario 4			37.9	44.0	43.2	42.4
SPAIN	Scenario 1	124.1	134.3	154.6	175.2	194.7	216.3
	Scenario 2			183.4	217.0	236.5	257.8
	Scenario 3			183.4	210.3	225.6	242.1
	Scenario 4			151.2	162.5	148.3	135.3
FRANCE	Scenario 1	328.4	358.5	414.1	472.5	520.9	574.2
	Scenario 2			434.5	515.7	564.1	617.1
	Scenario 3			434.5	457.7	475.0	493.0
	Scenario 4			413.2	445.3	448.4	451.6
IRELAND	Scenario 1	11.7	13.1	15.7	17.7	20.2	23.0
	Scenario 2			18.0	21.2	23.8	26.8
	Scenario 3			18.0	20.6	21.9	23.4
	Scenario 4			15.3	16.8	16.7	16.6
ITALY	Scenario 1	209.8	236.7	274.5	309.1	337.1	367.7
	Scenario 2			288.3	330.9	359.8	391.3
	Scenario 3			288.3	304.8	315.1	325.9
	Scenario 4			270.6	285.6	294.9	304.5
LUXEMBOURG	Scenario 1	3.9	4.8	5.3	5.9	6.4	6.9
	Scenario 2			5.6	6.5	6.9	7.2
	Scenario 3			5.6	6.0	6.0	6.0
	Scenario 4			5.6	5.4	5.3	5.2
NETHERLANDS	Scenario 1	69.8	75.6	85.2	91.0	100.3	110.6
	Scenario 2			90.6	98.6	106.8	115.6
	Scenario 3			90.6	93.3	95.2	97.1
	Scenario 4			84.3	84.4	85.6	86.7
PORTUGAL	Scenario 1	22.3	26.7	33.4	38.0	44.5	52.2
	Scenario 2			36.8	44.9	50.1	55.8
	Scenario 3			36.8	42.7	46.3	50.3
	Scenario 4			32.6	35.4	36.0	36.6
UNITED KINGDOM	Scenario 1	291.4	317.3	352.6	382.0	403.1	425.3
	Scenario 2			366.1	410.0	431.0	453.1
	Scenario 3			366.1	376.0	381.8	387.7
	Scenario 4			350.1	358.0	348.3	338.9

Source: SOEC and DG XVII A2 estimates

STRUCTURE OF ELECTRICITY PRODUCTION BY FUEL

(EUROPE 12)



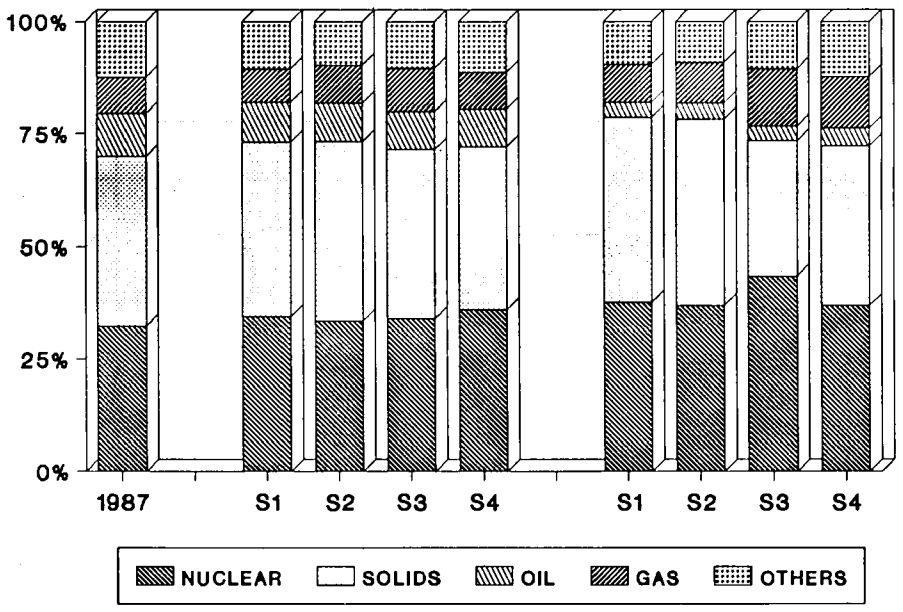


Table 5.2.2 ELECTRICITY PRODUCTION BY FUEL - SCENARIO 1

TWH		Nuclear	Solids	Oil	Gas	Renew.	TOTAL
EUROPE 12	1990	603.6	621.7	176.7	115.3	199.6	1716.9
	1995	675.1	685.0	224.9	141.5	213.3	1939.7
	2000	739.3	822.4	192.8	161.2	223.8	2139.5
	2010	949.4	1030.0	85.5	211.8	240.2	2516.9
BELGIUM	1990	37.5	16.2	5.5	3.4	1.6	64.2
	1995	37.5	17.2	7.7	6.0	1.6	70.1
	2000	37.5	25.5	6.7	8.3	2.2	80.3
	2010	52.7	30.0	3.1	9.0	2.9	97.7
DENMARK	1990		28.0	1.3	0.5	0.5	30.4
	1995		29.6	1.3	2.2	1.0	34.1
	2000		31.9	1.2	2.9	1.6	37.6
	2010		35.5	1.4	6.4	1.3	44.6
GERMANY	1990	159.4	198.6	22.4	22.7	21.4	424.5
	1995	159.5	204.4	36.1	33.4	21.9	455.4
	2000	157.4	235.0	11.9	45.6	23.4	473.2
	2010	183.5	258.7	4.9	36.0	27.5	510.6
GREECE	1990		22.3	6.8		3.4	32.5
	1995		25.9	4.2	2.1	5.8	37.9
	2000		34.3	3.4	1.8	7.4	47.0
	2010		54.7	2.5	1.3	10.0	68.5
SPAIN	1990	48.2	49.0	6.1	3.8	33.6	140.6
	1995	48.2	64.6	7.6	1.9	38.7	161.0
	2000	62.9	65.6	10.1	3.4	39.8	181.7
	2010	91.1	79.4	3.5	7.0	43.2	224.2
FRANCE	1990	293.7	27.1	1.5	3.1	69.7	395.0
	1995	359.6	23.1	6.6	3.9	70.5	463.7
	2000	413.1	32.7	13.2	7.3	70.8	537.1
	2010	503.6	65.1	0.7	13.3	71.2	653.9
IRELAND	1990		7.8	1.7	3.1	1.1	13.6
	1995		7.7	4.2	3.2	1.1	16.2
	2000		10.0	4.2	2.9	1.1	18.2
	2010		19.4	1.1	1.9	1.3	23.7
ITALY	1990		39.0	94.1	32.4	48.9	214.5
	1995		63.9	90.7	44.1	52.4	251.2
	2000		89.5	79.6	52.7	56.1	277.8
	2010		161.4	50.5	67.2	59.2	338.3
LUXEMBOURG	1990			0.1	0.5	0.6	1.2
	1995			0.1	0.6	0.6	1.3
	2000			0.1	0.6	0.6	1.3
	2010			0.1	0.6	0.6	1.3
NETHERLANDS	1990	3.5	21.6	3.0	38.4	0.5	67.1
	1995	3.1	29.6	8.1	33.4	0.6	74.7
	2000	3.1	45.2	8.5	21.3	0.9	79.0
	2010	25.5	47.5	2.6	27.9	1.4	104.9
PORTUGAL	1990		7.0	6.2	0.1	10.8	24.1
	1995		10.6	7.6	0.1	12.1	30.4
	2000		10.6	8.1	1.4	12.9	33.1
	2010		28.4	2.3	0.1	14.4	45.3
UNITED KINGDOM	1990	61.3	205.0	28.2	7.3	7.5	309.3
	1995	67.2	208.4	50.7	10.7	6.8	343.7
	2000	65.3	242.1	45.7	13.1	7.0	373.2
	2010	93.0	249.9	12.7	41.2	7.2	404.0

DG XVII A2 estimates

Table 5.2.3 **ELECTRICITY PRODUCTION BY FUEL - SCENARIO 2**

TWH		Nuclear	Solids	Oil	Gas	Renew.	TOTAL
EUROPE 12	1990	603.6	621.7	176.7	115.3	199.6	1716.9
	1995	703.9	741.6	237.1	167.7	211.3	2061.6
	2000	790.9	935.4	204.5	199.0	228.6	2358.4
	2010	1005.8	1122.2	97.4	244.6	248.8	2718.7
BELGIUM	1990	37.5	16.2	5.5	3.4	1.6	64.2
	1995	37.5	18.7	7.7	7.5	1.6	73.1
	2000	37.5	29.5	6.7	11.2	2.2	87.2
	2010	52.7	32.6	3.1	11.7	2.9	103.1
DENMARK	1990		28.0	1.3	0.5	0.5	30.4
	1995		31.1	1.4	2.2	1.0	35.7
	2000		34.5	1.4	3.2	1.6	40.6
	2010		38.9	1.6	3.2	4.8	48.4
GERMANY	1990	159.4	198.6	22.4	22.7	21.4	424.5
	1995	159.5	221.8	36.9	37.8	21.9	477.9
	2000	157.4	272.7	13.1	46.8	23.4	513.3
	2010	183.5	283.7	6.1	39.6	27.5	540.5
GREECE	1990		22.3	6.8		3.4	32.5
	1995		28.6	5.0	3.0	6.4	42.9
	2000		42.1	3.8	4.5	8.6	58.9
	2010		61.8	3.0	3.8	11.4	80.1
SPAIN	1990	48.2	49.0	6.1	3.8	33.6	140.6
	1995	48.2	85.8	11.9	4.0	38.7	188.7
	2000	62.9	98.4	13.1	6.4	41.6	222.3
	2010	91.1	112.0	6.5	10.0	45.0	264.5
FRANCE	1990	293.7	27.1	1.5	3.1	69.7	395.0
	1995	388.5	26.1	6.6	6.4	70.5	498.1
	2000	464.7	35.7	13.2	12.2	70.8	596.6
	2010	560.0	68.1	0.7	17.1	71.2	717.1
IRELAND	1990		7.8	1.7	3.1	1.1	13.6
	1995		7.7	5.8	4.0	1.1	18.5
	2000		12.4	4.2	4.0	1.1	21.7
	2010		22.1	1.2	3.0	1.3	27.5
ITALY	1990		39.0	94.1	32.4	48.9	214.5
	1995		66.3	93.7	49.0	52.4	261.5
	2000		91.9	85.0	60.9	56.0	293.9
	2010		163.8	55.5	75.0	59.2	353.5
LUXEMBOURG	1990			0.1	0.5	0.6	1.2
	1995			0.1	0.6	0.6	1.3
	2000			0.1	0.6	0.6	1.3
	2010			0.1	0.6	0.6	1.3
NETHERLANDS	1990	3.5	21.6	3.0	38.4	0.5	67.1
	1995	3.1	29.6	8.2	37.5	0.6	78.9
	2000	3.1	45.2	8.6	26.8	0.9	84.6
	2010	25.5	47.5	2.8	31.3	1.4	108.5
PORTUGAL	1990		7.0	6.2	0.1	10.8	24.1
	1995		12.9	7.6	0.1	9.6	30.2
	2000		14.8	8.2	1.4	14.8	39.1
	2010		28.4	2.4	0.1	16.2	47.2
UNITED KINGDOM	1990	61.3	205.0	28.2	7.3	7.5	309.3
	1995	67.2	213.0	52.2	15.7	6.8	354.9
	2000	65.3	258.1	47.3	21.1	7.0	398.9
	2010	93.0	263.3	14.4	49.2	7.2	427.2

DG XVII A2 estimates

Table 5.2.4 **ELECTRICITY PRODUCTION BY FUEL - SCENARIO 3**

TWH		Nuclear	Solids	Oil	Gas	Renew.	TOTAL
EUROPE 12	1990	603.6	621.7	176.7	115.3	199.6	1716.9
	1995	703.9	741.6	237.1	167.7	214.3	2064.6
	2000	745.8	818.6	188.5	211.6	227.5	2191.9
	2010	1013.1	698.0	76.8	299.4	245.4	2332.8
BELGIUM	1990	37.5	16.2	5.5	3.4	1.6	64.2
	1995	37.5	18.7	7.7	7.5	1.6	73.1
	2000	37.5	21.0	6.7	11.2	2.2	78.6
	2010	52.7	12.7	2.5	13.7	2.9	84.5
DENMARK	1990		28.0	1.3	0.5	0.5	30.4
	1995		31.1	1.4	2.2	1.0	35.7
	2000		31.4	1.2	3.2	1.6	37.4
	2010		25.3	1.0	7.3	2.9	36.5
GERMANY	1990	159.4	198.6	22.4	22.7	21.4	424.5
	1995	159.5	221.8	36.9	37.8	21.9	477.9
	2000	157.4	252.7	12.9	50.1	23.4	496.4
	2010	198.2	203.4	3.5	51.6	27.5	484.2
GREECE	1990		22.3	6.8		3.4	32.5
	1995		28.6	5.0	3.0	6.4	42.9
	2000		33.4	3.6	4.7	8.1	49.7
	2010		37.7	2.8	8.8	10.6	59.9
SPAIN	1990	48.2	49.0	6.1	3.8	33.6	140.6
	1995	48.2	85.8	11.9	4.0	38.7	188.7
	2000	62.9	92.6	12.4	6.4	41.4	215.5
	2010	112.6	79.9	2.9	10.0	44.7	250.0
FRANCE	1990	293.7	27.1	1.5	3.1	69.7	395.0
	1995	388.5	26.1	6.6	6.4	70.5	498.1
	2000	419.6	26.6	6.7	10.3	70.8	534.0
	2010	483.8	19.9	0.7	14.6	71.2	590.1
IRELAND	1990		7.8	1.7	3.1	1.1	13.6
	1995		7.7	5.8	4.0	1.1	18.5
	2000		11.8	4.2	4.0	1.1	21.1
	2010		16.4	1.1	5.3	1.3	24.1
ITALY	1990		39.0	94.1	32.4	48.9	214.5
	1995		66.3	93.7	49.0	52.4	261.5
	2000		69.9	78.9	65.1	56.1	270.0
	2010		95.5	44.1	97.7	59.2	296.4
LUXEMBOURG	1990			0.1	0.5	0.6	1.2
	1995			0.1	0.6	0.6	1.3
	2000			0.1	0.6	0.6	1.3
	2010			0.1	0.6	0.6	1.3
NETHERLANDS	1990	3.5	21.6	3.0	38.4	0.5	67.1
	1995	3.1	29.6	8.2	37.5	0.6	78.9
	2000	3.1	40.3	8.4	28.6	0.9	81.3
	2010	33.3	25.9	2.6	28.2	1.4	91.3
PORTUGAL	1990		7.0	6.2	0.1	10.8	24.1
	1995		12.9	7.6	0.1	12.6	33.2
	2000		13.2	8.1	1.4	14.4	37.2
	2010		19.6	1.3	6.5	15.9	43.4
UNITED KINGDOM	1990	61.3	205.0	28.2	7.3	7.5	309.3
	1995	67.2	213.0	52.2	15.7	6.8	354.9
	2000	65.3	225.8	45.3	26.1	7.0	369.5
	2010	132.6	161.9	14.3	55.1	7.3	371.0

DG XVII A2 estimates

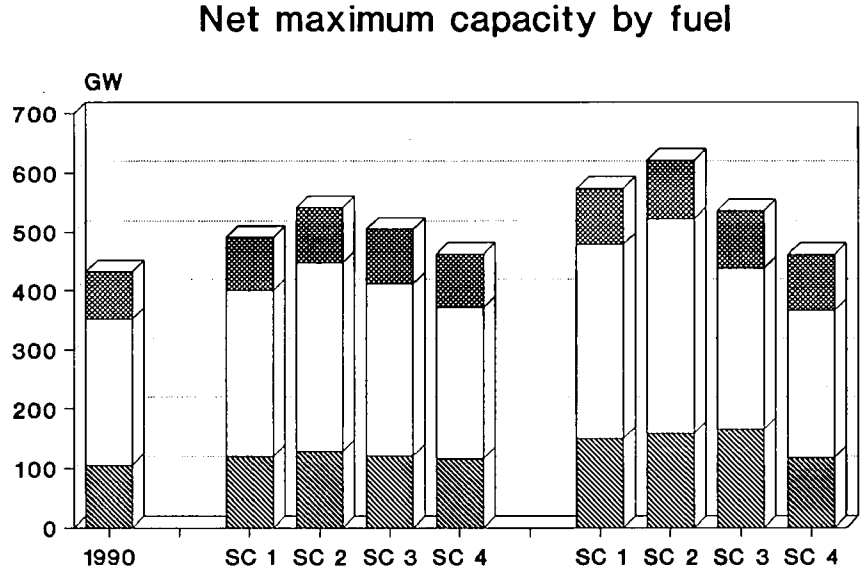
Table 5.2.5 ELECTRICITY PRODUCTION BY FUEL - SCENARIO 4

TWH		Nuclear	Solids	Oil	Gas	Renew.	TOTAL
EUROPE 12	1990	603.6	621.7	176.7	115.3	199.6	1716.9
	1995	675.1	690.4	216.2	145.0	194.5	1921.2
	2000	722.4	716.3	170.1	164.9	224.8	1998.5
	2010	724.4	692.6	79.1	227.5	240.3	1963.8
BELGIUM	1990	37.5	16.2	5.5	3.4	1.6	64.2
	1995	37.5	15.8	6.9	7.3	1.7	69.2
	2000	37.5	20.8	5.1	10.1	2.4	75.9
	2010	35.0	15.0	2.4	13.4	3.1	68.9
DENMARK	1990		28.0	1.3	0.5	0.5	30.4
	1995		29.4	1.3	2.2	1.1	33.9
	2000		28.8	1.2	3.1	1.6	34.7
	2010		23.3	1.1	6.4	2.9	33.8
GERMANY	1990	159.4	198.6	22.4	22.7	21.4	424.5
	1995	159.5	221.8	34.0	33.4	3.0	451.8
	2000	157.4	202.3	11.9	45.6	24.1	441.3
	2010	144.1	199.7	4.9	46.1	28.7	423.4
GREECE	1990		22.3	6.8		3.4	32.5
	1995		24.8	4.2	2.1	5.8	36.8
	2000		28.9	3.4	3.1	7.4	42.9
	2010		24.9	2.5	4.5	9.5	41.3
SPAIN	1990	48.2	49.0	6.1	3.8	33.6	140.6
	1995	48.2	59.1	7.6	4.0	38.7	157.6
	2000	55.5	62.0	7.1	4.5	39.9	169.0
	2010	55.9	38.8	3.1	4.7	40.7	143.2
FRANCE	1990	293.7	27.1	1.5	3.1	69.7	395.0
	1995	359.6	23.1	5.7	3.9	70.5	462.9
	2000	403.6	22.4	5.9	7.3	70.8	510.0
	2010	425.4	21.4	0.7	12.6	71.2	531.3
IRELAND	1990		7.8	1.7	3.1	1.1	13.6
	1995		7.7	3.9	3.2	1.1	15.8
	2000		8.4	4.2	3.7	1.1	17.3
	2010		10.7	1.1	4.1	1.3	17.3
ITALY	1990		39.0	94.1	32.4	48.9	214.5
	1995		61.0	89.8	44.1	52.4	247.3
	2000		70.0	77.1	51.2	56.1	254.3
	2010		106.6	45.5	63.8	59.2	275.1
LUXEMBOURG	1990			0.1	0.5	0.6	1.2
	1995			0.1	0.6	0.6	1.3
	2000			0.1	0.6	0.6	1.3
	2010			0.1	0.6	0.6	1.3
NETHERLANDS	1990	3.5	21.6	3.0	38.4	0.5	67.1
	1995	3.1	29.6	7.1	33.4	0.5	73.8
	2000	3.1	41.1	6.1	21.3	0.9	72.4
	2010	8.5	40.5	2.6	27.9	1.4	81.0
PORTUGAL	1990		7.0	6.2	0.1	10.8	24.1
	1995		9.8	7.6	0.1	12.2	29.7
	2000		9.6	6.5	1.4	13.0	30.5
	2010		10.8	2.3	2.2	14.4	29.7
UNITED KINGDOM	1990	61.3	205.0	28.2	7.3	7.5	309.3
	1995	67.2	208.4	48.2	10.7	6.8	341.2
	2000	65.3	222.2	41.6	13.1	7.0	349.2
	2010	55.5	200.9	12.7	41.2	7.3	317.6

DG XVII A2 estimates

ELECTRICITY CAPACITIES
(EUROPE 12)

Net maximum capacity by fuel



Fossil share declines in scenario 3 & 4

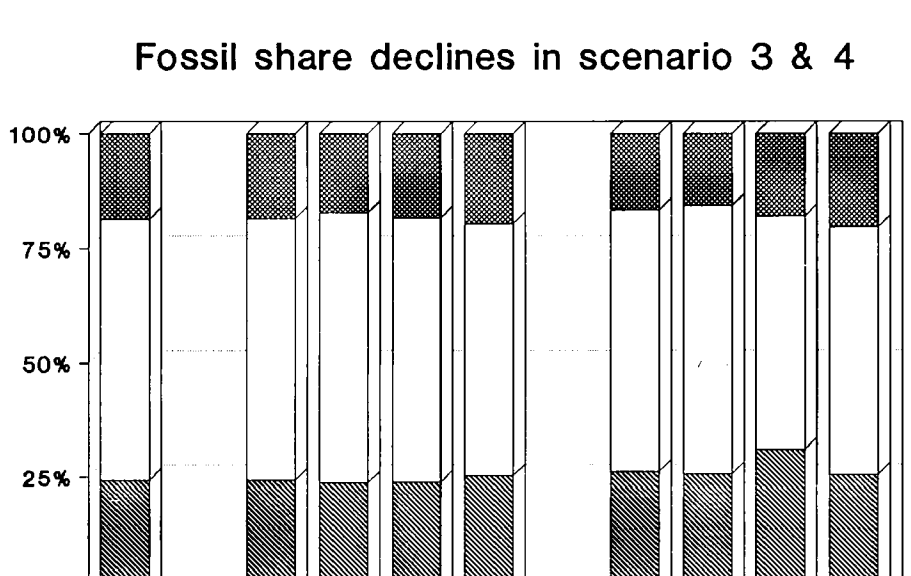


Table 5.2.6 **ELECTRICITY GENERATING CAPACITIES - SCENARIO 1**

GW		Nuclear	Solids	Oil	Gas	Oil+gas	Peak	Hydro	Renew.	TOTAL
EUROPE 12	1990	105.3	141.4	49.9	18.0	23.2	14.3	78.7	2.1	433.0
	1995	111.8	143.7	50.0	19.9	22.0	17.0	83.5	2.8	450.7
	2000	119.2	170.8	46.6	23.1	20.3	20.3	86.7	4.3	491.2
	2010	150.1	220.5	31.8	40.0	13.4	23.0	89.5	6.2	574.6
BELGIUM	1990	5.50	4.03	0.11	0.06	1.90	0.90	1.33		13.83
	1995	5.50	3.93	0.11	0.36	1.67	1.15	1.33		14.05
	2000	5.50	5.73	0.08	0.93	1.61	1.66	1.33	0.15	16.99
	2010	7.73	7.76		1.21	0.97	1.29	1.33	0.43	20.72
DENMARK	1990		6.62	0.55	0.15	0.26	0.27		0.12	7.97
	1995		7.19	0.55	0.31	0.26	0.28		0.31	8.90
	2000		7.45	0.55	0.45	0.26	0.31		0.44	9.46
	2010		8.92	0.28	0.72	0.26	0.36		0.64	11.18
GERMANY	1990	22.90	44.21	7.76	11.83		4.82	6.78	0.97	99.25
	1995	22.90	42.20	7.61	11.21		5.04	6.85	1.04	96.84
	2000	22.55	49.90	7.48	11.00		5.76	6.93	1.24	104.84
	2010	26.55	60.22	5.69	11.09		6.50	7.09	1.55	118.69
GREECE	1990		4.39	1.03			0.91	2.53	0.01	8.86
	1995		4.48	0.69	0.34		0.99	3.19	0.13	9.81
	2000		6.09	0.47	0.34		1.17	3.87	0.19	12.12
	2010		10.09		0.34		1.24	4.95	0.31	16.92
SPAIN	1990	7.45	9.89	5.22		1.90		15.94	0.00	40.40
	1995	7.45	9.71	4.62		1.90		18.41	0.00	42.09
	2000	9.72	10.41	2.72		1.90		19.98	0.00	44.72
	2010	14.08	13.54	0.54	0.60	3.01		20.85	0.00	52.62
FRANCE	1990	55.53	15.44	5.13	0.23	0.25	0.85	24.42	0.24	102.09
	1995	62.53	14.77	5.13	0.23	0.25	0.79	24.47	0.24	108.42
	2000	68.46	15.98	5.13	0.23	0.25	3.25	24.47	0.72	118.50
	2010	81.32	18.34	4.55	0.30	0.25	7.30	24.47	1.03	137.55
IRELAND	1990		1.29	0.58	0.26	0.74	0.36	0.51		3.73
	1995		1.29	0.58	0.26	0.74	0.36	0.51		3.73
	2000		1.57	0.98	0.26	0.74	0.36	0.51		4.41
	2010		3.17	0.78	0.17	0.49	0.36	0.51		5.48
ITALY	1990	1.27	9.74	15.67	0.37	11.11	2.54	18.76	0.65	60.10
	1995	1.27	13.56	16.87	1.57	11.11	2.51	19.32	0.88	67.10
	2000	1.27	18.03	16.22	3.97	10.27	2.42	19.71	1.15	73.04
	2010	1.27	31.77	12.27	10.78	7.40	2.29	19.71	1.27	86.76
LUXEMBOURG	1990		0.18			0.01	0.01	1.12		1.31
	1995		0.18			0.01	0.01	1.13		1.32
	2000		0.18			0.01	0.01	1.13		1.32
	2010		0.18			0.01	0.01	1.13		1.32
NETHERLANDS	1990	0.51	4.36		5.14	7.08	0.34		0.15	17.57
	1995	0.45	4.51		5.13	6.03	0.34		0.24	16.71
	2000	0.45	6.16		4.42	4.80	0.54		0.44	16.80
	2010	3.90	9.28		5.30	0.51	0.73		0.94	20.66
PORTUGAL	1990		1.27	1.70			0.33	3.10		6.41
	1995		1.81	1.70			0.33	4.09		7.94
	2000		1.81	1.23		0.47	0.46	4.54		8.51
	2010		4.96	1.23		0.47	0.13	5.20		11.99
UNITED KINGDOM	1990	12.14	40.05	12.15			2.98	4.21	0.00	71.52
	1995	11.69	40.07	12.12	0.50		5.24	4.22	0.00	73.85
	2000	11.21	47.47	11.71	1.50		4.38	4.24	0.00	80.52
	2010	15.29	52.27	6.51	9.47		2.86	4.27	0.00	90.67

Sources: UNIPEDE and DG XVII A2 estimates

Table 5.2.7 **ELECTRICITY GENERATING CAPACITIES - SCENARIO 2**

GW		Nuclear	Solids	Oil	Gas	Oil + gas	Peak	Hydro	Renew.	TOTAL
EUROPE 12	1990	105.3	141.4	49.9	18.0	23.2	14.3	78.7	2.2	433.0
	1995	114.7	155.3	51.0	22.7	24.1	18.8	84.0	2.9	473.3
	2000	127.9	197.7	47.2	28.3	23.9	23.2	88.5	4.4	541.0
	2010	158.8	244.7	32.4	44.6	17.0	25.5	91.3	6.4	620.7
BELGIUM	1990	5.50	4.03	0.11	0.06	1.90	0.90	1.33	0.00	13.83
	1995	5.50	4.23	0.11	0.66	1.67	1.15	1.33	0.00	14.65
	2000	5.50	6.63	0.08	1.53	1.61	1.72	1.33	0.15	18.56
	2010	7.73	8.36		1.81	0.97	1.35	1.33	0.43	21.98
DENMARK	1990		6.62	0.55	0.15	0.26	0.27		0.12	7.97
	1995		7.59	0.55	0.31	0.26	0.28		0.31	9.30
	2000		8.15	0.55	0.52	0.26	0.31		0.44	10.23
	2010		9.82	0.28	0.79	0.26	0.36		0.64	12.14
GERMANY	1990	22.90	44.21	7.76	11.83		4.82	6.78	0.97	99.25
	1995	22.90	46.10	7.61	11.21		5.54	6.85	1.04	101.24
	2000	22.55	58.60	7.48	11.00		6.46	6.93	1.24	114.24
	2010	26.55	67.02	5.69	11.09		6.86	7.09	1.55	125.85
GREECE	1990		4.39	1.03			0.91	2.53	0.01	8.86
	1995		4.89	0.69	0.49		1.02	3.49	0.15	10.73
	2000		7.52	0.47	0.84		1.26	4.47	0.26	14.81
	2010		11.51		0.84		1.39	5.56	0.52	19.82
SPAIN	1990	7.45	9.89	5.22		1.90		15.94	0.00	40.40
	1995	7.45	13.31	4.62	0.30	1.90		18.41	0.00	45.99
	2000	9.72	19.11	2.72	0.60	1.90		20.58	0.00	54.62
	2010	14.08	22.44	0.54	1.20	3.01		21.45	0.00	62.72
FRANCE	1990	55.53	15.44	5.13	0.23	0.25	0.85	24.42	0.24	102.09
	1995	65.43	15.37	5.13	0.53	0.25	1.39	24.47	0.24	112.82
	2000	77.16	16.78	5.13	0.86	0.25	4.08	24.47	0.72	129.46
	2010	90.02	18.94	4.55	0.90	0.25	7.66	24.47	1.03	147.81
IRELAND	1990		1.29	0.58	0.26	0.74	0.36	0.51		3.73
	1995		1.29	0.98	0.41	0.74	0.36	0.51		4.28
	2000		2.17	0.98	0.53	0.74	0.36	0.51		5.28
	2010		3.77	0.78	0.44	0.49	0.38	0.51		6.37
ITALY	1990	1.27	9.74	15.67	0.37	11.11	2.54	18.76	0.65	60.10
	1995	1.27	14.16	16.87	1.87	12.61	2.91	19.32	0.88	69.90
	2000	1.27	18.63	16.22	4.27	13.27	3.37	19.71	1.15	77.89
	2010	1.27	32.37	12.27	11.08	10.40	3.46	19.71	1.27	91.83
LUXEMBOURG	1990		0.18			0.01	0.01	1.12		1.31
	1995		0.18			0.01	0.01	1.13		1.32
	2000		0.18			0.01	0.01	1.13		1.32
	2010		0.18			0.01	0.01	1.13		1.32
NETHERLANDS	1990	0.51	4.36		5.14	7.08	0.34		0.15	17.57
	1995	0.45	4.51		5.43	6.63	0.48		0.24	17.75
	2000	0.45	6.16		5.02	5.40	0.68		0.44	18.14
	2010	3.90	9.28		5.40	1.11	0.86		0.94	21.49
PORTUGAL	1990		1.27	1.70			0.33	3.10		6.41
	1995		2.41	1.70			0.38	4.24		8.74
	2000		2.71	1.23		0.47	0.50	5.14		10.06
	2010		5.14	1.23		0.47	0.17	5.80		12.82
UNITED KINGDOM	1990	12.14	40.05	12.15			2.98	4.21	0.00	71.52
	1995	11.69	41.27	12.72	1.50		5.24	4.22	0.00	76.65
	2000	11.21	51.07	12.31	3.10		4.48	4.24	0.00	86.41
	2010	15.29	55.87	7.11	11.07		2.98	4.27	0.00	96.60

Sources: UNIPEDE and DG XVII A2 estimates

Table 5.2.8 **ELECTRICITY GENERATING CAPACITIES - SCENARIO 3**

GW		Nuclear	Solids	Oil	Gas	Oil + gas	Peak	Hydro	Renew.	TOTAL
EUROPE 12	1990	105.3	141.4	49.9	18.0	23.2	14.3	78.7	2.2	433.0
	1995	114.7	155.3	51.0	22.7	24.1	18.8	84.0	2.9	473.3
	2000	120.5	175.7	47.2	27.3	21.8	20.0	88.0	4.4	504.8
	2010	165.8	162.8	32.4	45.6	13.5	18.2	90.8	6.3	535.6
BELGIUM	1990	5.50	4.03	0.11	0.06	1.90	0.90	1.33	0.00	13.83
	1995	5.50	4.23	0.11	0.66	1.67	1.15	1.33	0.00	14.65
	2000	5.50	4.83	0.08	1.53	1.61	1.50	1.33	0.15	16.54
	2010	7.73	3.78		2.28	0.97	1.13	1.33	0.43	17.65
DENMARK	1990		6.62	0.55	0.15	0.26	0.27		0.12	7.97
	1995		7.59	0.55	0.31	0.26	0.28		0.31	9.30
	2000		7.33	0.55	0.52	0.26	0.31		0.44	9.41
	2010		6.42	0.28	1.24	0.26	0.33		0.64	9.16
GERMANY	1990	22.90	44.21	7.76	11.83		4.82	6.78	0.97	99.25
	1995	22.90	46.10	7.61	11.21		5.54	6.85	1.04	101.24
	2000	22.55	54.72	7.48	11.00		6.26	6.93	1.24	110.16
	2010	28.95	51.67	5.69	10.77		6.40	7.09	1.55	112.12
GREECE	1990		4.39	1.03			0.91	2.53	0.01	8.86
	1995		4.89	0.69	0.49		1.02	3.49	0.15	10.73
	2000		6.14	0.47	0.64		1.21	4.17	0.25	12.87
	2010		6.62		1.24		1.24	5.26	0.47	14.81
SPAIN	1990	7.45	9.89	5.22		1.90		15.94	0.00	40.40
	1995	7.45	13.31	4.62	0.30	1.90		18.41	0.00	45.99
	2000	9.72	18.25	2.72	0.60	1.90		20.58	0.00	53.77
	2010	18.16	16.04	0.54	1.20	1.61		21.45	0.00	59.01
FRANCE	1990	55.53	15.44	5.13	0.23	0.25	0.85	24.42	0.24	102.09
	1995	65.43	15.37	5.13	0.53	0.25	1.39	24.47	0.24	112.82
	2000	69.76	14.05	5.13	1.13	0.25	1.97	24.47	0.72	117.49
	2010	82.62	8.61	4.55	1.50	0.25	2.55	24.47	1.03	125.57
IRELAND	1990		1.29	0.58	0.26	0.74	0.36	0.51		3.73
	1995		1.29	0.98	0.41	0.74	0.36	0.51		4.28
	2000		2.02	0.98	0.52	0.74	0.36	0.51		5.12
	2010		2.90	0.78	0.53	0.49	0.36	0.51		5.57
ITALY	1990	1.27	9.74	15.67	0.37	11.11	2.54	18.76	0.65	60.10
	1995	1.27	14.16	16.87	1.87	12.61	2.91	19.32	0.88	69.90
	2000	1.27	15.18	16.22	3.97	11.77	2.82	19.71	1.15	72.09
	2010	1.27	20.89	12.27	11.07	8.90	2.39	19.71	1.27	77.77
LUXEMBOURG	1990		0.18			0.01	0.01	1.12		1.31
	1995		0.18			0.01	0.01	1.13		1.32
	2000		0.18			0.01	0.01	1.13		1.32
	2010		0.18			0.01	0.01	1.13		1.32
NETHERLANDS	1990	0.51	4.36		5.14	7.08	0.34		0.15	17.57
	1995	0.45	4.51		5.43	6.63	0.48		0.24	17.75
	2000	0.45	6.01		4.87	4.80	0.68		0.44	17.24
	2010	5.20	5.48		5.45	0.51	0.81		0.94	18.39
PORTUGAL	1990		1.27	1.70			0.33	3.10		6.41
	1995		2.41	1.70			0.38	4.24		8.74
	2000		2.41	1.23		0.47	0.48	4.96		9.55
	2010		3.47	1.23	0.60	0.47	0.15	5.62		11.55
UNITED KINGDOM	1990	12.14	40.05	12.15			2.98	4.21	0.00	71.52
	1995	11.69	41.27	12.72	1.50		5.24	4.22	0.00	76.65
	2000	11.21	44.58	12.31	2.50		4.38	4.24	0.00	79.23
	2010	21.89	36.78	7.11	9.74		2.86	4.27	0.00	82.65

Sources: UNIPEDE and DG XVII A2 estimates

Table 5.2.9 **ELECTRICITY GENERATING CAPACITIES - SCENARIO 4**

GW		Nuclear	Solids	Oil	Gas	Oil+gas	Peak	Hydro	Renew.	TOTAL
EUROPE 12	1990	105.3	141.4	49.9	18.0	23.2	14.3	78.7	2.2	433.0
	1995	111.8	142.3	50.0	19.9	22.0	16.4	83.5	2.8	448.8
	2000	116.7	148.1	46.6	23.1	20.3	16.7	86.7	4.3	462.6
	2010	117.1	149.3	31.8	40.8	11.2	16.6	88.4	6.2	461.4
BELGIUM	1990	5.50	4.03	0.11	0.06	1.90	0.90	1.33	0.00	13.83
	1995	5.50	3.79	0.11	0.36	1.67	1.12	1.33	0.00	13.88
	2000	5.50	4.69	0.08	1.23	1.61	1.48	1.33	0.15	16.08
	2010	5.13	3.57		2.10	0.97	1.11	1.33	0.43	14.64
DENMARK	1990		6.62	0.55	0.15	0.26	0.27		0.12	7.97
	1995		7.12	0.55	0.31	0.26	0.28		0.31	8.83
	2000		6.69	0.55	0.48	0.26	0.31		0.44	8.73
	2010		5.98	0.28	1.05	0.26	0.29		0.64	8.49
GERMANY	1990	22.90	44.21	7.76	11.83		4.82	6.78	0.97	99.25
	1995	22.90	42.20	7.61	11.21		4.74	6.85	1.04	96.54
	2000	22.55	43.93	7.48	11.00		4.76	6.93	1.24	97.87
	2010	23.25	47.91	5.69	11.09		4.77	7.09	1.55	101.34
GREECE	1990		4.39	1.03			0.91	2.53	0.01	8.86
	1995		4.48	0.69	0.34		0.99	3.19	0.13	9.81
	2000		5.19	0.47	0.51		1.17	3.87	0.19	11.40
	2010		4.38		0.81		1.17	4.68	0.31	11.35
SPAIN	1990	7.45	9.89	5.22		1.90		15.94	0.00	40.40
	1995	7.45	9.71	4.62		1.90		18.41	0.00	42.09
	2000	8.58	10.37	2.72		1.90		19.98	0.00	43.55
	2010	8.64	6.64	0.54		0.81		19.98	0.00	36.60
FRANCE	1990	55.53	15.44	5.13	0.23	0.25	0.85	24.42	0.24	102.09
	1995	62.53	14.77	5.13	0.23	0.25	0.79	24.47	0.24	108.42
	2000	67.16	12.95	5.13	0.23	0.25	1.35	24.47	0.72	112.26
	2010	68.03	10.72	4.55	0.60	0.25	3.50	24.47	1.03	113.13
IRELAND	1990		1.29	0.58	0.26	0.74	0.36	0.51		3.73
	1995		1.29	0.58	0.26	0.74	0.36	0.51		3.73
	2000		1.21	0.98	0.41	0.74	0.36	0.51		4.21
	2010		1.38	0.78	0.62	0.49	0.36	0.51		4.14
ITALY	1990	1.27	9.74	15.67	0.37	11.11	2.54	18.76	0.65	60.10
	1995	1.27	12.63	16.87	1.57	11.11	2.51	19.32	0.88	66.17
	2000	1.27	13.08	16.22	3.37	10.27	2.42	19.71	1.15	67.48
	2010	1.27	17.85	12.27	9.79	7.40	2.29	19.71	1.27	71.84
LUXEMBOURG	1990		0.18			0.01	0.01	1.12		1.31
	1995		0.18			0.01	0.01	1.13		1.32
	2000		0.18			0.01	0.01	1.13		1.32
	2010		0.18			0.01	0.01	1.13		1.32
NETHERLANDS	1990	0.51	4.36		5.14	7.08	0.34		0.15	17.57
	1995	0.45	4.51		5.13	6.03	0.34		0.24	16.71
	2000	0.45	5.63		4.42	4.80	0.36		0.44	16.09
	2010	1.30	7.77		5.30	0.51	0.38		0.94	16.20
PORTUGAL	1990		1.27	1.70			0.33	3.10		6.41
	1995		1.57	1.70			0.33	4.09		7.69
	2000		1.57	1.23		0.47	0.33	4.54		8.14
	2010		1.55	1.23		0.47	0.13	5.20		8.58
UNITED KINGDOM	1990	12.14	40.05	12.15			2.98	4.21	0.00	71.52
	1995	11.69	40.07	12.12	0.50		4.98	4.22	0.00	73.59
	2000	11.21	42.66	11.71	1.50		4.12	4.24	0.00	75.45
	2010	9.52	41.42	6.51	9.47		2.60	4.27	0.00	73.79

Sources: UNIPEDE and DG XVII A2 estimates

ELECTRICITY INVESTMENTS

(EUROPE 12)

Reduced pressure for investment in long term

in scenario 3 and4

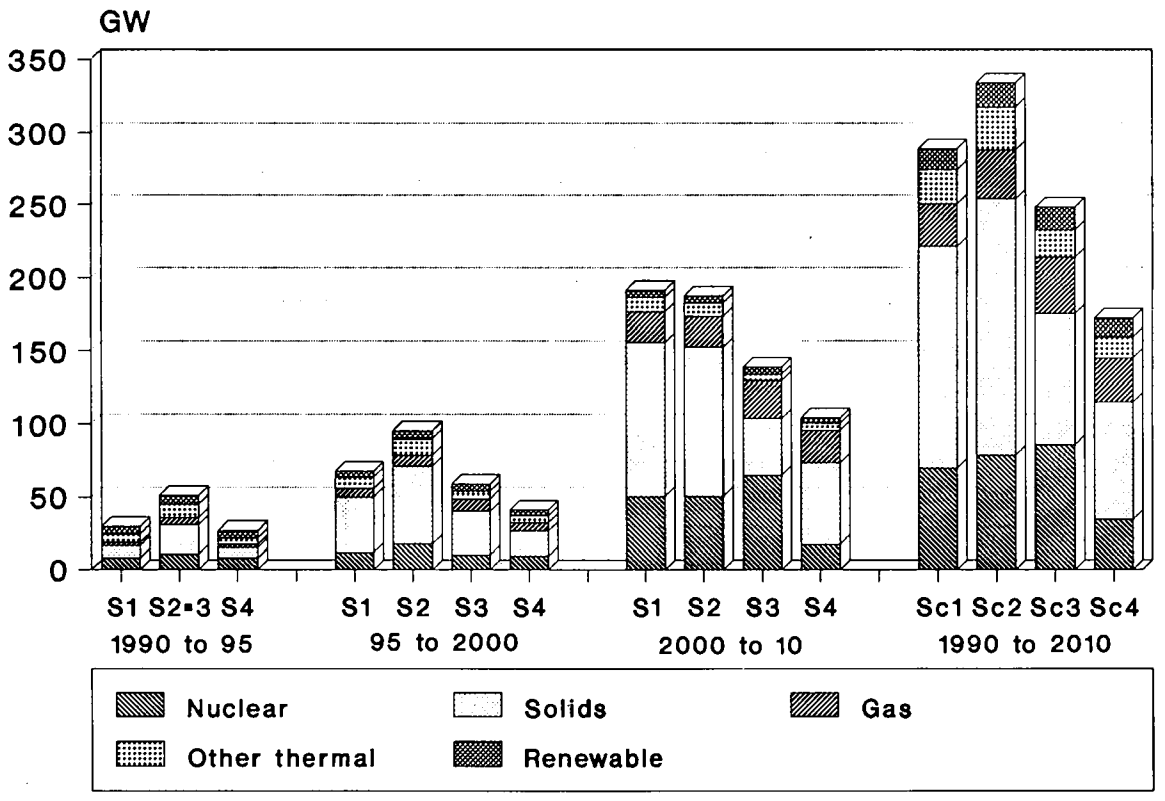


Table 5.2.10 INVESTMENT IN ELECTRICITY GENERATING CAPACITIES - SCENARIO 1

MW		Nuclear	Solids	Polyval. with Coal	Polyval. without Coal	Combin. Cycle	Peak Devices	Hydro	Renew.	TOTAL
EUROPE 12	1990-1995	7800	2949	5458	676	2300	4301	4958	219	28661
	1995-2000	11710	31137	7315	1329	5632	6426	3226	888	67663
	2000-2010	50580	70550	34103	2204	21187	7753	2960	1908	191245
	1990-2010	70090	104636	46876	4209	29119	18480	11144	3015	287569
BELGIUM	1990-1995		105	140		300	251			796
	1995-2000		1820	140		600	510		150	3220
	2000-2010	3900	2392	1303		311			280	8186
	1990-2010	3900	4317	1583		1211	761		430	12202
DENMARK	1990-1995			1129	76	150	18		12	1385
	1995-2000			698		150	34		15	897
	2000-2010			4448		300	72		80	4900
	1990-2010			6275	76	600	124		107	7182
GERMANY	1990-1995		325				1500	76	65	1966
	1995-2000		11029			1184	2826	76	196	15311
	2000-2010	5900	11940	7720		2318	1384	300	803	30365
	1990-2010	5900	23294	7720		3502	5710	452	1064	47642
GREECE	1990-1995		138	40			72	663	115	1028
	1995-2000		1686	29			186	679	60	2640
	2000-2010		5497	18			412	1086	120	7133
	1990-2010		7321	87			670	2428	295	10801
SPAIN	1990-1995							2470		2470
	1995-2000	2270	42					1571		3883
	2000-2010	5445	8103		2204	600		875		17227
	1990-2010	7715	8145		2204	600		4916		23580
FRANCE	1990-1995	7800						50		7850
	1995-2000	8285	2556	475			2370	50		13736
	2000-2010	25660	9237	1208		300	4225			40630
	1990-2010	41745	11793	1683		300	6595	100		62216
IRELAND	1990-1995									
	1995-2000		64	352						416
	2000-2010		184	1605			357			2146
	1990-2010		248	1957			357			2562
ITALY	1990-1995			4027		1200		694	2	5923
	1995-2000			5042		2398		385	267	8092
	2000-2010			17553		6993	950		125	25621
	1990-2010			26622		10591	950	1079	394	39636
LUXEMBOURG	1990-1995									
	1995-2000							5		5
	2000-2010									
	1990-2010							5		5
NETHERLANDS	1990-1995		600	122	600	150			25	1497
	1995-2000		710	579	1329	300	373		200	3491
	2000-2010	3900	4250	126		2393	353		500	11522
	1990-2010	3900	5560	827	1929	2843	726		725	16510
PORTUGAL	1990-1995		546					988		1534
	1995-2000						127	444		571
	2000-2010		3387	122				666		4175
	1990-2010		3933	122			127	2098		6280
UNITED KINGDOM	1990-1995		1235			500	2460	17		4212
	1995-2000	1155	13230			1000		17		15402
	2000-2010	5775	25560			7972		33		39340
	1990-2010	6930	40025			9472	2460	67		58954

Sources: UNIPEDE and DG XVII A2 estimates

Table 5.2.11 **INVESTMENT IN ELECTRICITY GENERATING CAPACITIES - SCENARIO 2**

MW		Nuclear	Solids	Polyval. with Coal	Polyval. without Coal	Combin. Cycle	Peak Devices	Hydro	Renew.	TOTAL
EUROPE 12	1990-1995	10700	10161	9858	3376	5100	6010	5411	239	50855
	1995-2000	17510	43251	10415	3099	7702	7712	4581	938	95208
	2000-2010	50580	68932	32803	2204	20687	7185	2960	2048	187399
	1990-2010	78790	122344	53076	8679	33489	20907	12952	3225	333462
BELGIUM	1990-1995		405	140		600	251			1396
	1995-2000		2420	140		900	570		150	4180
	2000-2010	3900	2092	1303		311			280	7886
	1990-2010	3900	4917	1583		1811	821		430	13462
DENMARK	1990-1995			1529	76	150	18		12	1785
	1995-2000			998	70	150	34		15	1267
	2000-2010			4648		300	72		80	5100
	1990-2010			7175	146	600	124		107	8152
GERMANY	1990-1995		2025	2200			2000	76	65	6366
	1995-2000		14529	1300		1184	3026	76	196	20311
	2000-2010	5900	11540	6220		2318	1044	300	803	28125
	1990-2010	5900	28094	9720		3502	6070	452	1064	54802
GREECE	1990-1995		550	40		150	97	966	135	1938
	1995-2000		2700	29	200	150	241	982	110	4412
	2000-2010		5497	18			479	1086	260	7340
	1990-2010		8747	87	200	300	817	3034	505	13690
SPAIN	1990-1995		3000	600		300		2470		6370
	1995-2000	2270	4242	900		300		2171		9883
	2000-2010	5445	8305		2204	600		875		17429
	1990-2010	7715	15547	1500	2204	1200		5516		33682
FRANCE	1990-1995	10700		600		300	600	50		12250
	1995-2000	14085	2556	475		300	2700	50		20166
	2000-2010	25660	9237	1208		300	3655			40060
	1990-2010	50445	11793	2283		900	6955	100		72476
IRELAND	1990-1995					150				150
	1995-2000		64	952		120				1136
	2000-2010		184	1605			380			2169
	1990-2010		248	2557		270	380			3455
ITALY	1990-1995			4627	1500	1500	400	694	2	8723
	1995-2000			5042	1500	2398	550	385	267	10142
	2000-2010			17553		6993	1170		125	25841
	1990-2010			27222	3000	10891	2120	1079	394	44706
LUXEMBOURG	1990-1995									
	1995-2000							5		5
	2000-2010									
	1990-2010							5		5
NETHERLANDS	1990-1995		600	122	1200	450	137		25	2534
	1995-2000		710	579	1329	600	373		200	3791
	2000-2010	3900	4250	126		1893	353		500	11022
	1990-2010	3900	5560	827	2529	2943	863		725	17347
PORTUGAL	1990-1995		1146				47	1138		2331
	1995-2000		300				127	896		1323
	2000-2010		2267	122				666		3055
	1990-2010		3713	122			174	2700		6709
UNITED KINGDOM	1990-1995		2435		600	1500	2460	17		7012
	1995-2000	1155	15730			1600	91	17		18593
	2000-2010	5775	25560			7972	32	33		39372
	1990-2010	6930	43725		600	11072	2583	67		64977

Sources: UNIPEDE and DG XVII A2 estimates

Table 5.2.12 INVESTMENT IN ELECTRICITY GENERATING CAPACITIES - SCENARIO 3

MW		Nuclear	Solids	Polyval. with Coal	Polyval. without Coal	Combin. Cycle	Peak Devices	Hydro	Renew.	TOTAL
EUROPE 12	1990-1995	10700	10161	9858	3376	5100	6010	5411	239	50855
	1995-2000	10110	24790	5418	799	8393	4466	3995	928	58899
	2000-2010	64960	23967	14761	954	25768	3161	2960	2008	138539
	1990-2010	85770	58918	30037	5129	39261	13637	12366	3175	248293
BELGIUM	1990-1995		405	140		600	251			1396
	1995-2000		620	140		900	348		150	2158
	2000-2010	3900	622			780			280	5582
	1990-2010	3900	1647	280		2280	599		430	9136
DENMARK	1990-1995			1529	76	150	18		12	1785
	1995-2000			176	70	150	34		15	445
	2000-2010			2076	150	600	40		80	2946
	1990-2010			3781	296	900	92		107	5176
GERMANY	1990-1995		2025	2200			2000	76	65	6366
	1995-2000		10751	1200		1184	2826	76	196	16233
	2000-2010	8300	5075	900		2320	784	300	803	18482
	1990-2010	8300	17851	4300		3504	5610	452	1064	41081
GREECE	1990-1995		550	40		150	97	966	135	1938
	1995-2000		1170	29		300	186	679	100	2464
	2000-2010		1829	18		750	380	1086	220	4283
	1990-2010		3549	87		1200	663	2731	455	8685
SPAIN	1990-1995		3000	600		300		2470		6370
	1995-2000	2270	3386	600		600		2071		8927
	2000-2010	9525	1963		804	1500		875		14667
	1990-2010	11795	8349	1200	804	2400		5416		29964
FRANCE	1990-1995	10700		600		300	600	50		12250
	1995-2000	6685		300		600	594	50		8229
	2000-2010	25660	1637	1208		600	655			29760
	1990-2010	43045	1637	2108		1500	1849	100		50239
IRELAND	1990-1995					150				150
	1995-2000		64	802		111				977
	2000-2010		184	788		200	357			1529
	1990-2010		248	1590		461	357			2656
ITALY	1990-1995			4627	1500	1500	400	694	2	8723
	1995-2000			1592		2098		385	267	4342
	2000-2010			9523		7283	650		125	17581
	1990-2010			15742	1500	10881	1050	1079	394	30646
LUXEMBOURG	1990-1995									
	1995-2000							5		5
	2000-2010									
	1990-2010							5		5
NETHERLANDS	1990-1995		600	122	1200	450	137		25	2534
	1995-2000		560	579	729	450	373		200	2891
	2000-2010	5200	600	126		2093	295		500	8814
	1990-2010	5200	1760	827	1929	2993	805		725	14239
PORTUGAL	1990-1995		1146				47	1138		2331
	1995-2000						105	713		818
	2000-2010		597	122		900		666		2285
	1990-2010		1743	122		900	152	2517		5434
UNITED KINGDOM	1990-1995		2435		600	1500	2460	17		7012
	1995-2000	1155	8239			2000		17		11411
	2000-2010	12375	11460			8742		33		32610
	1990-2010	13530	22134		600	12242	2460	67		51033

Sources: UNIPEDE and DG XVII A2 estimates

Table 5.2.13 **INVESTMENT IN ELECTRICITY GENERATING CAPACITIES - SCENARIO 4**

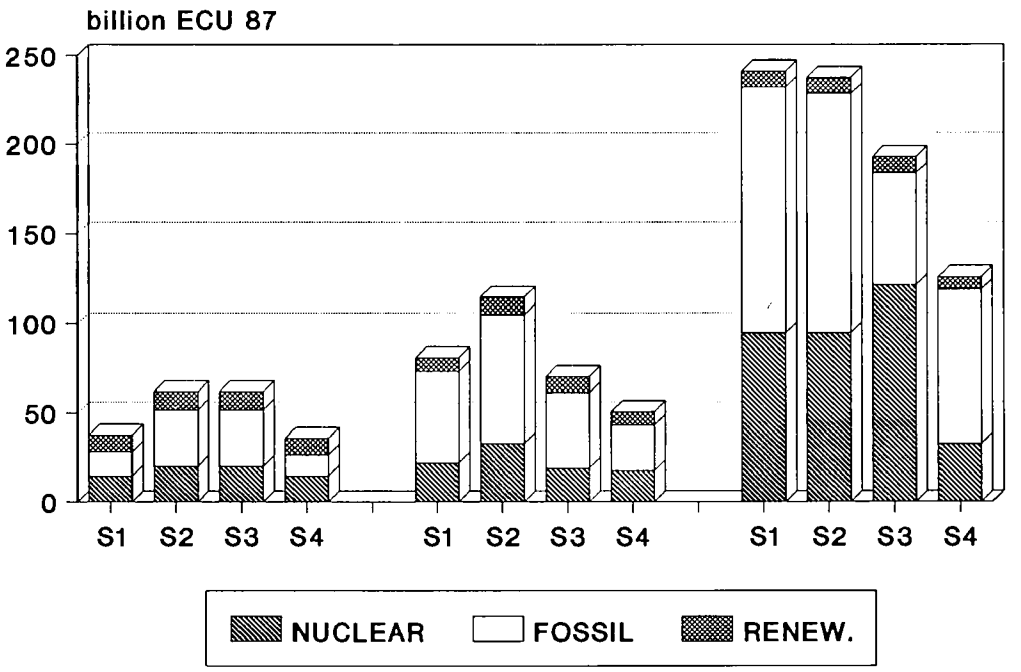
MW		Nuclear	Solids	Polyval. with Coal	Polyval. without Coal	Combin. Cycle	Peak Devices	Hydro	Renew.	TOTAL
EUROPE 12	1990-1995	7800	2703	4319	676	2300	3711	4958	219	26686
	1995-2000	9275	15962	1235	1359	5659	3462	3226	888	41066
	2000-2010	17405	39140	16988		21983	4830	1814	1908	104068
	1990-2010	34480	57805	22542	2035	29942	12003	9998	3015	171820
BELGIUM	1990-1995		105			300	221			626
	1995-2000		920	140		900	360		150	2470
	2000-2010	1300	545			900			280	3025
	1990-2010	1300	1570	140		2100	581		430	6121
DENMARK	1990-1995			1062	76	150	18		12	1318
	1995-2000				30	150	34		15	229
	2000-2010			2266		600			80	2946
	1990-2010			3328	106	900	52		107	4493
GERMANY	1990-1995		325				1200	76	65	1666
	1995-2000		5061			1184	2126	76	196	8643
	2000-2010		8740	4575		2318	624	300	803	17360
	1990-2010		14126	4575		3502	3950	452	1064	27669
GREECE	1990-1995		138	40			72	663	115	1028
	1995-2000		786	29		175	186	679	60	1915
	2000-2010		701	18		300	350	815	120	2304
	1990-2010		1625	87		475	608	2157	295	5247
SPAIN	1990-1995							2470		2470
	1995-2000	1135						1571		2706
	2000-2010	1135	1245							2380
	1990-2010	2270	1245					4041		7556
FRANCE	1990-1995	7800						50		7850
	1995-2000	6985					570	50		7605
	2000-2010	13670	4644	1208		600	2225			22347
	1990-2010	28455	4644	1208		600	2795	100		37802
IRELAND	1990-1995									
	1995-2000		64			150				214
	2000-2010		184	166		300	357			1007
	1990-2010		248	166		450	357			1221
ITALY	1990-1995			3095		1200		694	2	4991
	1995-2000			1017		1800		385	267	3469
	2000-2010			8587		6600	950		125	16262
	1990-2010			12699		9600	950	1079	394	24722
LUXEMBOURG	1990-1995									
	1995-2000							5		5
	2000-2010									
	1990-2010							5		5
NETHERLANDS	1990-1995		600	122	600	150			25	1497
	1995-2000		710	49	1329	300	186		200	2774
	2000-2010	1300	3266	126		2393	197		500	7782
	1990-2010	1300	4576	297	1929	2843	383		725	12053
PORTUGAL	1990-1995		300					988		1288
	1995-2000							444		444
	2000-2010		300	42			127	666		1135
	1990-2010		600	42			127	2098		2867
UNITED KINGDOM	1990-1995		1235			500	2200	17		3952
	1995-2000	1155	8421			1000		17		10593
	2000-2010		19515			7972		33		27520
	1990-2010	1155	29171			9472	2200	67		42065

Sources: UNIPEDE and DG XVII A2 estimates

AVERAGE INVESTMENT COSTS
ECU 87 / KW
(EUROPE 12)

NUCLEAR	1870
SOLIDS	1140
POLYVALENT WITH COAL	1140
POLYVALENT WITHOUT COAL	900
COMBINED CYCLE	600
PEAK DEVICES	450
HYDRAULIC	1800
RENEWABLES	2000

INVESTMENT EXPENSES
(EUROPE 12)
By Fuel and by Period

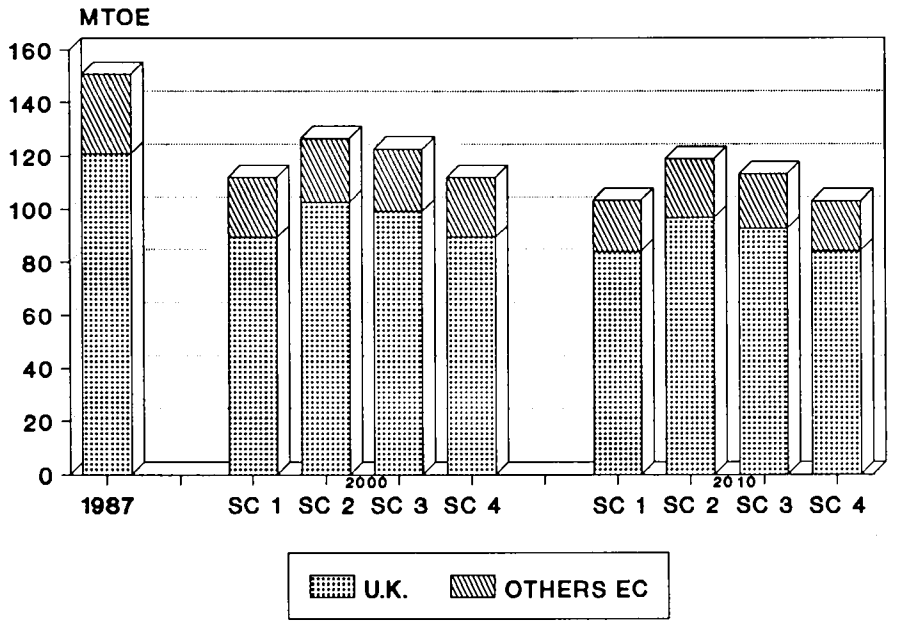


5.3 Oil Sector

OIL SUPPLY
(EUROPE 12)

Longer term oil supply similar in all scenarios

Crude Oil Production



Import needs similar, except in scenario 3 and 4 by 2010

Call On Imports

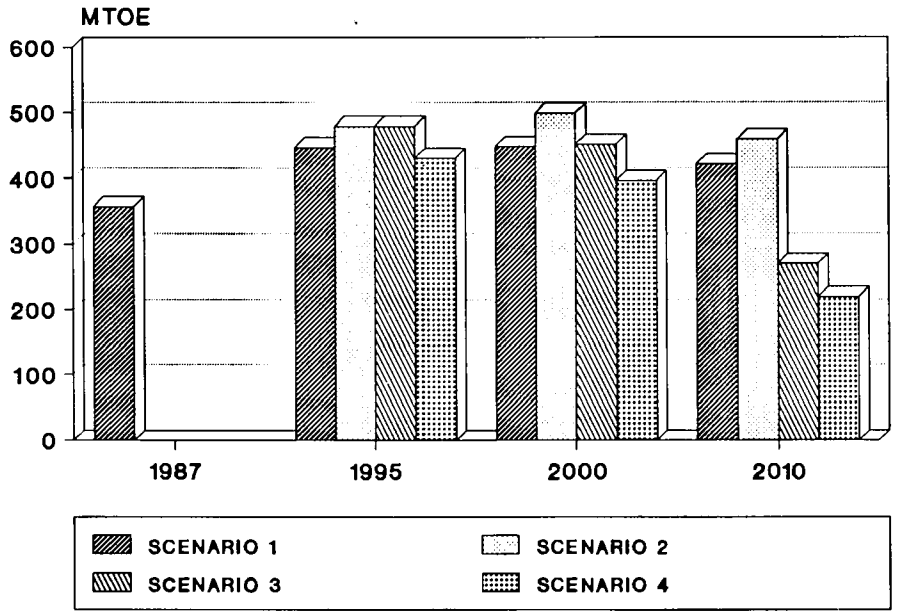


Table 5.3.1 **CRUDE OIL PRODUCTION**

MTOE		1987	1990	1995	2000	2005	2010
EUROPE 12	Scenario 1	150.91	147.10	125.18	111.93	107.46	103.30
	Scenario 2			132.33	126.44	122.66	119.02
	Scenario 3			132.33	122.64	117.78	113.15
	Scenario 4			125.11	111.82	107.17	102.84
BELGIUM	Scenario 1						
	Scenario 2						
	Scenario 3						
	Scenario 4						
DENMARK	Scenario 1	4.65	5.50	6.60	5.40	4.93	4.50
	Scenario 2			6.60	6.00	5.77	5.55
	Scenario 3			6.60	5.70	5.34	5.00
	Scenario 4			6.60	5.40	4.93	4.50
GERMANY	Scenario 1	4.78	3.80	3.41	3.02	3.02	3.02
	Scenario 2			3.41	3.02	3.02	3.02
	Scenario 3			3.41	3.02	3.02	3.02
	Scenario 4			3.34	2.91	2.73	2.57
GREECE	Scenario 1	1.24	0.50				
	Scenario 2						
	Scenario 3						
	Scenario 4						
SPAIN	Scenario 1	1.86	2.03	2.03	2.03	2.03	2.03
	Scenario 2			2.13	2.24	2.35	2.47
	Scenario 3			2.13	2.24	2.22	2.20
	Scenario 4			2.03	2.03	2.03	2.03
FRANCE	Scenario 1	3.75	3.43	3.23	2.83	2.23	1.75
	Scenario 2			3.28	2.88	2.73	2.58
	Scenario 3			3.28	2.83	2.51	2.23
	Scenario 4			3.23	2.83	2.22	1.74
IRELAND	Scenario 1						
	Scenario 2						
	Scenario 3						
	Scenario 4						
ITALY	Scenario 1	4.03	6.01	4.36	4.20	3.83	3.50
	Scenario 2			4.36	4.20	4.02	3.85
	Scenario 3			4.36	4.20	3.83	3.50
	Scenario 4			4.36	4.20	3.83	3.50
LUXEMBOURG	Scenario 1						
	Scenario 2						
	Scenario 3						
	Scenario 4						
NETHERLANDS	Scenario 1	4.71	5.08	5.80	5.20	4.84	4.50
	Scenario 2			5.80	5.45	5.19	4.95
	Scenario 3			5.80	5.40	5.04	4.70
	Scenario 4			5.80	5.20	4.84	4.50
PORTUGAL	Scenario 1						
	Scenario 2						
	Scenario 3						
	Scenario 4						
UNITED KINGDOM	Scenario 1	125.89	120.75	99.75	89.25	86.59	84.00
	Scenario 2			106.75	102.65	99.58	96.60
	Scenario 3			106.75	99.25	95.82	92.50
	Scenario 4			99.75	89.25	86.59	84.00

Sources: SOEC and DG XVII A2 estimates

Table 5.3.2 **NET OIL IMPORTS**

MTOE		1987	1990	1995	2000	2005	2010
EUROPE 12	Scenario 1	356.5	398.6	446.4	447.5	433.8	421.0
	Scenario 2			479.1	498.7	477.4	459.0
	Scenario 3			479.1	451.3	351.6	270.8
	Scenario 4			429.9	396.2	297.4	219.6
BELGIUM	Scenario 1	22.2	23.5	25.5	24.0	22.5	21.2
	Scenario 2			26.3	25.2	23.5	21.9
	Scenario 3			26.3	24.8	20.7	17.2
	Scenario 4			24.2	21.2	17.7	14.8
DENMARK	Scenario 1	6.0	5.6	4.8	5.7	6.4	7.2
	Scenario 2			5.2	5.9	6.3	6.8
	Scenario 3			5.2	5.4	4.0	3.0
	Scenario 4			4.5	4.9	3.8	2.9
GERMANY	Scenario 1	110.5	123.7	126.9	116.5	111.3	106.3
	Scenario 2			132.6	125.5	118.6	112.2
	Scenario 3			132.6	117.1	94.1	75.6
	Scenario 4			124.0	105.3	84.1	67.2
GREECE	Scenario 1	11.5	13.5	14.8	15.9	16.3	16.7
	Scenario 2			16.9	20.2	20.7	21.2
	Scenario 3			16.9	17.2	16.0	14.8
	Scenario 4			14.2	14.7	12.6	10.8
SPAIN	Scenario 1	41.5	42.4	46.2	48.7	49.7	50.6
	Scenario 2			53.4	60.8	60.7	60.6
	Scenario 3			53.4	53.2	46.2	40.2
	Scenario 4			44.9	44.3	33.4	25.1
FRANCE	Scenario 1	84.9	87.0	88.1	90.0	86.4	83.0
	Scenario 2			95.6	104.0	100.5	97.2
	Scenario 3			95.6	90.8	72.2	57.4
	Scenario 4			84.2	78.4	60.8	47.2
IRELAND	Scenario 1	4.5	4.6	5.6	5.7	5.5	5.4
	Scenario 2			6.6	6.7	6.4	6.1
	Scenario 3			6.6	6.2	5.2	4.3
	Scenario 4			5.3	5.3	3.9	3.0
ITALY	Scenario 1	88.0	89.8	91.3	85.7	81.7	77.8
	Scenario 2			98.1	95.6	90.9	86.6
	Scenario 3			98.1	89.9	71.4	56.7
	Scenario 4			89.3	79.2	62.6	49.4
LUXEMBOURG	Scenario 1	1.3	1.4	1.4	1.5	1.4	1.4
	Scenario 2			1.5	1.7	1.5	1.5
	Scenario 3			1.5	1.5	1.2	1.0
	Scenario 4			1.3	1.3	1.1	0.9
NETHERLANDS	Scenario 1	26.5	28.9	29.6	31.1	30.7	30.4
	Scenario 2			31.0	33.4	32.2	31.0
	Scenario 3			31.0	30.8	26.4	22.6
	Scenario 4			28.7	28.8	25.0	21.8
PORTUGAL	Scenario 1	8.8	10.4	11.7	12.0	11.8	11.6
	Scenario 2			12.6	13.7	13.2	12.7
	Scenario 3			12.6	12.8	10.7	9.0
	Scenario 4			11.3	10.9	8.9	7.2
UNITED KINGDOM	Scenario 1	-49.1	-32.0	0.6	10.8	10.1	9.3
	Scenario 2			-0.6	6.2	2.9	1.4
	Scenario 3			-0.6	1.8	-16.4	-31.0
	Scenario 4			-1.9	2.1	-16.4	-30.7

Sources: SOEC and DG XVII A2 estimates

Table 5.3.3 **OIL DEMAND BY PRODUCT - SCENARIO 1**

MTOE		Refinery Gas	L.P.G.	Naphta	Gasoline	Kerosene	Gasoil & Diesel	Residual Fuel oil	Others	TOTAL
EUROPE 12	1990	16.9	18.2	31.0	112.2	26.3	188.1	90.5	30.0	513.1
	1995	17.3	17.8	31.6	119.0	27.2	191.8	103.5	30.8	539.0
	2000	17.8	17.0	32.5	121.9	28.0	186.9	91.5	31.1	526.6
	2010	17.8	16.5	34.3	120.9	29.8	179.5	61.4	31.0	491.2
BELGIUM	1990	0.46	0.59	1.48	3.20	0.68	8.97	4.00	1.01	20.39
	1995	0.65	0.62	1.56	3.63	0.70	9.21	4.76	1.37	22.50
	2000	0.66	0.52	1.61	3.72	0.71	8.79	3.53	1.39	20.93
	2010	0.55	0.43	1.73	3.60	0.71	7.61	2.11	1.38	18.12
DENMARK	1990	0.32	0.13	0.04	1.70	0.80	5.31	1.76	0.56	10.62
	1995	0.33	0.09	0.03	1.79	0.83	5.36	1.81	0.62	10.86
	2000	0.32	0.08	0.03	1.83	0.85	5.02	1.75	0.67	10.55
	2010	0.32	0.08	0.04	2.00	0.98	5.04	1.98	0.75	11.19
GERMANY	1990	2.95	2.53	8.11	28.88	4.04	55.96	13.93	8.03	124.43
	1995	2.08	2.53	8.13	28.38	4.20	55.74	18.11	8.17	127.34
	2000	1.84	2.50	8.24	26.65	4.80	52.25	12.08	8.11	116.47
	2010	1.78	2.52	8.41	23.39	5.48	47.00	10.64	7.13	106.35
GREECE	1990	0.29	0.22	0.14	2.43	1.30	3.89	3.68	0.48	12.43
	1995	0.39	0.22	0.14	3.33	1.40	4.02	3.07	0.60	13.17
	2000	0.45	0.22	0.15	4.16	1.51	4.15	2.78	0.74	14.16
	2010	0.47	0.23	0.19	4.54	1.43	4.48	2.45	0.98	14.77
SPAIN	1990	1.24	2.55	4.00	7.56	2.61	13.06	7.43	2.46	40.91
	1995	1.04	2.74	3.88	8.84	2.80	14.49	8.33	2.55	44.67
	2000	1.01	2.68	3.96	9.70	2.86	15.97	8.37	2.70	47.25
	2010	1.04	2.60	4.34	10.20	2.74	18.54	6.67	3.04	49.17
FRANCE	1990	2.11	2.93	5.84	21.24	3.11	37.64	8.70	5.32	86.89
	1995	2.19	3.01	6.08	21.79	3.10	36.19	10.21	5.09	87.66
	2000	2.28	2.98	6.29	22.56	2.98	35.43	11.54	4.95	89.01
	2010	1.98	2.81	6.80	23.42	3.25	31.46	6.37	4.91	81.00
IRELAND	1990	0.03	0.12		1.04	0.45	1.36	1.32	0.17	4.49
	1995	0.06	0.11		1.08	0.45	1.45	2.11	0.19	5.45
	2000	0.10	0.11		1.17	0.47	1.53	1.99	0.21	5.58
	2010	0.20	0.19		1.38	0.48	1.69	1.04	0.25	5.23
ITALY	1990	2.40	2.85	2.90	13.59	2.52	30.52	31.16	5.05	90.99
	1995	2.53	2.65	3.07	14.41	2.65	31.63	29.01	4.99	90.94
	2000	2.91	2.49	3.15	15.48	2.49	29.27	24.24	5.03	85.06
	2010	3.09	2.36	3.37	15.39	2.55	29.14	15.39	5.16	76.45
LUXEMBOURG	1990		0.03		0.37	0.12	0.61	0.26	0.03	1.42
	1995		0.03		0.37	0.13	0.59	0.27	0.04	1.43
	2000		0.03		0.38	0.14	0.61	0.28	0.04	1.48
	2010		0.02		0.36	0.16	0.55	0.27	0.05	1.41
NETHERLANDS	1990	2.82	3.39	2.43	4.48	1.73	6.26	2.27	1.62	25.00
	1995	2.93	3.38	2.45	4.78	1.81	5.95	3.54	1.60	26.44
	2000	3.00	3.32	2.58	4.94	1.86	6.10	3.77	1.71	27.28
	2010	3.27	3.34	2.72	4.58	1.98	5.96	2.16	1.95	25.96
PORTUGAL	1990	0.13	0.58	1.18	1.50	0.62	2.24	3.14	0.47	9.86
	1995	0.18	0.54	1.27	1.88	0.67	2.47	3.61	0.54	11.16
	2000	0.18	0.47	1.38	1.93	0.70	2.50	3.80	0.56	11.52
	2010	0.30	0.47	1.38	1.95	0.80	2.79	2.39	0.80	10.88
UNITED KINGDOM	1990	4.15	2.24	4.92	26.18	8.27	22.25	12.82	4.82	85.65
	1995	4.92	1.91	5.01	28.71	8.45	24.72	18.62	4.99	97.33
	2000	5.06	1.62	5.11	29.33	8.64	25.23	17.41	4.95	97.35
	2010	4.84	1.44	5.35	30.13	9.22	25.23	9.91	4.55	90.67

Sources: SOEC and DG XVII A2 estimates

Table 5.3.4 **OIL DEMAND BY PRODUCT - SCENARIO 2**

MTOE		Refinery Gas	L.P.G.	Naphta	Gasoline	Kerosene	Gasoil & Diesel	Residual Fuel oil	Others	TOTAL
EUROPE 12	1990	16.9	18.2	31.0	112.2	26.3	188.1	90.5	30.0	513.1
	1995	19.8	18.8	33.0	131.4	30.1	206.4	107.7	31.1	578.4
	2000	21.8	18.7	34.5	147.2	33.5	208.6	95.4	31.6	591.4
	2010	21.6	17.5	34.9	147.9	33.1	194.5	65.1	29.5	544.1
BELGIUM	1990	0.46	0.59	1.48	3.20	0.68	8.97	4.00	1.01	20.39
	1995	0.82	0.64	1.63	3.85	0.74	9.62	4.64	1.32	23.26
	2000	0.88	0.54	1.71	4.28	0.81	9.26	3.36	1.35	22.19
	2010	0.67	0.44	1.75	3.91	0.78	8.00	2.08	1.18	18.81
DENMARK	1990	0.32	0.13	0.04	1.70	0.80	5.31	1.76	0.56	10.62
	1995	0.33	0.09	0.03	1.91	0.88	5.52	1.84	0.65	11.25
	2000	0.33	0.08	0.03	2.12	0.98	5.27	1.81	0.71	11.33
	2010	0.32	0.07	0.04	2.40	1.10	5.17	1.94	0.76	11.80
GERMANY	1990	2.95	2.53	8.11	28.88	4.04	55.96	13.93	8.03	124.43
	1995	3.69	2.37	8.48	30.54	4.52	58.15	16.77	8.44	132.96
	2000	3.39	2.34	8.76	30.91	5.56	54.34	11.96	8.26	125.52
	2010	3.27	2.23	8.50	28.96	5.21	46.76	9.82	7.44	112.19
GREECE	1990	0.29	0.22	0.14	2.43	1.30	3.89	3.68	0.48	12.43
	1995	0.35	0.24	0.15	4.06	1.70	4.71	3.39	0.64	15.24
	2000	0.36	0.24	0.16	6.00	2.17	5.35	3.33	0.80	18.41
	2010	0.37	0.24	0.19	6.64	2.38	5.33	3.15	0.93	19.23
SPAIN	1990	1.24	2.55	4.00	7.56	2.61	13.06	7.43	2.46	40.91
	1995	1.53	2.99	4.11	10.49	3.45	17.76	9.04	2.55	51.92
	2000	1.99	3.29	4.21	13.73	3.99	21.19	8.23	2.64	59.27
	2010	1.84	3.01	4.39	14.56	4.24	21.82	6.64	2.94	59.44
FRANCE	1990	2.11	2.93	5.84	21.24	3.11	37.64	8.70	5.32	86.89
	1995	2.40	3.07	6.29	25.02	3.56	38.92	9.90	5.95	95.11
	2000	2.73	3.04	6.63	28.99	3.83	40.60	10.93	6.18	102.93
	2010	2.53	3.08	7.01	29.21	3.86	38.05	6.79	5.28	95.81
IRELAND	1990	0.03	0.12		1.04	0.45	1.36	1.32	0.17	4.49
	1995	0.10	0.12		1.24	0.51	1.67	2.65	0.20	6.49
	2000	0.10	0.13		1.51	0.60	1.88	2.17	0.22	6.61
	2010	0.22	0.20		1.60	0.58	1.92	1.16	0.25	5.93
ITALY	1990	2.40	2.85	2.90	13.59	2.52	30.52	31.16	5.05	90.99
	1995	2.81	2.94	3.23	15.77	2.88	33.83	31.34	4.98	97.78
	2000	3.28	2.85	3.37	18.06	2.89	32.77	26.59	5.04	94.85
	2010	3.64	2.77	3.43	18.53	2.73	31.90	17.45	5.11	85.56
LUXEMBOURG	1990		0.03		0.37	0.12	0.61	0.26	0.03	1.42
	1995		0.03		0.40	0.14	0.64	0.29	0.04	1.54
	2000		0.03		0.45	0.17	0.70	0.30	0.04	1.69
	2010		0.02		0.41	0.15	0.60	0.27	0.05	1.50
NETHERLANDS	1990	2.82	3.39	2.43	4.48	1.73	6.26	2.27	1.62	25.00
	1995	2.92	3.55	2.55	5.11	1.93	6.32	3.45	1.97	27.80
	2000	3.02	3.58	2.74	5.74	2.14	6.86	3.77	2.00	29.85
	2010	3.39	3.42	2.75	5.19	1.92	6.27	2.39	1.61	26.94
PORTUGAL	1990	0.13	0.58	1.18	1.50	0.62	2.24	3.14	0.47	9.86
	1995	0.20	0.58	1.32	2.29	0.77	2.65	3.81	0.49	12.11
	2000	0.23	0.52	1.46	2.46	0.87	2.95	4.14	0.51	13.14
	2010	0.31	0.48	1.39	2.63	0.93	3.00	2.77	0.51	12.02
UNITED KINGDOM	1990	4.15	2.24	4.92	26.18	8.27	22.25	12.82	4.82	85.65
	1995	4.63	2.21	5.25	30.68	9.03	26.65	20.59	3.90	102.94
	2000	5.47	2.10	5.46	32.99	9.51	27.47	18.80	3.84	105.64
	2010	4.99	1.54	5.43	33.90	9.17	25.69	10.66	3.47	94.85

Sources: SOEC and DG XVII A2 estimates

Table 5.3.5 **OIL DEMAND BY PRODUCT - SCENARIO 3**

MTOE		Refinery Gas	L.P.G.	Naphta	Gasoline	Kerosene	Gasoil & Diesel	Residual Fuel oil	Others	TOTAL
EUROPE 12	1990	16.9	18.2	31.0	112.2	26.3	188.1	90.5	30.0	513.1
	1995	19.8	18.8	33.0	131.4	30.1	206.4	107.7	31.1	578.4
	2000	20.4	18.0	31.4	126.2	29.2	195.4	91.7	28.3	540.5
	2010	15.5	13.5	24.3	78.1	18.5	130.3	50.8	20.7	351.6
BELGIUM	1990	0.46	0.59	1.48	3.20	0.68	8.97	4.00	1.01	20.39
	1995	0.82	0.64	1.63	3.85	0.74	9.62	4.64	1.32	23.26
	2000	0.81	0.56	1.56	3.72	0.72	9.23	3.78	1.33	21.71
	2010	0.54	0.38	1.21	2.18	0.46	6.48	2.09	0.83	14.17
DENMARK	1990	0.32	0.13	0.04	1.70	0.80	5.31	1.76	0.56	10.62
	1995	0.33	0.09	0.03	1.91	0.88	5.52	1.84	0.65	11.25
	2000	0.30	0.08	0.03	1.81	0.84	5.10	1.77	0.65	10.58
	2010	0.29	0.06	0.03	1.16	0.53	3.50	1.44	0.53	7.54
GERMANY	1990	2.95	2.53	8.11	28.88	4.04	55.96	13.93	8.03	124.43
	1995	3.69	2.37	8.48	30.54	4.52	58.15	16.77	8.44	132.96
	2000	3.21	2.32	7.96	26.57	4.79	53.10	12.11	7.09	117.15
	2010	2.33	1.73	5.90	15.43	2.79	35.57	6.89	5.04	75.68
GREECE	1990	0.29	0.22	0.14	2.43	1.30	3.89	3.68	0.48	12.43
	1995	0.35	0.24	0.15	4.06	1.70	4.71	3.39	0.64	15.24
	2000	0.33	0.25	0.14	4.47	1.62	4.66	3.21	0.55	15.23
	2010	0.30	0.20	0.13	4.01	1.44	3.66	2.66	0.50	12.90
SPAIN	1990	1.24	2.55	4.00	7.56	2.61	13.06	7.43	2.46	40.91
	1995	1.53	2.99	4.11	10.49	3.45	17.76	9.04	2.55	51.92
	2000	1.77	2.98	3.83	11.28	3.28	17.96	8.38	2.48	51.96
	2010	1.24	2.69	3.04	8.40	2.44	14.22	4.94	2.13	39.10
FRANCE	1990	2.11	2.93	5.84	21.24	3.11	37.64	8.70	5.32	86.89
	1995	2.40	3.07	6.29	25.02	3.56	38.92	9.90	5.95	95.11
	2000	2.52	3.06	6.10	23.91	3.16	37.06	8.41	5.58	89.80
	2010	1.48	2.29	4.92	14.30	1.89	22.73	4.48	3.99	56.08
IRELAND	1990	0.03	0.12		1.04	0.45	1.36	1.32	0.17	4.49
	1995	0.10	0.12		1.24	0.51	1.67	2.65	0.20	6.49
	2000	0.13	0.12		1.28	0.51	1.68	2.16	0.20	6.08
	2010	0.18	0.15		1.01	0.38	1.38	0.97	0.18	4.25
ITALY	1990	2.40	2.85	2.90	13.59	2.52	30.52	31.16	5.05	90.99
	1995	2.81	2.94	3.23	15.77	2.88	33.83	31.34	4.98	97.78
	2000	3.13	2.82	3.09	15.97	2.60	31.22	25.89	4.48	89.20
	2010	2.35	1.99	2.42	9.31	1.37	19.73	14.90	3.44	55.51
LUXEMBOURG	1990		0.03		0.37	0.12	0.61	0.26	0.03	1.42
	1995		0.03		0.40	0.14	0.64	0.29	0.04	1.54
	2000		0.03		0.36	0.13	0.61	0.28	0.04	1.45
	2010		0.01		0.24	0.09	0.42	0.21	0.04	1.01
NETHERLANDS	1990	2.82	3.39	2.43	4.48	1.73	6.26	2.27	1.62	25.00
	1995	2.92	3.55	2.55	5.11	1.93	6.32	3.45	1.97	27.80
	2000	2.95	3.25	2.49	5.01	1.88	6.11	3.56	1.87	27.12
	2010	2.96	2.33	1.91	3.04	1.16	4.04	1.75	1.17	18.36
PORTUGAL	1990	0.13	0.58	1.18	1.50	0.62	2.24	3.14	0.47	9.86
	1995	0.20	0.58	1.32	2.29	0.77	2.65	3.81	0.49	12.11
	2000	0.23	0.53	1.22	2.22	0.78	2.75	4.06	0.46	12.25
	2010	0.24	0.45	0.97	1.67	0.59	2.08	2.08	0.37	8.45
UNITED KINGDOM	1990	4.15	2.24	4.92	26.18	8.27	22.25	12.82	4.82	85.65
	1995	4.63	2.21	5.25	30.68	9.03	26.65	20.59	3.90	102.94
	2000	4.99	1.97	4.97	29.61	8.84	25.96	18.06	3.52	97.92
	2010	3.60	1.19	3.77	17.36	5.32	16.50	8.34	2.51	58.59

Sources: SOEC and DG XVII A2 estimates

Table 5.3.6 **OIL DEMAND BY PRODUCT - SCENARIO 4**

MTOE		Refinery Gas	L.P.G.	Naphta	Gasoline	Kerosene	Gasoil & Diesel	Residual Fuel oil	Others	TOTAL
EUROPE 12	1990	16.9	18.2	31.0	112.2	26.3	188.1	90.5	30.0	513.1
	1995	16.3	17.4	31.6	114.9	26.4	186.4	99.6	30.0	522.6
	2000	16.5	16.0	32.3	107.8	24.8	164.2	84.3	29.8	475.7
	2010	12.0	10.9	23.4	58.7	13.7	99.7	51.5	21.1	291.0
BELGIUM	1990	0.46	0.59	1.48	3.20	0.68	8.97	4.00	1.01	20.39
	1995	0.62	0.58	1.56	3.46	0.66	8.50	4.40	1.37	21.15
	2000	0.59	0.45	1.61	3.21	0.61	7.25	3.15	1.34	18.21
	2010	0.49	0.30	1.24	1.86	0.36	4.79	1.56	1.11	11.71
DENMARK	1990	0.32	0.13	0.04	1.70	0.80	5.31	1.76	0.56	10.62
	1995	0.32	0.08	0.03	1.75	0.81	5.18	1.75	0.62	10.54
	2000	0.31	0.07	0.03	1.65	0.77	4.57	1.64	0.67	9.71
	2010	0.26	0.05	0.03	1.02	0.47	3.09	1.42	0.54	6.88
GERMANY	1990	2.95	2.53	8.11	28.88	4.04	55.96	13.93	8.03	124.43
	1995	2.03	2.45	8.13	27.84	4.12	54.78	17.16	7.78	124.29
	2000	1.80	2.27	8.23	23.97	4.32	45.14	11.87	7.58	105.18
	2010	1.41	1.73	6.14	12.94	2.34	29.21	8.10	4.98	66.85
GREECE	1990	0.29	0.22	0.14	2.43	1.30	3.89	3.68	0.48	12.43
	1995	0.35	0.21	0.14	3.13	1.32	3.85	2.98	0.56	12.54
	2000	0.36	0.20	0.15	3.65	1.33	3.77	2.68	0.69	12.83
	2010	0.26	0.13	0.11	2.63	0.95	2.43	1.82	0.66	8.99
SPAIN	1990	1.24	2.55	4.00	7.56	2.61	13.06	7.43	2.46	40.91
	1995	1.04	2.68	3.95	8.20	2.70	14.36	8.15	2.33	43.41
	2000	1.05	2.48	3.96	8.74	2.54	14.19	7.43	2.47	42.86
	2010	0.76	1.44	2.23	4.72	1.37	7.70	4.42	1.46	24.10
FRANCE	1990	2.11	2.93	5.84	21.24	3.11	37.64	8.70	5.32	86.89
	1995	2.15	2.87	6.00	20.82	2.96	34.45	9.55	5.06	83.86
	2000	2.11	2.66	6.15	19.16	2.53	30.76	9.37	4.87	77.61
	2010	1.39	1.88	4.83	10.35	1.37	17.44	4.78	3.55	45.59
IRELAND	1990	0.03	0.12		1.04	0.45	1.36	1.32	0.17	4.49
	1995	0.06	0.10		1.05	0.44	1.38	1.95	0.19	5.17
	2000	0.08	0.10		1.05	0.42	1.36	1.93	0.21	5.15
	2010	0.07	0.11		0.59	0.22	0.91	0.80	0.15	2.85
ITALY	1990	2.40	2.85	2.90	13.59	2.52	30.52	31.16	5.05	90.99
	1995	2.48	2.56	3.06	14.02	2.58	30.93	28.45	4.93	89.01
	2000	2.63	2.24	3.13	13.70	2.21	26.52	23.42	4.93	78.78
	2010	1.85	1.50	2.41	7.12	1.05	15.89	14.78	3.79	48.39
LUXEMBOURG	1990		0.03		0.37	0.12	0.61	0.26	0.03	1.42
	1995		0.03		0.35	0.12	0.54	0.25	0.04	1.33
	2000		0.03		0.33	0.12	0.50	0.26	0.04	1.28
	2010		0.01		0.21	0.08	0.33	0.19	0.04	0.86
NETHERLANDS	1990	2.82	3.39	2.43	4.48	1.73	6.26	2.27	1.62	25.00
	1995	2.73	3.30	2.45	4.66	1.75	5.73	3.39	1.59	25.60
	2000	2.63	3.15	2.58	4.47	1.67	5.52	3.39	1.66	25.07
	2010	2.37	2.23	1.96	2.55	0.97	3.50	2.48	1.35	17.41
PORTUGAL	1990	0.13	0.58	1.18	1.50	0.62	2.24	3.14	0.47	9.86
	1995	0.18	0.52	1.27	1.92	0.65	2.28	3.48	0.54	10.84
	2000	0.17	0.44	1.38	1.76	0.62	2.20	3.24	0.56	10.37
	2010	0.11	0.33	0.87	1.12	0.40	1.43	1.85	0.63	6.74
UNITED KINGDOM	1990	4.15	2.24	4.92	26.18	8.27	22.25	12.82	4.82	85.65
	1995	4.36	2.04	5.01	27.72	8.25	24.45	18.05	4.99	94.87
	2000	4.77	1.86	5.11	26.13	7.65	22.46	15.92	4.75	88.65
	2010	3.07	1.20	3.56	13.59	4.12	13.01	9.26	2.83	50.64

Sources: SOEC and DG XVII A2 estimates

GLOBAL REFINERY PROSPECTS

Total Refinery Inputs

MTOE	Scenario 1	Scenario 2	Scenario 3	Scenario 4
1995	552	591	591	540
2000	550	613	564	505
2010	519	568	389	335

SCENARIO 1

*Until 1995 :	Saturation of existing equipement + some needs of conversion units.
*1995-2000 :	Required investment both in distillation and conversion units including some deep conversion.
*2000-2010 :	Uncreased requirement in conversion units towards deep conversion.

SCENARIO 2

*1990-2010 :	Amplification of investment, both for distillation and conversion units. More oriented to deep conversion.

SCENARIO 3

*Until 1995 :	Similar to scenario 2.
*1995-2000 :	Stabilisation of equipement.
*2000-2010 :	Required restucturation.

SCENARIO 4

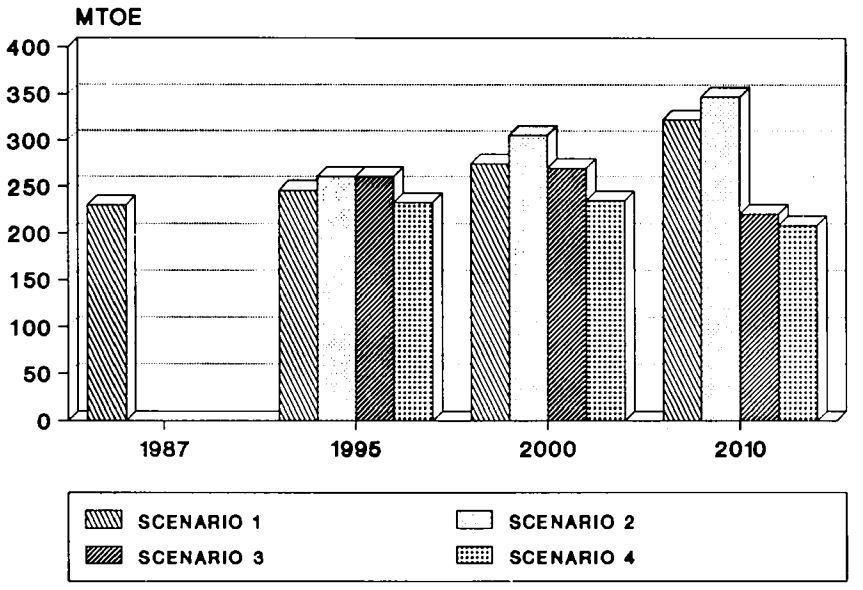
*Until 1995 :	Similar to scenario 1.
*1995-2000 :	Overcapacities emerging.
*2000-2010 :	In depth restructuration required.
ALL SCENARIOS:	**Increasing demand in upgrading units to assure lead free gasoline production.**

5.4 Coal Sector

SOLID FUELS DEMAND
(EUROPE 12)

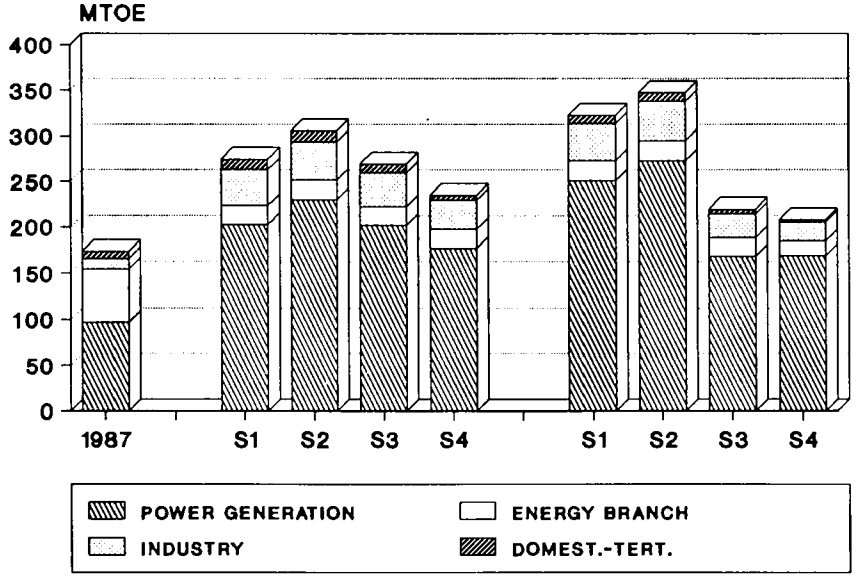
150 Mtoe range in demand by 2010

Total Demand



The power generation dominates

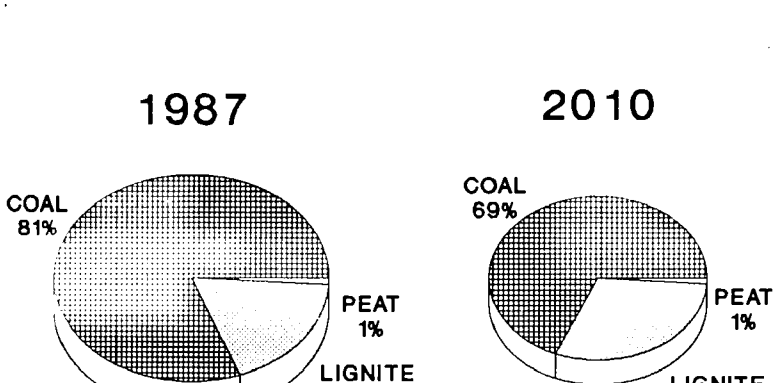
Demand by Sector



COAL SUPPLY
(EUROPE 12)

Hard coal production falls, lignite remains constant.

Production



Wide range on coal imports by 2010.

Net Imports

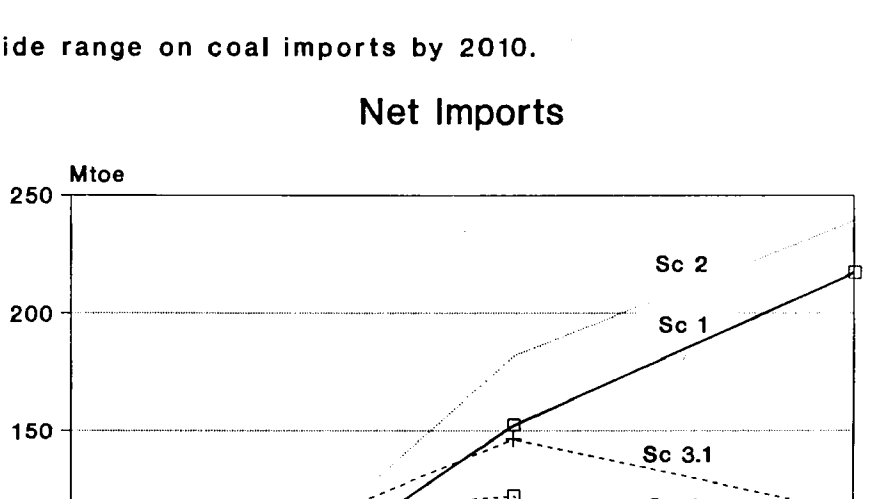


Table 5.4.1 SOLIDS FUELS PRODUCTION

Total Production By Products For All Scenarios (*)

COAL MTOE	1987	1990	1995	2000	2010
BELGIUM	2.97	2.10			
GERMANY	54.36	49.98	43.40	35.00	28.00
SPAIN	9.21	11.13	10.13	8.13	7.13
FRANCE	8.83	6.50	5.25	4.00	0.04
PORTUGAL	0.10	0.10	0.10	0.10	0.10
UNITED KINGDOM	60.86	55.00	50.75	44.00	37.00
EUROPE 12	136.33	124.81	109.63	91.23	72.27

PEAT MTOE	1987	1990	1995	2000	2010
IRELAND	1.68	1.37	1.35	1.35	1.20

COAL + PEAT MTOE	1987	1990	1995	2000	2010
BELGIUM	2.97	2.10			
DENMARK					
GERMANY	75.40	72.36	65.35	54.00	47.00
SPAIN	12.04	13.60	12.60	10.60	9.60
FRANCE	9.64	7.00	5.65	4.30	0.19
GREECE	5.97	6.50	7.25	8.00	10.25
IRELAND	1.68	1.37	1.35	1.35	1.20
ITALY	0.28	0.30	0.31		
LUXEMBOURG					
NETHERLAND					
PORTUGAL	0.10	0.10	0.10	0.10	0.10
UNITED KINGDOM	60.86	55.00	50.75	44.00	37.00
EUROPE 12	168.94	158.33	143.36	122.35	105.34

* Same levels of production for each scenario, except the production of lignite in Greece; which is link to electricity production (see below).

Table 5.4.2 LIGNITE PRODUCTION IN GREECE

LIGNITE MTOE	1987	1990	1995	2000	2010
Scenario 1	5.97	6.50	7.25	8.00	10.25
Scenario 2	5.97	6.50	7.25	9.20	12.75
Scenario 3	5.97	6.50	7.25	8.79	9.91
Scenario 4	5.97	6.50	7.25	8.00	6.85

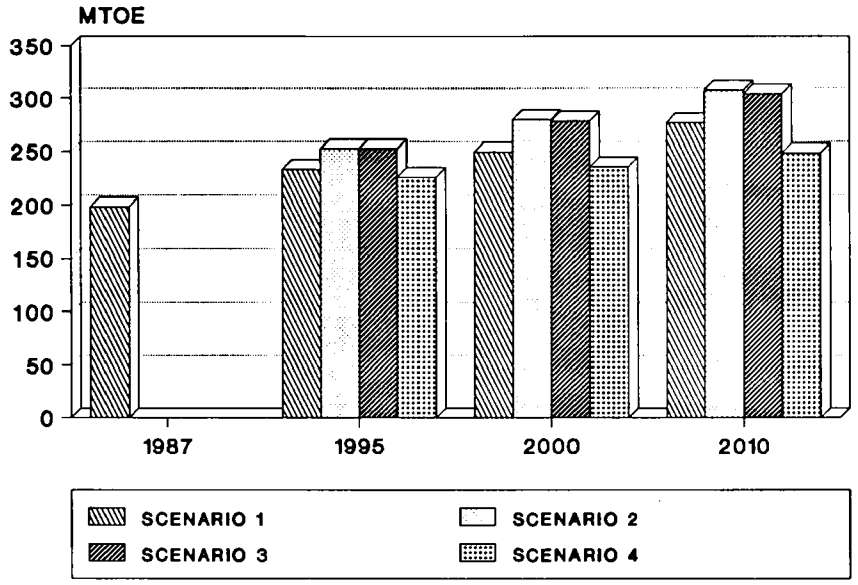
Table 5.4.3 **NET SOLID FUEL IMPORT**

MTOE		1987	1990	1995	2000	2005	2010
EUROPE 12	Scenario 1	59.6	76.8	102.8	152.2	180.8	216.94
	Scenario 2			116.6	181.7	204.1	239.24
	Scenario 3			116.6	146.4	128.2	114.97
	Scenario 4			89.8	112.6	111.2	106.23
BELGIUM	Scenario 1	5.4	7.9	10.2	11.9	12.5	13.06
	Scenario 2			10.7	13.1	13.4	13.77
	Scenario 3			10.7	10.6	9.1	7.72
	Scenario 4			9.1	9.7	8.5	7.35
DENMARK	Scenario 1	7.4	7.7	8.2	8.6	9.1	9.52
	Scenario 2			8.6	9.3	9.8	10.34
	Scenario 3			8.6	8.5	7.7	6.88
	Scenario 4			8.0	7.7	6.9	6.17
GERMANY	Scenario 1	0.9	1.8	8.5	24.6	29.7	36.00
	Scenario 2			14.4	35.2	39.3	43.82
	Scenario 3			14.4	28.0	22.3	17.73
	Scenario 4			5.5	13.4	13.9	14.45
GREECE	Scenario 1	1.1	1.1	1.4	2.9	4.2	6.27
	Scenario 2			1.6	3.8	4.6	5.59
	Scenario 3			1.6	2.0	2.0	2.11
	Scenario 4			0.9	1.3	1.3	1.24
SPAIN	Scenario 1	5.4	5.0	9.3	11.4	13.2	15.22
	Scenario 2			12.3	19.2	20.9	22.89
	Scenario 3			12.3	17.0	14.6	12.58
	Scenario 4			7.2	9.5	5.2	2.89
FRANCE	Scenario 1	8.9	12.1	12.0	16.0	21.5	28.90
	Scenario 2			12.9	17.2	22.5	29.32
	Scenario 3			12.9	13.7	13.1	12.61
	Scenario 4			10.5	10.8	11.0	11.25
IRELAND	Scenario 1	1.9	2.5	2.6	3.0	4.0	5.22
	Scenario 2			2.7	3.9	4.8	6.07
	Scenario 3			2.7	3.5	3.8	4.11
	Scenario 4			2.0	1.5	1.7	1.91
ITALY	Scenario 1	13.3	15.5	21.2	27.0	34.2	43.17
	Scenario 2			21.9	27.9	35.0	43.93
	Scenario 3			21.9	21.9	23.6	25.55
	Scenario 4			19.9	21.9	27.7	1.91
LUXEMBOURG	Scenario 1	1.1	1.2	1.2	1.2	1.2	1.15
	Scenario 2			1.2	1.2	1.2	1.09
	Scenario 3			1.2	1.2	1.1	0.98
	Scenario 4			1.1	1.0	0.9	0.86
NETHERLANDS	Scenario 1	7.1	7.8	9.4	12.9	13.0	13.24
	Scenario 2			9.6	13.2	13.3	13.44
	Scenario 3			9.6	11.8	9.7	7.90
	Scenario 4			9.2	11.7	11.1	10.61
PORTUGAL	Scenario 1	1.5	2.2	3.2	3.2	4.9	7.68
	Scenario 2			3.7	4.3	5.7	7.75
	Scenario 3			3.7	3.8	4.5	5.25
	Scenario 4			2.8	2.8	2.9	2.91
UNITED KINGDOM	Scenario 1	5.5	12.0	15.8	29.5	33.3	37.51
	Scenario 2			17.0	33.6	33.6	41.23
	Scenario 3			17.0	24.4	16.8	11.55
	Scenario 4			13.7	21.3	20.1	18.88

Sources: SOEC and DG XVII A2 estimates

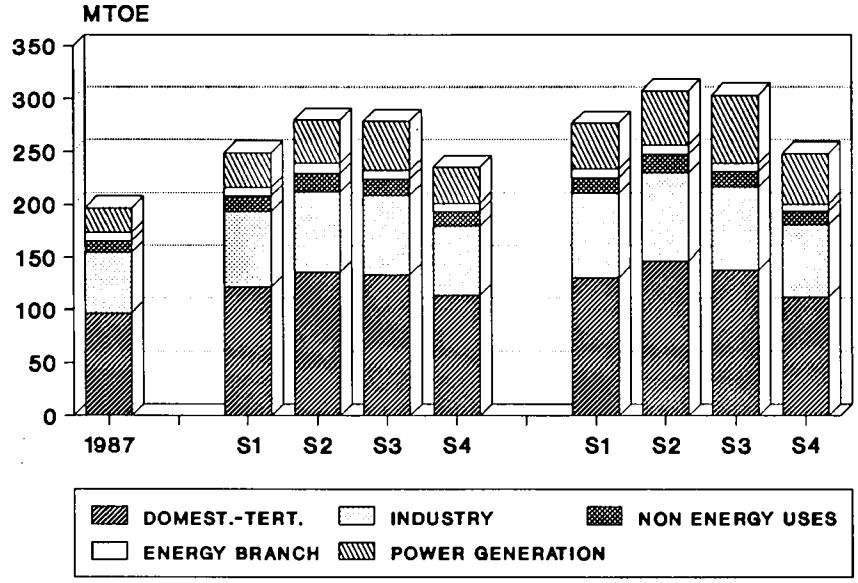
5.5 Gas Sector

GAS DEMAND
(EUROPE 12)
Total Demand



Domestic and tertiary sectors remain the most important despite growth in power sector.

Demand by Sector (*)

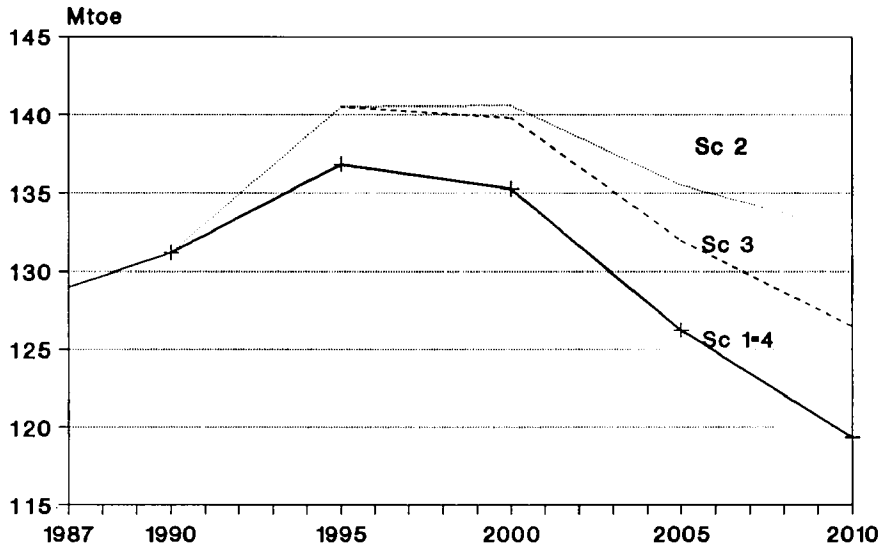


(*) NATURAL GAS ONLY

GAS SUPPLY
(EUROPE 12)

Depletion leads to declining production after 2000

Production



Wide range of uncertainty by 2010

Net Imports

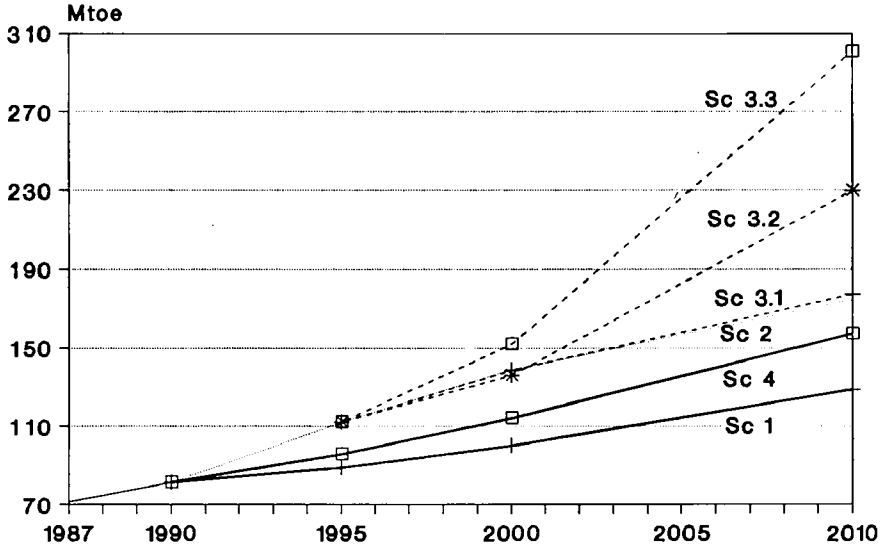


Table 5.5.1 **NATURAL GAS DOMESTIC PRODUCTION**

MTOE		1987	1990	1995	2000	2005	2010
EUROPE 12	Scenario 1	129.0	131.2	136.8	135.3	126.2	119.36
	Scenario 2			140.5	140.6	135.5	132.55
	Scenario 3			140.5	139.8	132.0	126.46
	Scenario 4			136.8	135.1	126.2	119.36
BELGIUM	Scenario 1	0.0					
	Scenario 2						
	Scenario 3						
	Scenario 4						
DENMARK	Scenario 1	2.1	2.7	3.5	4.0	4.2	4.40
	Scenario 2			3.6	4.3	4.6	4.84
	Scenario 3			3.6	4.2	4.3	4.55
	Scenario 4			3.5	3.9	4.2	4.40
GERMANY	Scenario 1	12.8	11.6	12.3	11.9	11.6	11.31
	Scenario 2			12.3	11.9	11.6	11.31
	Scenario 3			12.3	11.9	11.6	11.31
	Scenario 4			12.3	11.9	11.6	11.31
GREECE	Scenario 1	0.1	0.1				
	Scenario 2						
	Scenario 3						
	Scenario 4						
SPAIN	Scenario 1	0.6	0.9	1.2	1.5	1.7	1.90
	Scenario 2			1.5	1.9	2.1	2.40
	Scenario 3			1.5	1.8	1.9	2.10
	Scenario 4			1.2	1.5	1.7	1.90
FRANCE	Scenario 1	3.3	2.4	1.4	1.0	0.9	0.75
	Scenario 2			1.4	1.0	0.9	0.75
	Scenario 3			1.4	1.0	0.9	0.75
	Scenario 4			1.4	1.0	0.9	0.75
IRELAND	Scenario 1	1.3	1.7	1.9	1.5		
	Scenario 2			1.9	1.7		
	Scenario 3			1.9	1.7		
	Scenario 4			1.9	1.5		
ITALY	Scenario 1	13.2	14.0	15.3	16.5	16.4	16.25
	Scenario 2			16.0	17.3	17.4	17.50
	Scenario 3			16.0	17.3	17.1	17.00
	Scenario 4			15.3	16.5	16.4	16.25
LUXEMBOURG	Scenario 1						
	Scenario 2						
	Scenario 3						
	Scenario 4						
NETHERLANDS	Scenario 1	56.1	55.3	53.0	48.8	44.0	39.75
	Scenario 2			54.4	50.0	45.7	41.75
	Scenario 3			54.4	50.0	45.1	40.75
	Scenario 4			53.0	48.8	44.0	39.75
PORTUGAL	Scenario 1						
	Scenario 2						
	Scenario 3						
	Scenario 4						
UNITED KINGDOM	Scenario 1	39.3	42.5	48.3	50.0	47.4	45.00
	Scenario 2			49.5	52.5	53.2	54.00
	Scenario 3			49.5	52.0	51.0	50.00
	Scenario 4			48.3	50.0	47.4	45.00

Sources: SOEC and DG XVII A2 estimates

Table 5.5.2 **NET GAS IMPORT**

MTOE		1987	1990	1995	2000	2005	2010
EUROPE 12	Scenario 1	71.4	81.4	95.9	114.1	135.6	157.30
	Scenario 2			112.0	139.0	157.6	174.82
	Scenario 3			112.0	138.7	157.9	177.24
	Scenario 4			88.8	100.2	114.5	128.81
BELGIUM	Scenario 1	7.5	8.7	9.3	11.1	11.5	12.05
	Scenario 2			10.3	12.8	13.3	13.88
	Scenario 3			10.3	11.6	12.0	12.39
	Scenario 4			9.2	10.8	11.2	11.72
DENMARK	Scenario 1	-0.8	-0.9	-1.0	-1.0	-0.7	-0.48
	Scenario 2			-0.9	-1.0	-0.9	-0.91
	Scenario 3			-0.9	-0.8	-0.1	-0.02
	Scenario 4			-1.0	-1.0	-0.6	-0.43
GERMANY	Scenario 1	33.1	33.7	36.8	41.8	42.3	42.73
	Scenario 2			40.9	45.4	46.8	48.26
	Scenario 3			40.9	47.8	50.2	52.73
	Scenario 4			35.1	38.4	41.4	44.58
GREECE	Scenario 1			1.6	2.0	2.2	2.53
	Scenario 2			2.2	3.9	4.2	4.62
	Scenario 3			2.2	3.5	4.1	4.90
	Scenario 4			1.5	2.2	2.3	2.44
SPAIN	Scenario 1	2.2	2.8	3.1	4.2	4.9	5.69
	Scenario 2			3.7	5.6	6.4	7.31
	Scenario 3			3.7	5.6	6.7	8.08
	Scenario 4			3.4	4.1	3.6	3.12
FRANCE	Scenario 1	22.6	26.1	30.0	32.7	35.6	38.82
	Scenario 2			31.9	36.1	38.5	41.11
	Scenario 3			31.9	36.3	38.5	40.81
	Scenario 4			29.1	30.5	32.1	33.81
IRELAND	Scenario 1				0.6	1.2	2.30
	Scenario 2			0.3	1.1	1.9	3.25
	Scenario 3			0.3	0.9	1.6	2.97
	Scenario 4				0.7	1.2	2.12
ITALY	Scenario 1	19.2	21.0	25.8	28.7	31.5	34.51
	Scenario 2			27.9	32.6	35.1	37.80
	Scenario 3			27.9	31.9	35.3	39.17
	Scenario 4			24.4	26.5	28.0	29.50
LUXEMBOURG	Scenario 1	0.4	0.4	0.4	0.5	0.6	0.65
	Scenario 2			0.4	0.5	0.6	0.70
	Scenario 3			0.4	0.6	0.6	0.63
	Scenario 4			0.4	0.5	0.5	0.55
NETHERLANDS	Scenario 1	-22.5	-20.8	-18.3	-15.9	-8.0	-4.03
	Scenario 2			-17.2	-14.1	-7.4	-3.90
	Scenario 3			-17.2	-14.2	-9.4	-6.20
	Scenario 4			-19.7	-17.5	-12.0	-8.27
PORTUGAL	Scenario 1				1.3	1.6	2.00
	Scenario 2			0.0	1.7	2.1	2.60
	Scenario 3			0.0	1.5	2.2	3.14
	Scenario 4				1.2	1.4	1.67
UNITED KINGDOM	Scenario 1	10.0	10.5	8.2	8.0	12.8	20.53
	Scenario 2			12.4	14.4	17.0	20.10
	Scenario 3			12.4	14.0	16.2	18.64
	Scenario 4			6.6	3.8	5.5	8.00

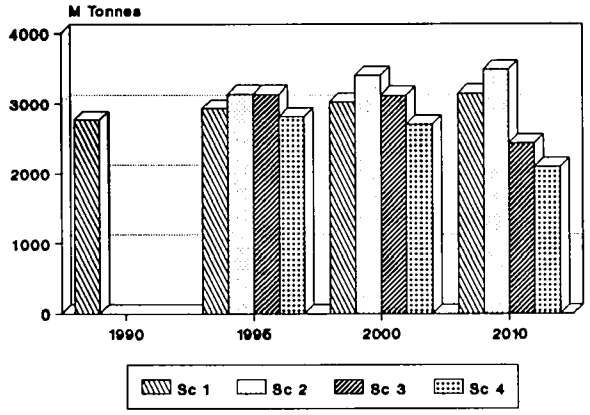
Sources: SOEC and DG XVII A2 estimates

5.6 Atmospheric Pollutants

Scenario Comparisons
(EUROPE 12)

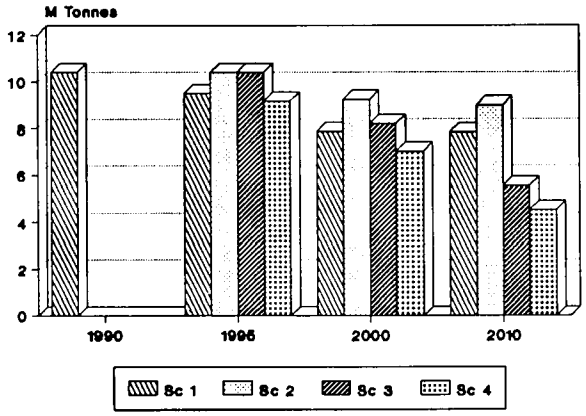
Emissions up in scenarios 1 and 2, down in scenarios 3 and 4

CO2



Emissions down in all scenarios

NOx



Emissions down in all scenarios

SO2

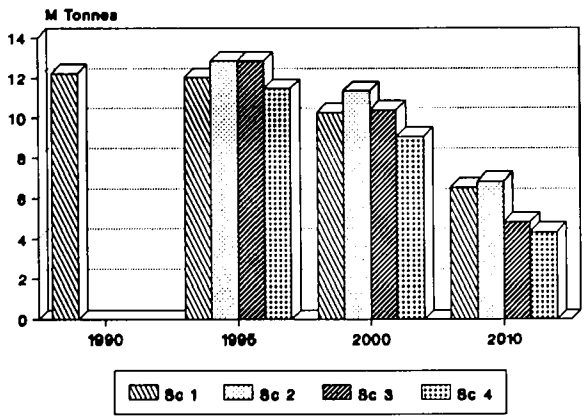


Table 5.6.1 **EUR12 SO2 Emissions** (Mtons)

Greatest scope for reductions in the power generation sector.

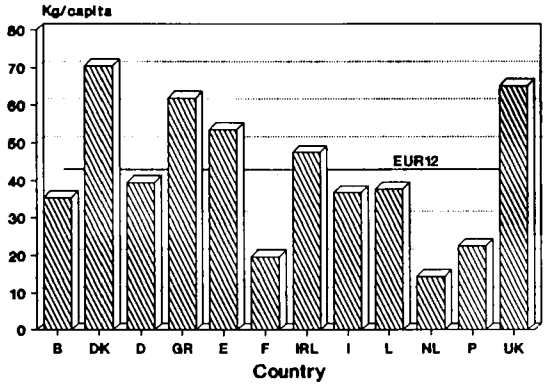
Conventional Wisdom						Driving Into Tensions				
Emissions by sector	1986	1990	1995	2000	2010	1986	1990	1995	2000	2010
TOTAL	13.40	12.23	12.02	10.26	6.56	13.40	12.23	12.83	11.33	6.85
Power Generation	8.61	7.65	7.39	5.90	2.39	8.61	7.65	7.85	6.63	2.52
Energy sector	0.82	0.67	0.71	0.62	0.51	0.82	0.67	0.80	0.68	0.53
Final Sector	3.97	3.90	3.93	3.74	3.66	3.97	3.90	4.17	4.03	3.80
Industry	2.12	2.12	2.17	2.05	2.07	2.12	2.12	2.29	2.16	2.08
Transports	0.56	0.68	0.73	0.76	0.79	0.56	0.68	0.83	0.94	0.96
Residential/Tertiary	1.30	1.10	1.02	0.93	0.79	1.30	1.10	1.05	0.92	0.75

Sustaining High Economic Growth						High Prices				
Emissions by sector	1986	1990	1995	2000	2010	1986	1990	1995	2000	2010
TOTAL	13.40	12.23	12.83	10.39	4.81	13.40	12.23	11.47	9.07	4.32
Power Generation	8.61	7.65	7.85	5.98	1.84	8.61	7.65	7.22	5.33	1.76
Energy sector	0.82	0.67	0.80	0.60	0.37	0.82	0.67	0.75	0.69	0.69
Final Sector	3.97	3.90	4.17	3.82	2.61	3.97	3.90	3.50	3.04	1.88
Industry	2.12	2.12	2.29	2.10	1.51	2.12	2.12	1.88	1.69	1.11
Transports	0.56	0.68	0.83	0.80	0.51	0.56	0.68	0.71	0.68	0.37
Residential/Tertiary	1.30	1.10	1.05	0.91	0.58	1.30	1.10	0.91	0.68	0.40

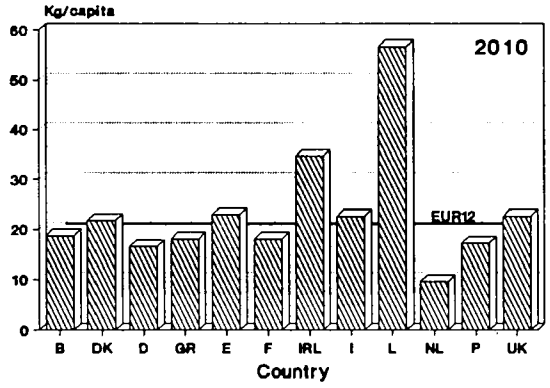
Source: DG XVII A2 estimates

SO2 EMISSIONS PER CAPITA

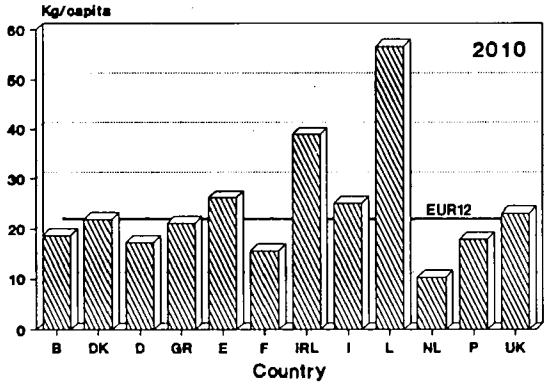
1986



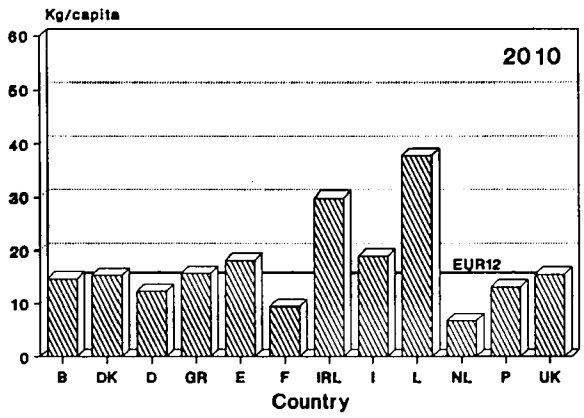
Conventional Wisdom



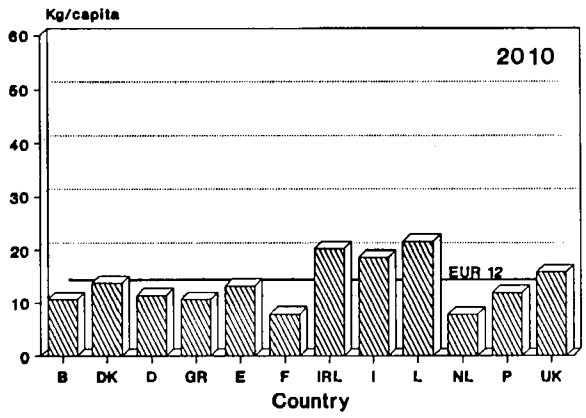
Driving Into Tensions



Sustaining High Economic Growth



High Prices



(DG XVII A2 estimates)

Table 5.6.2 **EUR12 NOx Emissions** (Mtons)

Conventional Wisdom						Driving Into Tensions				
Emissions by sector	1986	1990	1995	2000	2010	1986	1990	1995	2000	2010
TOTAL	9.56	10.38	9.50	7.88	7.85	9.56	10.38	10.38	9.24	8.98
Power Generation	2.40	2.25	2.20	1.76	1.61	2.40	2.25	2.37	2.07	1.79
Energy sector	0.21	0.23	0.25	0.25	0.23	0.21	0.23	0.25	0.25	0.24
Final Sector	6.95	7.90	7.06	5.87	6.01	6.95	7.90	7.76	6.92	6.96
Industry	0.72	0.75	0.77	0.77	0.80	0.72	0.75	0.80	0.80	0.82
Transports	5.62	6.53	5.67	4.51	4.64	5.62	6.53	6.31	5.50	5.55
Residential/Tertiary	0.61	0.62	0.62	0.59	0.57	0.61	0.62	0.65	0.63	0.59

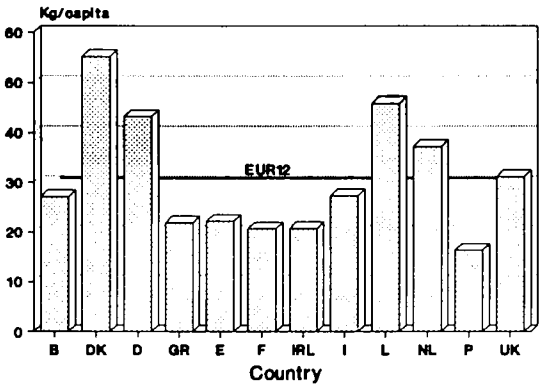
Behaviour change in the transport sector required to significantly reduce NOx emission (scenarios 3 and 4)

Sustaining High Economic Growth						High Prices				
Emissions by sector	1986	1990	1995	2000	2010	1986	1990	1995	2000	2010
TOTAL	9.56	10.38	10.38	8.20	5.55	9.56	10.38	9.17	7.03	4.53
Power Generation	2.40	2.25	2.37	1.86	1.24	2.40	2.25	2.15	1.61	1.20
Energy sector	0.21	0.23	0.25	0.22	0.17	0.21	0.23	0.25	0.25	0.21
Final Sector	6.95	7.90	7.76	6.11	4.14	6.95	7.90	6.77	5.18	3.13
Industry	0.72	0.75	0.80	0.77	0.65	0.72	0.75	0.68	0.65	0.52
Transports	5.62	6.53	6.31	4.71	2.97	5.62	6.53	5.51	4.02	2.20
Residential/Tertiary	0.61	0.62	0.65	0.63	0.52	0.61	0.62	0.59	0.51	0.40

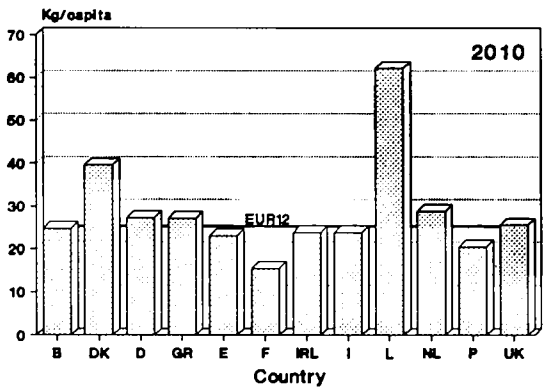
Source: DG XVII A2 estimates

NOX EMISSIONS PER CAPITA

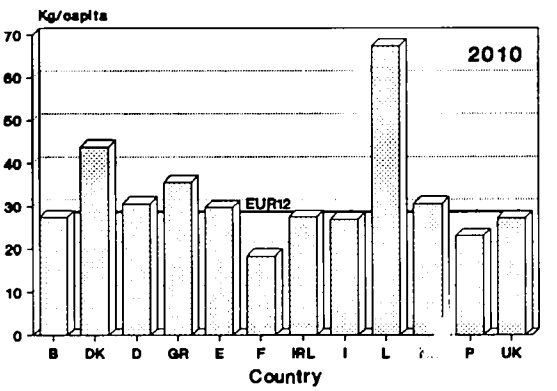
1986



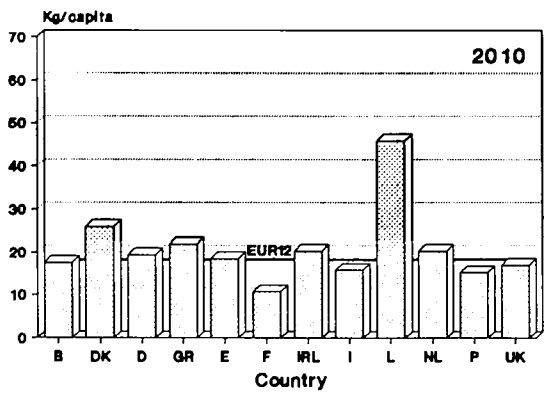
Conventional Wisdom



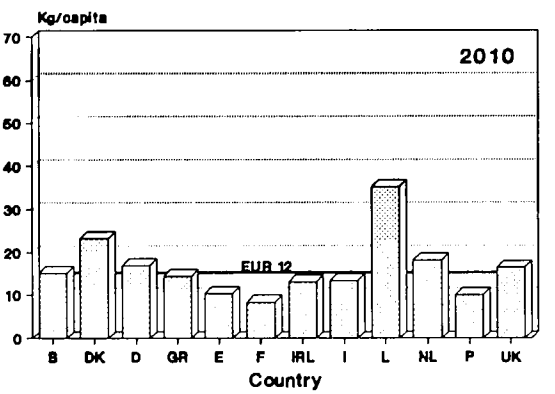
Driving Into Tensions



Sustaining High Economic Growth



High Prices



(DG XVII A2 estimates)

Table 5.6.3 **EUR12 CO2 Emissions** (Mtons)

Conventional Wisdom						Driving Into Tensions				
Emissions by sector	1986	1990	1995	2000	2010	1986	1990	1995	2000	2010
TOTAL	2560.46	2764.98	2930.10	3025.79	3143.25	2560.46	2764.98	3135.91	3405.35	3481.70
Power Generation	786.41	857.46	965.93	1046.37	1190.51	786.41	857.46	1034.80	1218.29	1334.18
Energy sector	93.32	103.29	111.03	110.41	105.72	93.32	103.29	114.96	115.68	105.07
Final Sector	1680.72	1804.24	1853.14	1869.02	1847.03	1680.72	1804.24	1986.15	2071.39	2042.45
Industry	496.48	513.27	517.90	521.68	518.53	496.48	513.27	538.85	540.03	541.48
Transports	577.53	672.91	716.76	743.42	759.26	577.53	672.91	797.69	898.28	907.16
Residential/Tertiary	606.72	618.06	618.49	603.92	569.23	606.72	618.06	649.62	633.08	593.81

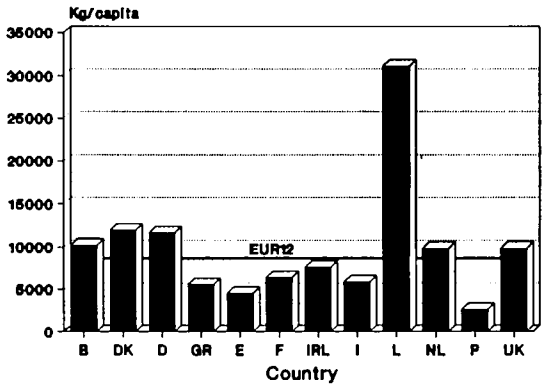
Major behavioural changes are required to reduce CO2 emissions levels by 2010.
(scenarios 3 and 4)

Sustaining High Economic Growth						High Prices				
Emissions by sector	1986	1990	1995	2000	2010	1986	1990	1995	2000	2010
TOTAL	2560.46	2764.98	3135.91	3120.83	2426.25	2560.46	2764.98	2812.98	2701.52	2098.37
Power Generation	786.41	857.46	1034.80	1099.88	912.30	786.41	857.46	947.15	961.79	880.51
Energy sector	93.32	103.29	114.96	101.88	77.78	93.32	103.29	111.44	110.20	96.14
Final Sector	1680.72	1804.24	1986.15	1919.07	1436.17	1680.72	1804.24	1754.39	1629.53	1121.73
Industry	496.48	513.27	538.85	516.90	424.57	496.48	513.27	471.94	455.93	353.29
Transports	577.53	672.91	797.69	769.32	480.22	577.53	672.91	695.72	656.07	357.32
Residential/Tertiary	606.72	618.06	649.62	632.86	531.39	606.72	618.06	586.73	517.53	411.12

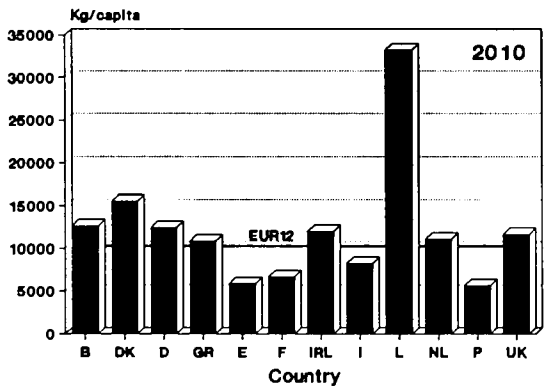
Source: DG XVII A2 estimates

CO2 EMISSIONS PER CAPITA

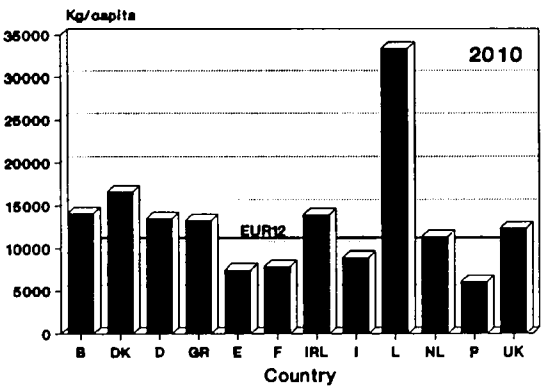
1986



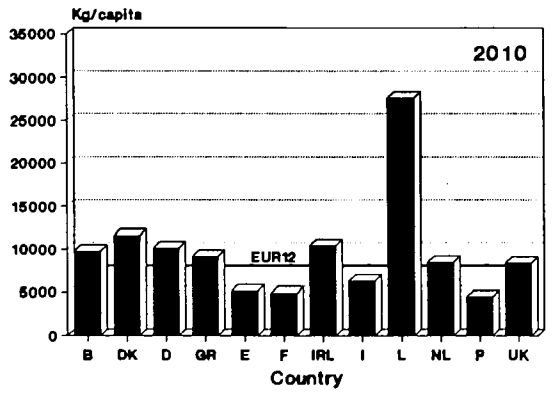
Conventional Wisdom



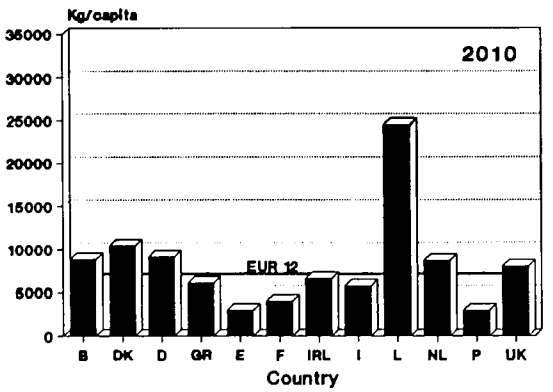
Driving Into Tensions



Sustaining High Economic Growth



High Prices



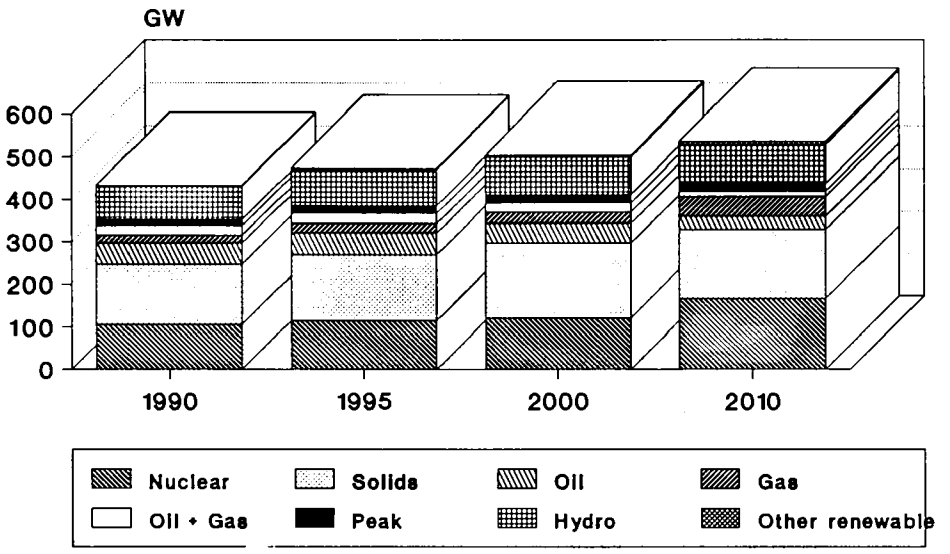
(DG XVII A2 estimates)

6. SENSITIVITY ANALYSIS ON SCENARIO 3

6.1 Electricity Generating Capacities

Europe 12

Scenario 3.1



Large capacity differences by 2010

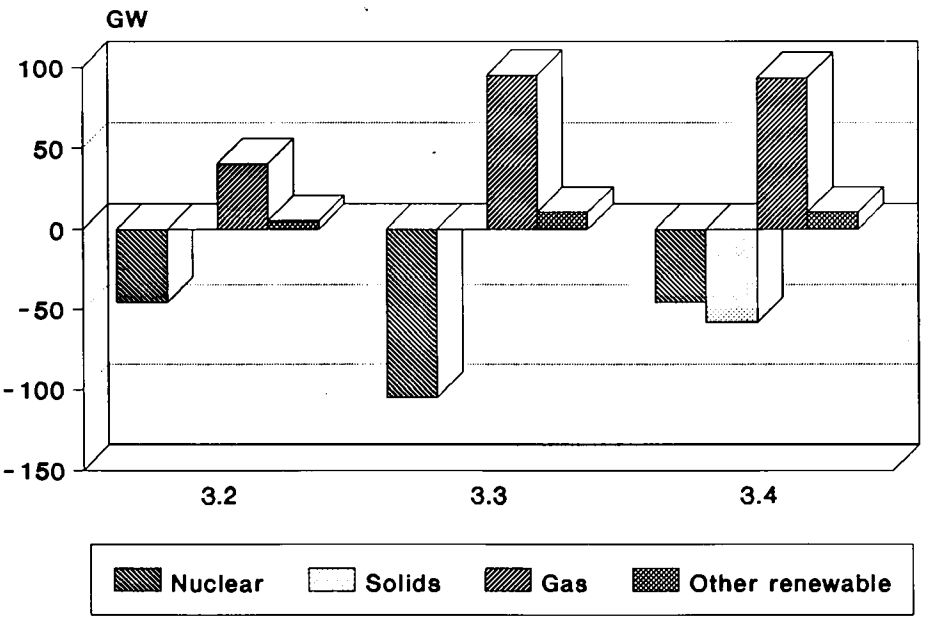


Table 6.1.1 EVOLUTION OF NET MAXIMUM CAPACITIES : SUSTAINING HIGH ECONOMIC GROWTH

SCENARIO 3.1 : REFERENCE

EUROPE 12	1990	1995	2000	2010
TOTAL	433.04	473.35	504.78	535.56
NUCLEAR	105.29	114.69	120.46	165.82
HYDRO	78.70	83.98	88.02	90.84
THERMAL	246.90	271.82	291.91	272.57
solids	141.45	155.32	175.69	162.85
oil	49.88	50.97	47.17	32.44
conv. gas	18.04	17.61	15.23	11.48
com. c. gas	0.00	5.10	12.04	34.14
oil+gas	23.24	24.07	21.81	13.46
peak	14.30	18.75	19.96	18.21
RENEW	2.15	2.86	4.38	6.34
wind	0.03	0.16	0.76	2.54
geoth	0.42	0.53	0.85	1.07
bio-mass	1.46	1.93	2.52	2.48
solar	0.00	0.00	0.00	0.00
tydal	0.24	0.24	0.24	0.24

EUROPE 12 Shares	1990	1995	2000	2010
TOTAL	100.0%	100.0%	100.0%	100.0%
NUCLEAR	24.3%	24.2%	23.9%	31.0%
HYDRO	18.2%	17.7%	17.4%	17.0%
THERMAL	57.0%	57.4%	57.8%	50.9%
solids	32.7%	32.8%	34.8%	30.4%
oil	11.5%	10.8%	9.3%	6.1%
conv. gas	4.2%	3.7%	3.0%	2.1%
com. c. gas	0.0%	1.1%	2.4%	6.4%
oil+gas	5.4%	5.1%	4.3%	2.5%
peak	3.3%	4.0%	4.0%	3.4%
RENEW	0.5%	0.6%	0.9%	1.2%
wind	0.0%	0.0%	0.2%	0.5%
geoth	0.1%	0.1%	0.2%	0.2%
bio-mass	0.3%	0.4%	0.5%	0.5%
solar	0.0%	0.0%	0.0%	0.0%
tydal	0.1%	0.1%	0.0%	0.0%

Table 6.1.2 EVOLUTION OF NET MAXIMUM CAPACITIES : SUSTAINING HIGH ECONOMIC GROWTH

SCENARIO 3.2 : Nuclear Stable After 2000 With Medium Renewables

EUROPE 12	1990	1995	2000	2010
TOTAL	433.04	473.35	504.94	535.88
NUCLEAR	105.29	114.69	120.46	120.46
HYDRO	78.70	83.98	88.02	90.84
THERMAL	246.90	271.82	289.75	313.04
solids	141.45	155.32	175.69	162.85
oil	49.88	50.97	47.17	32.44
conv. gas	18.04	17.61	15.23	11.48
com. c. gas	0.00	5.10	9.88	74.61
oil+gas	23.24	24.07	21.81	13.46
peak	14.30	18.75	19.96	18.21
RENEW	2.15	2.86	6.71	11.54
wind	0.03	0.16	1.26	3.50
geoth	0.42	0.53	0.85	1.07
bio-mass	1.46	1.93	4.36	6.72
solar	0.00	0.00	0.00	0.00
tydal	0.24	0.24	0.24	0.24

EUROPE 12 Shares	1990	1995	2000	2010
TOTAL	100.0%	100.0%	100.0%	100.0%
NUCLEAR	24.3%	24.2%	23.9%	22.5%
HYDRO	18.2%	17.7%	17.4%	17.0%
THERMAL	57.0%	57.4%	57.4%	58.4%
solids	32.7%	32.8%	34.8%	30.4%
oil	11.5%	10.8%	9.3%	6.1%
conv. gas	4.2%	3.7%	3.0%	2.1%
com. c. gas	0.0%	1.1%	2.0%	13.9%
oil+gas	5.4%	5.1%	4.3%	2.5%
peak	3.3%	4.0%	4.0%	3.4%
RENEW	0.5%	0.6%	1.3%	2.2%
wind	0.0%	0.0%	0.2%	0.7%
geoth	0.1%	0.1%	0.2%	0.2%
bio-mass	0.3%	0.4%	0.9%	1.3%
solar	0.0%	0.0%	0.0%	0.0%
tydal	0.1%	0.1%	0.0%	0.0%

Table 6.1.3 EVOLUTION OF NET MAXIMUM CAPACITIES : SUSTAINING HIGH ECONOMIC GROWTH

SCENARIO 3.3 : Nuclear Moratorium With Maximum Renewables

EUROPE 12	1990	1995	2000	2010
TOTAL	433.04	473.35	505.01	536.29
NUCLEAR	105.29	114.69	106.16	60.87
HYDRO	78.70	83.98	88.02	90.84
THERMAL	246.90	271.82	302.01	367.60
solids	141.45	155.32	175.69	162.85
oil	49.88	50.97	47.17	32.44
conv. gas	18.04	17.61	15.23	11.48
com. c. gas	0.00	5.10	22.14	129.17
oil+gas	23.24	24.07	21.81	13.46
peak	14.30	18.75	19.96	18.21
RENEW	2.15	2.86	8.83	16.98
wind	0.03	0.16	1.47	4.19
geoth	0.42	0.53	0.85	1.07
bio-mass	1.46	1.93	6.27	11.47
solar	0.00	0.00	0.00	0.00
tydal	0.24	0.24	0.24	0.24

EUROPE 12 Shares	1990	1995	2000	2010
TOTAL	100.0%	100.0%	100.0%	100.0%
NUCLEAR	24.3%	24.2%	21.0%	11.4%
HYDRO	18.2%	17.7%	17.4%	16.9%
THERMAL	57.0%	57.4%	59.8%	68.5%
solids	32.7%	32.8%	34.8%	30.4%
oil	11.5%	10.8%	9.3%	6.0%
conv. gas	4.2%	3.7%	3.0%	2.1%
com. c. gas	0.0%	1.1%	4.4%	24.1%
oil+gas	5.4%	5.1%	4.3%	2.5%
peak	3.3%	4.0%	4.0%	3.4%
RENEW	0.5%	0.6%	1.7%	3.2%
wind	0.0%	0.0%	0.3%	0.8%
geoth	0.1%	0.1%	0.2%	0.2%
bio-mass	0.3%	0.4%	1.2%	2.1%
solar	0.0%	0.0%	0.0%	0.0%
tydal	0.1%	0.1%	0.0%	0.0%

Table 6.1.4 EVOLUTION OF NET MAXIMUM CAPACITIES : SUSTAINING HIGH ECONOMIC GROWTH

SCENARIO 3.4 : Nuclear Stable After 2000 With Maximum Gas And Maximum Renewables

EUROPE 12	1990	1995	2000	2010
TOTAL	433.04	473.35	505.01	536.29
NUCLEAR	105.29	114.69	120.46	120.46
HYDRO	78.70	83.98	88.02	90.84
THERMAL	246.90	271.82	287.70	308.01
solids	141.45	155.32	153.64	104.85
oil	49.88	50.97	47.17	32.44
conv. gas	18.04	17.61	15.23	11.48
com. c. gas	0.00	5.10	29.89	127.58
oil+gas	23.24	24.07	21.81	13.46
peak	14.30	18.75	19.96	18.21
RENEW	2.15	2.86	8.83	16.98
wind	0.03	0.16	1.47	4.19
geoth	0.42	0.53	0.85	1.07
bio-mass	1.46	1.93	6.27	11.47
solar	0.00	0.00	0.00	0.00
tydal	0.24	0.24	0.24	0.24

EUROPE 12 Shares	1990	1995	2000	2010
TOTAL	100.0%	100.0%	100.0%	100.0%
NUCLEAR	24.3%	24.2%	23.9%	22.5%
HYDRO	18.2%	17.7%	17.4%	16.9%
THERMAL	57.0%	57.4%	57.0%	57.4%
solids	32.7%	32.8%	30.4%	19.6%
oil	11.5%	10.8%	9.3%	6.0%
conv. gas	4.2%	3.7%	3.0%	2.1%
com. c. gas	0.0%	1.1%	5.9%	23.8%
oil+gas	5.4%	5.1%	4.3%	2.5%
peak	3.3%	4.0%	4.0%	3.4%
RENEW	0.5%	0.6%	1.7%	3.2%
wind	0.0%	0.0%	0.3%	0.8%
geoth	0.1%	0.1%	0.2%	0.2%
bio-mass	0.3%	0.4%	1.2%	2.1%
solar	0.0%	0.0%	0.0%	0.0%
tydal	0.1%	0.1%	0.0%	0.0%

6.2 Comparison of CO2 Emissions and Imports

Table 6.2.1 Comparative Summary

Main Findings in 2000

CO2 Output (M tonnnes)		Sc 3.1	Sc 3.2	Sc 3.3	Sc 3.4
Power Generation	(1) + (2)	533.0	529.6	548.6	503.7
	Solids (1)	473.0	473.0	473.0	416.1
	Gas (2)	60.0	56.7	75.6	87.6
TOTAL EMISSIONS		3120.8	3117.5	3136.5	3091.5
Variations in % of base case			-0.1	0.5	-0.9

Net Imports (M toe)	Sc 3.1	Sc 3.2	Sc 3.3	Sc 3.4
Hard coal	146.4	146.4	146.4	122.1
Natural gas	138.7	135.9	151.8	161.8
TOTAL	737.6	734.8	750.7	736.4

Call On Import (%)	Sc 3.1	Sc 3.2	Sc 3.3	Sc 3.4
Hard coal	54.3	54.3	54.3	49.8
Natural gas	49.8	49.3	52.1	53.7
TOTAL	55.9	55.8	56.8	55.9

Main Findings in 2010

CO2 Output (M tonnes)		Sc 3.1	Sc 3.2	Sc 3.3	Sc 3.4
Power Generation	(1) + (2)	475.8	538.5	622.9	470.8
	Solids (1)	395.2	395.2	395.2	245.6
	Gas (2)	80.6	143.2	227.7	225.2
TOTAL EMISSIONS		2426.2	2488.9	2573.4	2421.3
Variations in % of base case			2.6	6.1	-0.2

Net Imports (M toe)	Sc 3.1	Sc 3.2	Sc 3.3	Sc 3.4
Hard coal	115.0	115.0	115.0	51.0
Natural gas	177.3	229.8	300.5	298.5
TOTAL	562.1	614.6	685.3	619.3

Call On Import (%)	Sc 3.1	Sc 3.2	Sc 3.3	Sc 3.4
Hard coal	52.3	52.3	52.3	32.7
Natural gas	58.4	64.5	70.4	70.3
TOTAL	47.7	52.8	59.4	52.5

7. GLOSSARY

Factors	Name	Symbol
1.E+03	kilo	Kg
1.E+06	mega	M
1.E+09	giga	G
1.E+12	tera	T
1.E+15	peta	P

UNITS

Volume	Symbol	Equivalence
barrel	bbl	158.98 litres
US gallon		3.785 litres
cubic foot	ftE3	28.32 litres

HEAT

	Kcal	Joule	BTU	Kwh
Kcal	1	2.389E-04	2.520E-01	860
Joule	4186	1	1054.8	3.60E+06
BTU	3.969	9.480E-04	1	3413
Kwh	1.160E-03	2.780E-07	2.930E-04	1

Example : 1 BTU = 1054.8 joules

1 toe = 1.0E+7 Kcal
1 tce = 7.0E+6 Kcal

ABBREVIATIONS

bpd	barrel per day
CHP	Combined production of Heat and Power
CIF	Cost, Insurance, Freight
CPEs	Centrally Planned Economies
DC	Develloping Countries
DH	District Heating
FOB	Free On Board
GDP	Gross Domestic Product
LDCs	Less Developed Countries
LNG	Liquified Natural Gas
LPG	Liquified Petroleum Gas
mbd	million barrels day
NGL	Natural Gas Liquids
OECD	Organisation for Economic Cooperation and Development
OPEC	Organisation of Petroleum Exporting Countries
SOEC	Statistical Office of European Community
UNIPEDE	International Union of Producers and Distributors of Electrical Energy
WEC	World Energy Conference

8. LIST OF WORKING DOCUMENTS

1. Scenario Description and Main Assumptions (BETEP/ESAP)
2. Demand Side Analysis (BETEP)
3.1 Bilans de Synthèse - L'Offre d'Energie et Bilans Energétiques Globaux - Conventional Wisdom (ESAP/BETEP/DGXVII-A-2)
3.2 Bilans de Synthèse - L'Offre d'Energie et Bilans Energétiques Globaux - Driving into Tensions (ESAP/BETEP/DGXVII-A-2)
3.3 Bilans de Synthèse - L'Offre d'Energie et Bilans Energétiques Globaux - Sustaining High Economic Growth (ESAP/BETEP/DGXVII-A-2)
3.4 Bilans de Synthèse - L'Offre d'Energie et Bilans Energétiques Globaux - High Prices (ESAP/BETEP/DGXVII-A-2)
4. Balance Sheets of Pollutants SO_2 NO_x CO_2 (DGXVII-A-2)
5. Les Equipements de Maîtrise de l'Energie en Europe (Explicit)
6. Technologie et Offre d'Energie(BIPE)
7. Perspectives du Secteur Pétrolier (ESAP)
8. Perspectives du Secteur Electrique Européen à Moyen et Long Terme(ESAP)
9. The Benefits of Integration in the European Electricity System (Coherence)
10. Effets de l'Harmonisation des Accises et de la TVA sur la Demande d'Energie dans Quatre Pays de la CEE : Etude à l'Aide du Modèle MIDAS (DULBEA/DGXVII-A-2)
11. The Effects of the Completion of the Internal Market for Petroleum Products (R. Bacon)
12. The World Oil Market - A Scenario Approach (DGXVII-A-2)
13. Energy Outlook of the USSR and Eastern Europe (DGXVII-A-2)
14. World Energy Outlook (DGXVII-A-2)
15. Réserves et Ressources Energétiques (Non-Renouvelables).(Michel Grenon)
16. Energy Reserves and Resources (Non-Renewable) (Michel Grenon)
17. Energy and Environment (Official Commission Document: COM(89) 369 final)
18. Internal Energy Market - First Progress Report 1988-1990
19. Major Themes in Energy - September 1989

Conference on

Energy for a new century:

The European Perspective

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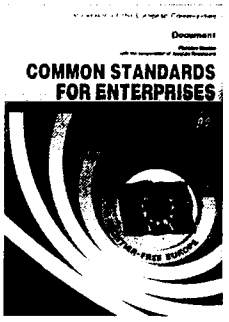

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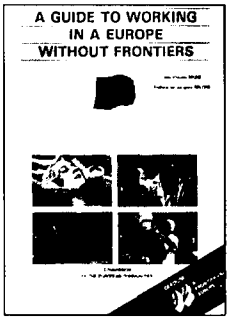

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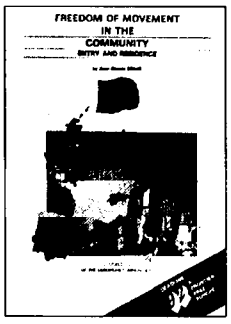

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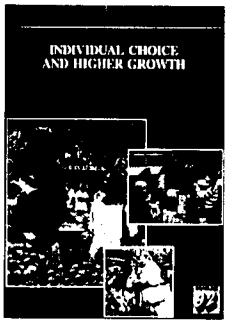

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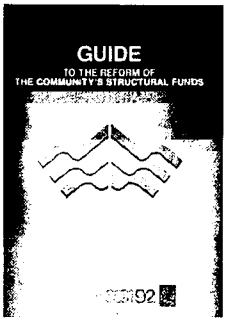

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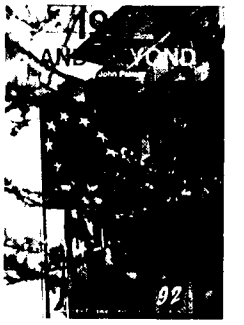

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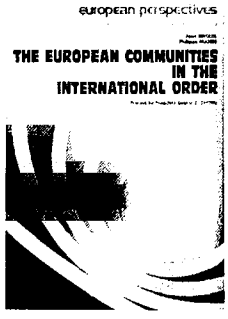

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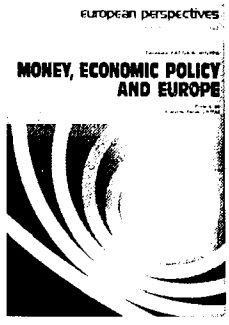

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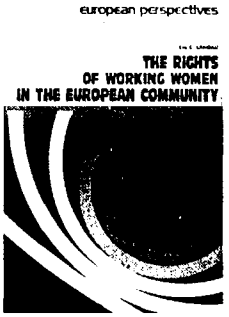

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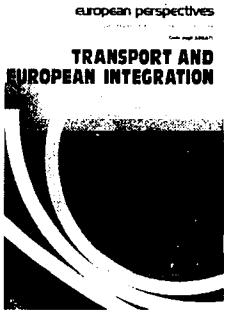

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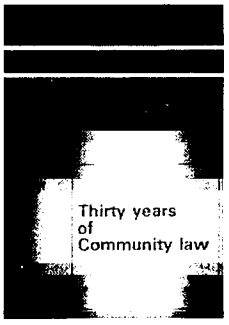

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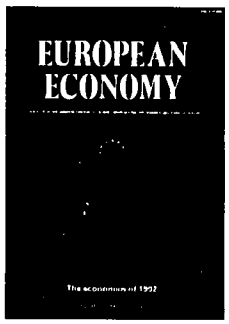

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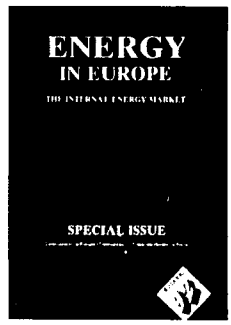

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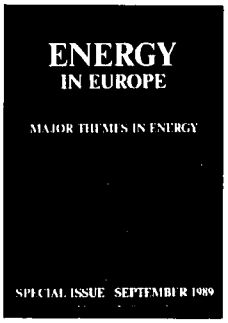

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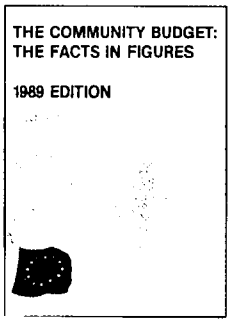

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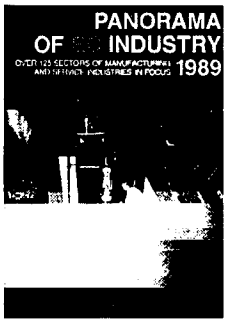

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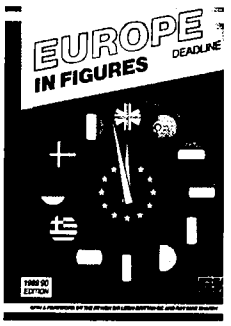

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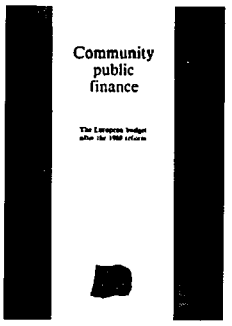

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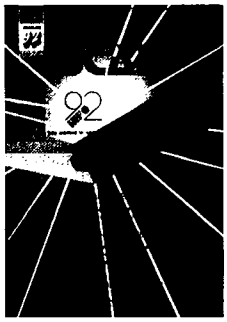

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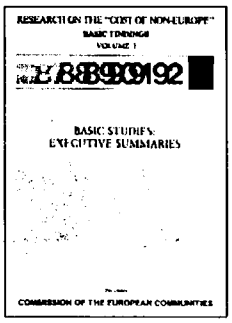

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