ENERGY
IN EUROPE

MAJOR THEMES IN ENERGY

SPECIAL ISSUE SEPTEMBER 1989

Commission of the European Communities □ Directorate-General for Energy

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For further information concerning articles or items in this publication please contact:

The Editor
Energy in Europe
DG XVII
Commission of the European Communities
200 rue de la Loi
B-1049 Brussels

Telex: COMEU B 21877
Fax: Brussels 235.01.50

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Introduction by Commissioner Cardoso e Cunha on the occasion of the World Energy Conference Montreal, September 1989.

*It is appropriate at this major conference that we address as one of our key themes «***Sustainable Energy Growth - Attainable or Impossible?***». Essentially the question is «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?» Such a fundamental question can only be put in a global context.*

*This document is a contribution by the Commission of the European Communities to this theme. Following a brief review of current developments in energy policy at Community level, including the drive to complete the Community Internal Energy Market by the end of 1992, there is a first preview of the long-term study currently underway in the Commission entitled «***Major Themes in Energy to 2010***». This shows possible alternative paths for our energy future. One is a «conventional route» with continuing growth in energy consumption and CO_2 emissions. Another path suggests a way of controlling energy consumption and its environmental impact whilst at the same time maintaining economic growth - the challenge of* **sustainable energy growth.**

The European Community and Energy

From all points of view, the European Community is a major player on the world scene. Its population of 325 million persons produces nearly 5 billion ecu of goods and services a year which amounts to 20% of world production. The Community is a major trader accounting for around 37% of world trade.

The same is true in the energy sector. Last year, the Community accounted for some 14% of the world's energy consumption and 8% of world energy production. As in other sectors, the Community is heavily involved in energy trade, accounting for 38% of world energy trade. No less than 45% of the Community's total energy supplies are imported from third countries. The health and vitality of the European Community rests upon safe and secure supplies of energy which are economic and environmentally sound.

Whilst talking about the European Community as a whole, it is important to bear in mind the diversity which exists between Member States, in the energy sector as much as in others. For example, energy resources are not evenly divided within the Community. At the one extreme, there is the UK with its rich natural endowment of coal, oil and gas reserves, whilst others like Belgium, Portugal and Luxembourg lack substantial energy resources. Likewise energy consumption and trade patterns differ considerably between Member States and even regions of the Community.

The 1992 Single European Market

Despite these differences, energy policy is increasingly being undertaken at Community level. Nowhere is this more true than in the Community's drive to complete the Internal Energy Market by the end of 1992. For the European Community, 1992 is the symbol of renewed dynamism and this is as true in the energy sector as anywhere else.

The blueprint for achieving the Single Energy Market was set out by the Commission in May 1988[1]. The Commission's action plan was given political endorsement by Energy Ministers later in the year. We are now at the critical stage of making proposals to the Council of Energy Ministers on a range of highly significant issues which, if adopted, will begin to change the face of energy in the Community.

1 «The Internal Energy Market» (COM(88)238 final) published as a special edition of «Energy in Europe»

In October this year, Energy Ministers will be asked to agree proposals which will increase exchanges of electricity and gas within the Community by organising the implementation of the right of transit for utilities within and across national borders. At a later stage and before 1992, following consultations with the parties concerned, the Commission will put forward further proposals on third party access for large consumers and distributors to the gas and electricity networks.

Also on Energy Ministers' agenda this autumn will be proposals to extend a system of price transparency to large industrial consumers in the gas and electricity sectors. Price and indeed cost transparency are seen as vital ingredients to a truly integrated, single energy market based on fair and open competition.

In the same vein, the Commission has also made proposals to ensure co-ordination between Member States and the Commission when planning investments for the production and transport of energy in the Community. Energy policy makers and decision takers must henceforth be encouraged to plan from a Community point of view rather than from a strictly national standpoint.

These specific proposals will be followed by others, all designed to introduce greater competition in the Community's energy sector and to remove restrictive national barriers. By increasing competition and exploiting the advantages of a large, single market, energy prices will be reduced to the benefit of all energy consumers. This in turn will increase the competitiveness of Community industry on world markets. The stakes are high. Potential benefits of achieving the Internal Energy Market have been put as high as 30 billion ecus per year.

Further Elements in Community Energy Policy

The drive to complete the Internal Energy Market is the Community's highest energy policy priority at present but it is not being pursued in isolation. Energy *security of supply* remains of paramount concern despite today's reasonably relaxed energy markets. No one should forget the suffering caused by the oil crises of the 1970's, both at an individual level and to our economies. The Community will strive to maintain and improve diversity in energy supplies, avoiding undue dependence on any single supply source, and to achieve the energy efficiency gains which are so sorely needed. Within the Community framework, all energy options will be kept open, including the safe use of nuclear power and the clean use of coal. In addition, the Community will continue to develop ways and means to be able to respond effectively in an international context to any future supply crisis.

Energy policy can no longer be developed without deep consideration of the implications for the *environment*. This applies at all stages of the energy chain from the time energy is produced, through transportation and use, to waste disposal. Such environmental threats as acid rain, the depletion of the ozone layer, the safe removal of toxic waste and above all, global climate warming will from now on help determine the shape of future Community energy policy. In line with the Single European Act of 1987, all Commission proposals must henceforth take as their base a high level of environmental protection and safety. The Commission is busy considering alternative energy strategies to take fully into account the need to preserve and indeed improve our environmental heritage.

The contribution that *energy technology* must make to energy security and a clean environment cannot be underestimated. It is fitting therefore that the Commission this year has launched a new 5-year energy technology programme called «THERMIE». Once agreed by the Member States, the programme should commence in 1990 and will cover the areas of energy efficiency, renewable energies, hydrocarbon development and the clean use of coal. Special emphasis will be given among other things to environmental benefits, the dissemination of energy technology within the Community, small and medium enterprises, and joint projects involving undertakings from more than one Member State.

The diversity within the Community has already been mentioned. This extends to differences in economic well-being between Member States and regions. The Community has a policy to narrow such differences under a heading of economic and social cohesion. To achieve this the Community has at its disposal some 52 billion ecus to be allocated by 1993 in the form of the Structural Funds. To provide perspective, this is in real terms more than the amount available under the Marshall Aid programme which put Europe back on its feet after World War II.

Substantial amounts of these Funds and from other sources will be spent on energy projects, for example energy infrastructure, to redress the balance between the well-off and poorer parts of the Community.

Community energy policy has to be put in a global context. There must be an *external dimension*. In addition to energy trade, the Community aims to develop structured relationships with energy producer and consumer countries whether they be developed or developing. This is carried out bilaterally and on a multilateral basis. External energy relations form a significant element of Community energy policy. The aim is to develop trading links and build increased understanding and awareness in a world that is rapidly shrinking and where international co-operation is increasingly necessary.

Energy policy arrived at is not in isolation. The Commission, as the initiator of Community energy policy, consults as widely as possible when formulating proposals. Depending on the proposals concerned, consultations can embrace Member States, industry, local Government, research and academic institutions and third countries. Only after extensive consultation can the Commission produce balanced and rational policy proposals. This is especially true in the case of the Internal Energy Market when interests can very often be opposed to one another.

The logic of the 1992 process is leading the Community towards a truly common energy policy, requiring a framework for the internal Community dynamic as well as for relations with the rest of the world. This will be central to the Commission's thinking as the Community's medium-term energy strategy is revised and extended over the coming 12-18 months. The Commission's «Major Themes in Energy to 2010» will make an important contribution to this work.

In January 1989, the present Commission of the European Communities took up its responsibilities under the Presidency of Mr Jacques Delors. The Commissioner with responsibility for energy in the Commission is Mr Antonio CARDOSO E CUNHA.

Mr Cardoso e Cunha is a graduate from an institute for chemical and industrial engineering (Institute technique supérieur de génie chimique et industriel). From 1965 to 1976 he was the President and Director-General of a large group of private companies operating in Angola. He then became Director of several private sector companies in Portugal before becoming Secretary of State for External Trade in 1978 and Secretary of State for the Manufacturing Industry in 1979. In January 1980 he was appointed Minister for Agriculture and Fisheries.

Following the adhesion of Portugal to the European Community in January 1986, Mr Cardoso e Cunha was appointed as Commissioner with special responsibilities for Fisheries.

In addition to energy, his present responsibilities also include personnel, administration and translation, the Euratom Supply Agency, small businesses, distributive trades and tourism and cooperatives.

Mr Cardoso e Cunha is 55 years old, married with four children.

MAJOR THEMES IN ENERGY TO 2010

- A discussion paper -

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This discussion paper is presented by the Commission of the European Communities as a contribution to ongoing debate about energy's future development. The results and analyses in this paper are preliminary. Comments, suggestions and criticisms are most welcome. These can be addressed to:

Mr K Leydon
Head of Division: Analyses and Forecasting
Directorate-General for Energy
Commission of the European Communities
200 rue de la Loi
B-1049 Brussels
Belgium

Telex : COMEU B 21877
Fax : Brussels 235.01.50

Foreword

The Commission of the European Communities' Directorate-General for Energy has been examining many of the factors that could influence the Community's energy future and trying to see what this future might look like. Of the range of influences at work on both the demand for and supply of energy, a number are identified as «major themes» which may determine the direction of future policy in the early 1990's.

Arriving at a working consensus about the broad direction of policy is important in tackling the challenges posed to the energy sector. The present analysis is presented to facilitate a dialogue between often opposing interests; leading eventually to a better understanding between world partners and, within the Community, to the development of an energy policy commensurate with the challenges of the internal market, developments in world energy, and with cherishing the environment.

This discussion paper is presented as a contribution to the ongoing debate on energy questions. Our results are preliminary. Comments, suggestions and criticisms are most welcome.

Challenges and themes

The past twenty years have been turbulent ones for the energy sector, with major consequences for the economic and social life of the world's citizens. Certainly there is no surprise-free future; some of these surprises may be benign - such as a major breakthrough in energy efficiency. Equally, there is the uncertainty of major disruptions to energy supply - the risk of war, major accidents or serious environmental deterioration.

There is indeed always uncertainty - risk cannot be avoided, but can it be better "managed"? Clearly energy is firmly embedded in a rapidly evolving economic and political setting. Its development will be influenced by outside events but, because of its basic strategic importance, it can itself effect economic and environmental conditions. Perhaps because of the complexity of the relationships, with all the uncertainties, we have more need today for a robust policy framework.

Certainly there is no lack of interesting challenges and questions to address. These include:

- How can growing demand for energy services be reconciled with the need to improve the quality of the environment?
- Can we realise the Community's internal market in the energy sector without putting at risk our security of supply?
- Are the objectives of strong economic growth, a clean environment and moderately priced, secure energy supply compatible?

Addressing these and similar questions requires reflecting on energy and its interaction with:

- economic growth and the impact of the internal market;
- the environment and particularly CO_2 and SO_2 and NO_x emissions;

We also need to study:

- the role for technology in mastering energy consumption; in producing more efficiently our supply and cutting down on emissions;
- the need for continuing attention to energy security and what this means in the 1990s; and
- the Community's needs in a global context, how other regions will develop; our partners in OECD, neighbours in the rest of Europe and in the Mediterranean Basin, and in the developing countries.

Scope of the analysis

Drawing on internal analyses, specially commissioned studies and exchanges of views with experts in Member States and in the energy sector, the major themes of energy and economic growth, environment, technology and security were reviewed in a global setting. The three scenarios presented as a framework for reflection seek:

a) to present the "conventional wisdom" currently reigning in the energy world about the long-term outlook (Scenario 1);

b) to test the robustness of these views (Scenario 2) and, finally;

c) to define the framework required to achieve strong economic growth, a cleaner environment, with secure supply of moderately priced energy (Scenario 3).

The scenarios chosen are not "forecasts" of what will happen; rather they seek to explore the issues involved and to offer a basis for wide-ranging discussion on what could constitute the "Energy Agenda" for the 1990s.

The Community summary presented here is based on detailed Member State supply and demand analysis, sector by sector and fuel by fuel with special studies prepared on world economic outlook, energy resources, world coal and oil prices, the role of technology in both the production and use of energy, the future of the car, and a new innovation - emission balances for CO_2, NO_x and SO_2.

The Directorate-General for Energy acknowledges the active cooperation of the Systems Analysis Unit of the Directorate-General for Research and Development, particularly in the development of emission balances, the development of the MIDAS model and cofinancing part of the supply and demand analysis.

Chapter 1 - The challenge

Addressing the 1989 World Energy Conference in Montreal, **Commissioner Cardoso e Cunha** put the challenge for the European Community when he said:

"Energy is politics in the noblest sense of that word. It effects us all in our daily lives, lighting and heating our homes, powering our factories and providing us with the freedom of transport. But in doing so we consume the world's resources and create pollution. The challenge is to provide energy services efficiently, cleanly and at moderate cost; this we must address not only within the European Community but with our global partners."

Over the past twenty years the failure to manage energy has cost the Community part of its growth potential - perhaps half of its potential between 1974 and 1981, leading to large scale unemployment, severe strains on the balance of payments and on world financial management. The debt problem in developing countries, a serious continuing problem, has much of its origins in the attempt to cushion those economies from the full rigour of the resulting recessions.

Yet there were positive effects as well. These include fundamental changes in the pattern of energy consumption resulting from major restructuring of the industrial sectors and the way both the transport and domestic users sought to reduce the full effect on their economic welfare.

Energy production also changed - greater stimulation of non-OPEC oil production, the penetration of gas, the growth in the contribution of nuclear energy and coal to power generation.

The effect of changes on both the volume and efficiency of energy use and the production mix are still being felt. The energy sector is still in transition but there are few supply sources which are accepted today without controversy - nuclear because of radiation fears, oil because of price shocks, coal, gas and oil because of CO_2 and other emissions. Growing reliance on imports for all fuels deepens these concerns.

Concern on the supply side is mirrored in the uncertainty surrounding the growth in consumption particularly for electricity and transportation fuels. This is reinforced by indications of a slowdown in the improvement in efficiency and conservation.

Currently energy policy is unclear. Indeed, there is little consensus as to the basis for future policy. Consequently, the need arises for a full debate of the factors which could determine the structure of the sector - a debate facilitated by the availability of a clear and objective analysis which looks at how energy will interact with economic development, and the internal market with the environment; how technology will assist in being more efficient in energy production and use; and what risks there could be to energy security.

Energy and growth

There is a close link between economic growth and the availability and price of energy. In the late 19th century and early twentieth century coal was the basic energy source in Europe. Regions with coal were the first to industralize and this, linked particularly to the iron and steel industry, formed the industrial heart-lands of many of the Community's Member States. Those without indigenous resources imported them.

Gradually, after the second world war oil replaced coal, drawing resources from the newly available fields in the Middle East, and Europe became a major market, after the United States, for oil.

While European reconstruction was fuelled by coal, the economic boom of the 1960's looked more and more to oil as the essential fuel - meeting the expanding transport market, a demand which underlays the substantial car industry which developed simultaneously.

One of the key traditional indicators of economic welfare is the demand for electricity. Over the past eighty years this demand has grown steadily and electricity will be the fuel for the electronic age.

The structure of economic activity, its volume and rate of growth has been strongly correlated to the type of energy source available. Coming to the close of the century the fuel mix choice is much wider than it was in the early decades when coal was the essential source of commercial energy. Today coal, gas, oil and electricity compete in many markets, for example, domestic heating and cooking, industrial processes (under boiler markets), and gas, coal and nuclear are available for power generation. Only the transport sector and specific electricity uses are natural preserves of one particular fuel. But they are the leading sectors for energy consumption!

Oil price developments of 1973 and 1979/80 raised serious questions about traditional views on the link between growth and energy. The fear of being cut off from oil sources and the sharp increases in prices to historically high levels shocked the world economy, threatening the financial system, bringing growth to a halt and questioning confidence in the total economic system.

The structure of the industrial process began to alter, as did the energy/growth relationship until one heard, around 1983/4, that the link between energy and growth was broken. Certainly the relationship has changed, but it has not been broken. This is true for industrialized as well as centrally planned and developing countries. Incremental changes in economic welfare require additional energy - the amount required per unit has been reduced and will continue to fall, but nevertheless, additional energy is required - more in developing countries and in centrally planned economies than in OECD countries.

During the late '70's and early '80's policy initiatives began to be effective in restructuring the energy sector and particularly in how oil is used.

But that is history. Looking to the future the Community's growth is closely linked with achieving the single market; a major policy area which requires a strong energy contribution, affecting the demand for energy through higher economic growth, changes in industrial and commercial structures and through evolving individual consumption patterns (influenced by tax harmonisation).

The completion of the internal market will also influence the supply side. Cost structures will be affected through public tendering, increased trade and market integration, reduction of State aids, pricing and tariff transparency, leading to changing market behaviour by the key actors.

The full dynamic of the internal energy market is difficult to quantify, indeed much of the detail has yet to be defined, yet it will have a central role when defining future energy policy.

Energy and environment

Reflecting the growing concern with the environment and particularly CO_2, SO_2 and NO_x emissions and the fact that, without attention, these pollutants would increase, the Commission, following the emphasis put on environment in the Single European Act, has initiated a range of actions which have direct effect on the energy sector - car emissions, SO_2 abatement etc. Work in this policy area is likely to intensify as detailed legislation is adopted in the coming years and will have direct effects on how we use energy and the price we pay for it. Two areas which will be particularly affected are power generation and transport, sectors in which demand is growing above the average. These sectors are key to the normal economic and social life, but pose major challenges in reducing emission levels while popular demand for these energy services continues to grow.

To facilitate the debate surrounding energy and environment this report presents an important innovation by providing matching emission balances accompanying the traditional energy balances[1,2,3]. The global dimension of the climate question and the transfrontier dimension of other pollutants implies a wider analysis beyond the Community.

Energy and technology

Greater energy efficiency and fuel conservation facilitated by improvements in technology and its application to both using and producing energy is perhaps the key to reconciling many of the conflicting forces at work - the desire for the benefits energy offers and the wish to avoid the negative consequences of increasing pollution.

We look to technology as a means of improving considerably the efficient use of electricity and transportation fuels - thus reducing the production levels required to meet the service levels desired. We look also at how technology can contribute to more efficient production techniques, reducing pollution and helping to maintain production cost levels.

During discussions with experts two distinct views emerged. While there was general agreement on the vital importance of improving energy efficiency, opinions differed on whether the full potential for efficiency would be achieved. Some argued that given reigning oil prices, little was expected because of the lack of price incentive. Others considered that the potential for improving energy efficiency was very important and that not only was it "on the shelf" but it would be exploited and that considerable reduction in consumption could be expected through time.

1 Demand Side Analysis to 2010 (Working Paper): Prepared by A Dumort (Bureau d'Etude Technique Economique et Prospectif) in working cooperation with the Analysis and Forecasting Division of DG XVII.

2 Supply Side Analysis and Energy Balances: J-F Guilmot (Energy Systems Analysis and Planning) in working cooperation with the Analysis and Forecasting Division of DG XVII.

3 Emission Balance Sheets to 2010 for CO_2, NO_x and SO_2: prepared by CO<H>ERENCE S.C.

Opinions on the future change radically depending on the view held about improving efficiencies. Because of this, two special reports on future penetration of better technology were commissioned[4,5].

Energy security

Energy security is, and will remain, a pillar of Community energy policy. Import dependency is a feature of the Community's energy supply.

We reached, in the mid-1980's, the lowest level of dependency since the early 1970's. However, this dependency is likely to grow in the future.

Concern with supply of and the price for oil dominated thinking in the 1970's and early 1980's. We have already discussed how the price shocks of 1973 and 1979/80 had major consequences for economic growth - pushing the world economies into deep recessions and putting in train fundamental changes in economic structures.

The resulting changes in the structure and level of energy use - substituting gas, coal and nuclear for oil in the various end use markets (except for transport) and power generation and the reduction in the volume of energy required for each unit of GDP have been important and probably long-lasting. But consumption is increasing and essentially the Community will import the incremental barrel of oil, cubic metre of gas and tonne of coal.

In addition the quality of these imports of oil and coal will be important - the trend towards low sulphur content in gasoil and fuel oil could increase the premium accorded to low sulpher materials in international trade. Thus, looking to the future and assessing the dangers, and indeed the opportunities, requires reflection on the resource base[6], sources of supply, the world supply and demand balance and resulting oil price paths which could develop in the 1990's.

Perception about the security dimension does change. In the 1970's the current wisdom was of imminent depletion of energy resources, with steadily rising prices to levels predicted for the late 80's, three and four times actual prevailing prices.

Today's common wisdom is of sufficient resources. Expected prices for 2000 for oil range from USD 15 to USD 30 a barrel (and here the debate is active between those who support a USD 15 to USD 20 range and supporters of a USD 25 to USD 30 possibility). There is currently no school advocating sustained USD 40 to USD 60 oil. There is a declared willingness to supply by all major sources. Similarly views on coal prices and supply are equally benign. How robust is todays conventional thinking? (Annex I).

The Community in a global setting

The global dimension is the appropriate setting for reviewing resources, pressure on these resources from other OECD users, centrally planned economies and developing countries. External energy relations provide opportunities for better definition of Community interest in the Gulf area, Eastern Europe and the Mediterranean Basin which can complement our traditional links with other OECD partners. To place the Community's energy future in context, views on demand/import requirements of other regions were developed (Annex II).

These traditional interests in global energy trends were reinforced by growing concern with the environment and in particular with world climate. While the scientific community has yet to offer final guidance on what is popularly called the "greenhouse effect" and the possible future climatic changes, the current concern with CO_2 can only be adequately tackled on a global basis.

The Community must be able to follow energy/environment trends - placing its emissions in context, assessing impacts of possible strategies (e.g. the Toronto conference recommendation on CO_2 reduction by 2005), and finally developing joint action pro-grammes. To facilitate such work, CO_2 emission balances are estimated on a global basis in addition to a view on the energy supply and demand trends.

Scenario approach

To explore further possible energy futures for the Community three scenarios have been developed. The first reflects "conventional wisdom", a view based on "business as usual", certainly not without dynamic elements but which does not foresee fundamental changes in the way people think about energy.

The second scenario, "driving into tensions", tests the robustness of the first by searching for the limitations to its coherence - and finds it wanting. If economic growth were to be faster and if the relative decline of traditional heavy industry was slower and later than

4 Les Equipements de Maîtrise de l'Energie en Europe: Explicit S.A.

5 Developments in Supply Side Technology: Bureau d'Informations et de Prévisions Economiques.

6 Energy Resource: M. Grenon

expected, pressure on prices and emission levels could be such as to place in doubt the rate of economic growth (about 3.5% as against 2.7% for the Community in the first scenario).

The third scenario, "sustaining high economic growth", is deliberately normative. It seeks to explore and define the conditions in which higher economic growth, a clean environment and secure and moderately priced energy would be compatible objectives. Each is a desirable objective - but are they mutually attainable and what must be done to balance what some regard as opposing objectives?

Each of the major themes described in this chapter are analysed within each of the three scenarios.

Annex III contains the summary energy balance sheets for the three scenarios and Annex IV the corresponding emission balances for CO_2. Balances for N0x and SO_2 for Scenario 1 are also included.

Chapter 2 -A conventional view of the future - Scenario 1

A steadily changing world

A Community population increasing only slowly but with more money to spend, more time to spend it and growing increasingly concerned about the environment in which it lives.

How much energy will be required will be determined by the size, make-up and lifestyle of the population and, of course, the rate of economic growth. In the final accounting, it will also depend on how efficiently we recover it and/or convert it from one form to another and how efficiently we use it.

Technology will continue to improve and the effects on end-use and on production could be important - resulting in substantial efficiencies (35% decrease in energy intensity). The distinguishing feature is the lack of special concern with energy policy, with market forces driving the system within existing policy frameworks. The setting for the scenario defining conventional wisdom is described in Box A.

Economic Growth

Scenario 1 is based on a steady, if unspectacular, economic growth (2.7% p.a. over the period) with the gradual development of existing policies and ways of thinking about issues.

The corresponding world GDP is 3.2%, with developing countries growing at 4%, the centrally planned economies at 2.7% and OECD with an average growth of 2.8%.

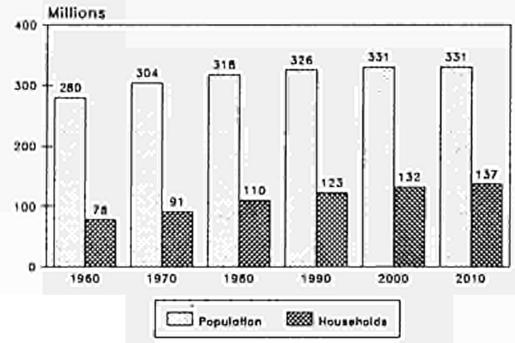
Population

Over the next twenty years we do not see any major change in the size of the population of the European Community, with perhaps another 5 million people before the end of the century and then virtually no increase over the next ten years. However, because of a falling birthrate - and increasing life expectancy - the average age of the population will steadily increase. In the Community, by the end of the period, nearly half of the population will be 45 years old or older. The average person will have more money to spend and, probably, more time in which to spend it.

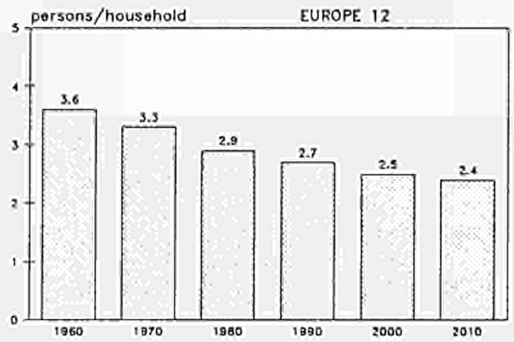
The number of households will increase appreciably and more people will own cars. Both the houses and the cars could well be bigger, on average, than today.

Figure 1
Demographic Influences

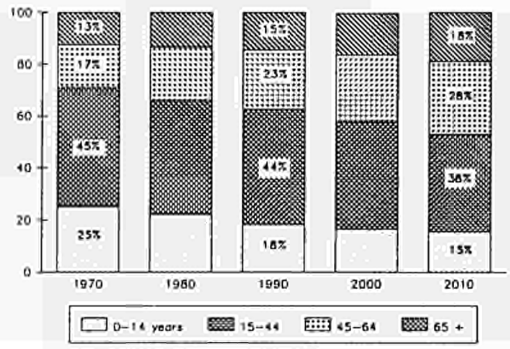
Population and households



Declining size of households



Ageing population



BOX A

Scenario 1 assumptions

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.

Scenario 1 definition: *"Conventional wisdom"*

1. International setting

- **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.

As a result we could require more energy per person - final demand today is about 2.2 tonnes of oil equivalent per person which could rise to 2.6 toe in 2010 - even if more energy-efficient appliances were to be available.

Oil Price

It is "generally accepted" that the price of oil will, over time, follow an upward trend - partly to pay for the fuel and partly to encourage further exploration. Of course, variations in the oil price over the last 40 years, for example, do not clearly support this. We opted in this scenario for a smoothly increasing oil price - leading to a 20$/barrel in 2000 and a 30$/barrel in 2010 (in 1987 prices). Many other scenarios are, of course, possible (see Annex I).

Exchange rate fluctuations could, of course, have a bigger effect on what we will pay for our oil than the price of oil itself.

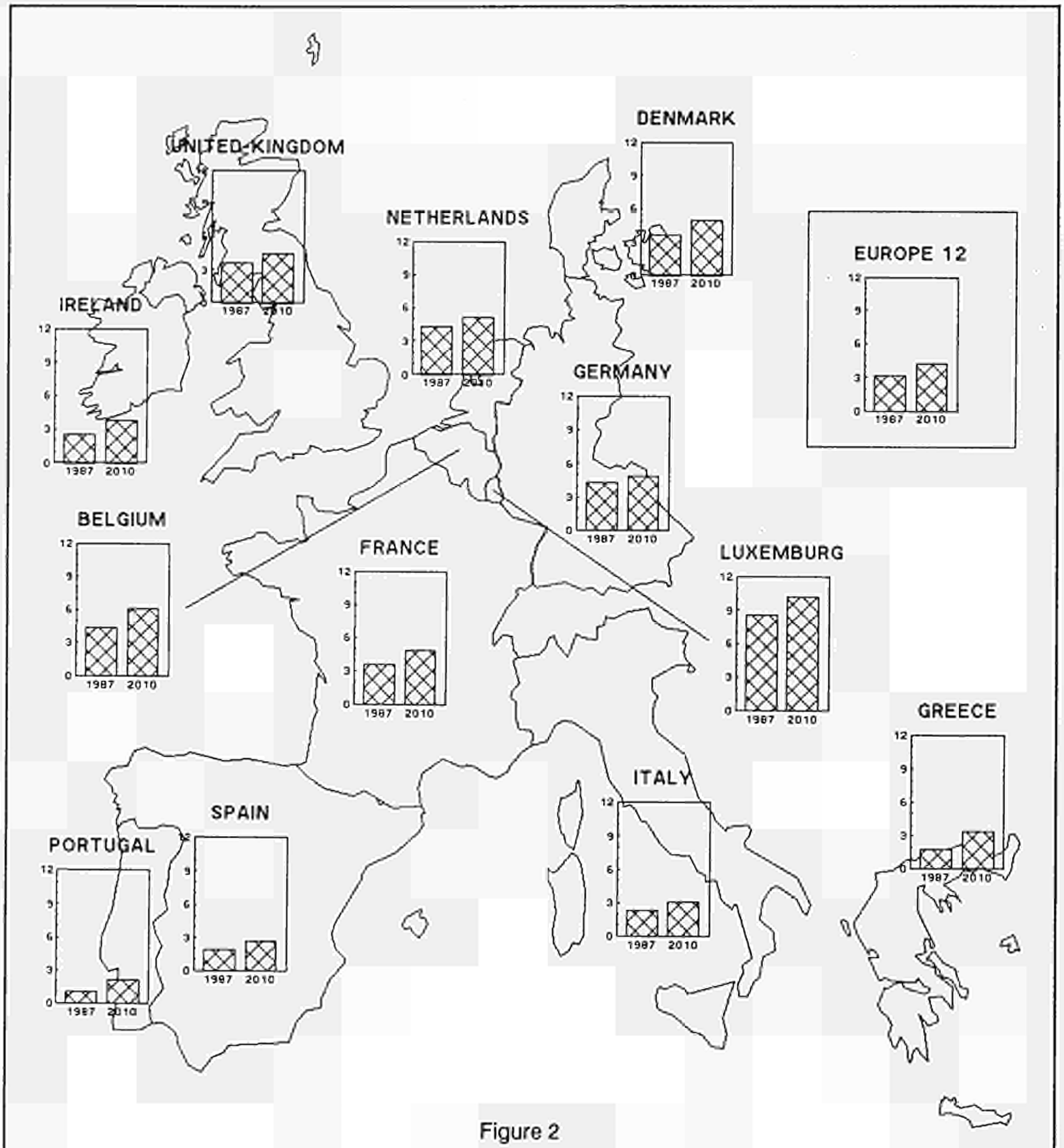


Figure 2

Primary energy consumption (Toe) per capita

Regional variations

A Community of twelve Member States, each with its own culture and traditions, growing at different speeds, with different uses and requirements for energy, and different ways of producing it.

While we often talk of the European Community as a single unit, it is important to remember that it is made up of twelve Member States which have widely different characteristics and which have been developing at different rates - and in different directions - over hundreds of years. Membership of the Community, which for some countries is as short as three years, has not - fortunately - resulted in a monotonous homogeneity. In some ways, in fact, the Community is less homogeneous now than in the 1960s. At that time the energy structures were all oil-based. This is no longer the case.

We expect quite large variations in economic growth both between the earlier and later part of the period and from one country to another. In general the less developed countries of the Community would have the fastest growth, but because the existing differences in the standards of living are quite substantial they will require particular attention under the cohesion policies of the single market. Infrastructure investment will be an important requirement.

The energy outlook

Growing final energy demand - *Steady growth in all sectors with transport continuing to be the determining factor in how much oil we use. Electricity increasing its share of the market and gas substituting for oil and solid fuels - but at a slower rate. Outside of power generation, solid fuel use declining.*

Steady growth is expected in final energy demand in all sectors; growing on average by under 1% per annum (0.8%). But this long-run growth rate is the result of two distinct trends: the rate of growth being much faster to the mid-1990s (at 1½% per annum) declining in the later period to ½% p.a.. This decline is due to changes in economic structures, technical efficiencies and saturation in some markets (e.g. car ownership, household appliances). Transport will continue to be the determining factor in how much oil we use. By individual fuel, electricity will increase its share of the market, as substitution for oil and solid fuels continues - but at a slower rate than in the past. Outside of power generation, solid fuel use will decline.

The consumption of energy in its final form in the Community is expected to rise from its present annual level of close to 700 mtoe to around 810 mtoe by the turn of the century, and close to 850 mtoe by 2010. With GDP growing faster than final energy consumption during this period (2.7%/year), the ratio between the two, the "energy intensity", will gradually decline from 0.2 to 0.13 tonnes of oil per 1000 ECU (1980), a decrease of 35%.

By sector, transport and industry grow at about 1% over the twenty year period but transport grows much faster to 1995 - about 2.2% p.a. with industry and the domestic sector growing at 1.3% p.a.. As one goes towards the end of the century the rate of increase for all sectors drops significantly.

Looking at consumption by fuel type indicates some important changes. Solid fuels will lose ground in both of its major sectors - industry and residential/tertiary. Oil use will increase in all sectors except the residential/tertiary sector where it will show a steady decline. Both gas and electricity could grow strongly in both these sectors with electricity growing the faster of the two.

Table 1 : **Incremental final energy**

Europe 12: Scenario 1
(Mtoe)

	Industry	Transport	Domestic +tertiary	Final demand
Solids	- 1		- 8	- 9
Oil	- 1	+52	-26	+25
Gas	+20		+32	+52
Electr.	+27	+ 3	+42	+72
Heat	+ 4		+ 2	+ 6
Renewable			+ 3	+ 3
Total	+49	+55	+45	+149

The increase in electricity demand (72 mtoe) and transportation fuels (52 mtoe) accounts for over 80% of the additional 150 mtoe consumed annually between now and 2010.

In other words, electricity is replacing mainly solid fuels in the industrial sector and electricity and gas are replacing solid fuels and oil in the residential and tertiary sector. Oil will continue to dominate transport (98%).

There are significant variations between Member States. In very general terms, these differences are the result of, on the one hand, a swing away from energy intensive industries (such as steel production) in the more industrially developed Member States while, on the other hand, those countries which presently have a relatively small - but growing - number of cars per capita will have a rapidly increasing consumption of fuel.

Since before the first oil crisis the Commission has argued strongly for substitution of oil wherever possible. A great deal has already been achieved and progress is still being made. In the field of electricity production, in particular, giant strides have been made. However, the transport sector is proving very resistant to change and continues to be the main influence accounting for close to 50% of our total primary oil consumption.

The transport sector

The sector which consumes most of our oil. A major source of atmospheric pollution which resists substitution. An area in which technology is trying to overcome one of the less desirable effects of increasing affluence, but where improvements in engine efficiency will be more than offset by increases in the number and size of vehicles and greater distances travelled.

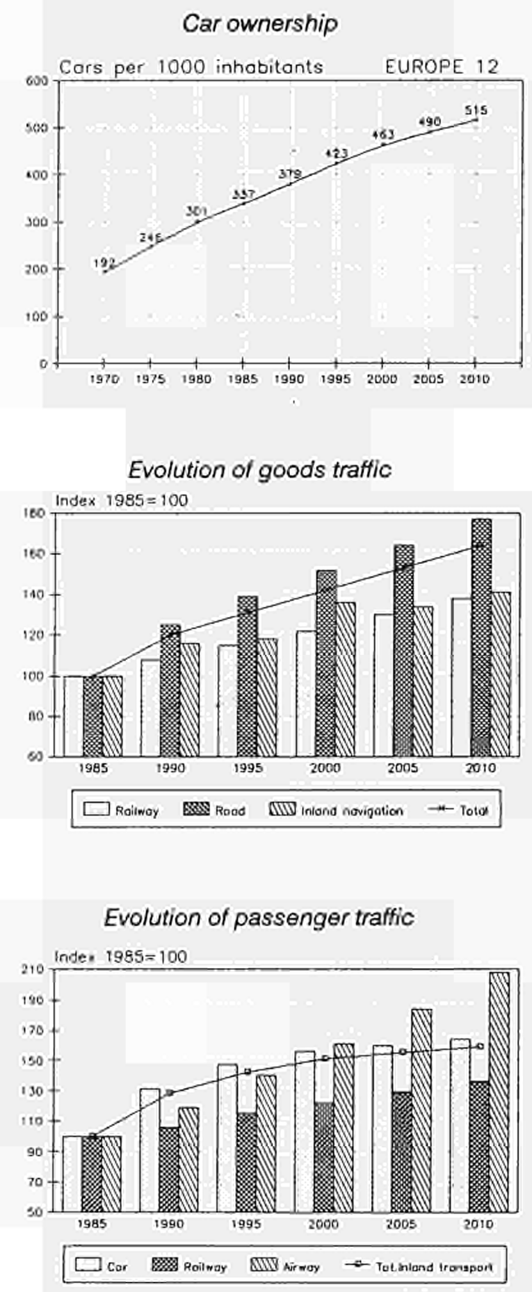
One of the effects of the greater disposable income in the Community is that more cars will appear on our roads. Because of increased efficiency of new cars, we expect that total fuel consumption will grow more slowly than the size of the car fleet. However, by 2010 close to 130 mtoe of fuel - over 55% of the fuel consumed in the transport sector, one-third of our oil - will be burned in motor cars every year.

Table 2 : **Traffic, energy consumption & emission trends**

Europe 12: Scenario 1
(Index 1985 = 100)

	1985	1995	2000	2010
Traffic of passengers				
Inland transport	100	142	151	159
1. Car	100	147	156	164
2. Railway	100	115	122	136
3. Airway	100	140	161	208
Traffic of goods				
1. Road	100	139	152	177
2. Railway	100	115	122	138
3. Inland navigation	100	118	126	141
Total (1+2+3)	100	131	142	164
Energy consumption (transport)	100	131	135	140
Emissions (transport)				
CO_2	100	129	133	137
SO_2	100	127	134	143
NO_x	100	111	98	100

Figure 3
Transport indicators



In the road freight sector, higher load factors and technical progress to reduce unit consumption by between 25% and 30% 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 the jet fuel savings per passenger. Replacement of existing fleet by higher capacity, more economic aircraft, combined with higher occupancy rates, could almost halve unit consumption by aircraft over the 25 year period.

We will still be burning enormous quantities of oil for transport - over 20% more than now - with all that this implies for our atmosphere. Breaking the link between transport requirements and oil consumption is perhaps the greatest energy challenge facing us today.

Electricity generation

A sector growing in importance, competition - and controversy. A fuel viewed as environmentally benign when it is being used - but not when it is being produced. An area in which there are several options for the decision-makers but one in which there is a marked reluctance to make the major decisions which need to be taken.

During the last 15 years the demand for electricity has grown faster than that for all other fuels. It has often grown in close proportion to - though faster than - the rate of economic growth (GDP).

Because of the importance of this sector a special study[7] was undertaken to understand better the range of options which could result from the uncertainties on the future structure and level of demand, and the often difficult fuel choice decisions which would determine the investments to be made. This provided a detailed background when undertaking the 2010 analysis.

Following the logic of this conventional wisdom scenario, the annual demand for electricity could grow by an average 2% over the period to 2010 but again growth to the mid-1990's is likely to be higher than the average long-run rate (3% p.a.). Increased electricity would represent about half of the incremental final demand between 1987 and 2010. Industry accounts for 36% of this additional demand with the tertiary/domestic sector absorbing 58%.

Electricity production would need to increase by 1000 Twh from 1650 Twh in 1987 to meet this demand. While coal and nuclear will continue to be the major source of inputs of this production (85% in 2010) oil burn could increase from 36 mtoe in 1987 to 56 mtoe in 1995, falling back to 21 mtoe in 2010. This reflects the reluctance of utilities to invest in new capacity, preferring to have recourse to existing capacities to meet increasing demand. Gas burn under this scenario could rise gradually from 29 mtoe to 47 mtoe over the period 1987 to 2010 - an increase lower than its potential.

The installed capacity in GWs could be:

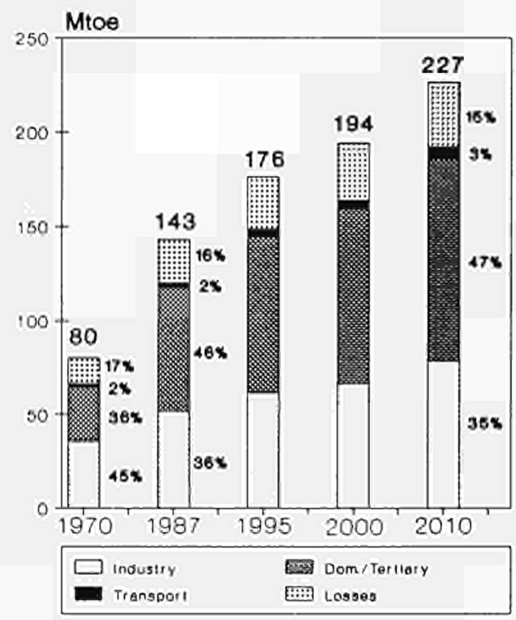
Table 3 : **Installed capacity**

Europe 12: Scenario 1

	1985	1995	2000	2010
Nuclear	90	112	119	150
Other	321	329	348	387
Total	411	441	467	537

There would be a steady reduction in SO_2 emissions throughout the period as new plants equipped with flue gas desulphurisation are brought on line and existing plants are retrofitted. Unfortunately, we cannot say the same for NO_x or CO_2.

Figure 4



Electricity demand
Europe12: Scenario 1

7 The Medium- and Long-Term Outlook for the European Electricity Sector: ESAP

Figure 5
Primary energy demand
Europe12: Scenario 1

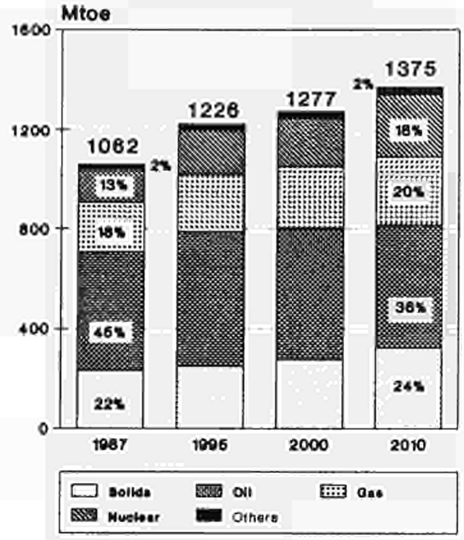


Figure 6
Total oil demand
Europe12: Scenario 1

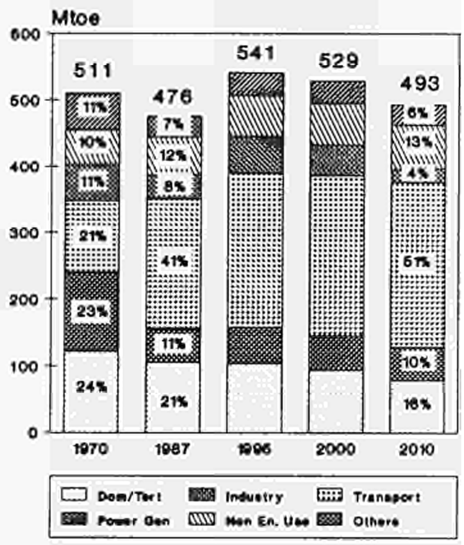


Figure 7
Natural gas demand
Europe12: Scenario 1

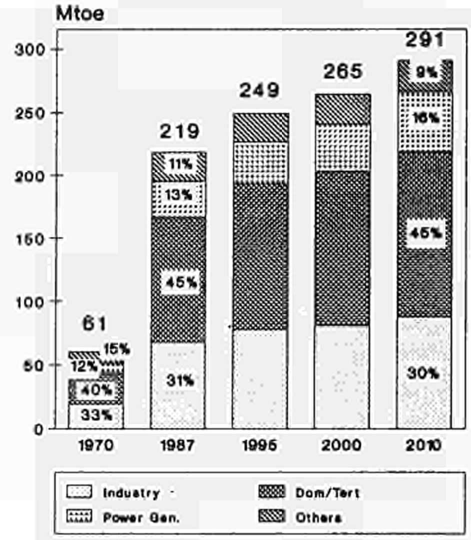
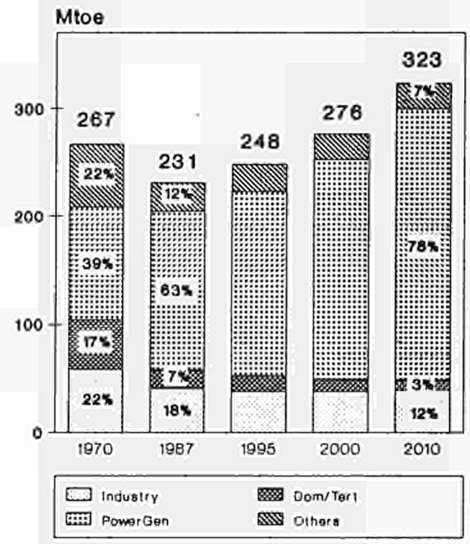


Figure 8
Solid fuels demand
Europe12: Scenario 1



Total primary energy demand

Increases for all fuels but oil's share decreasing slightly.

Total primary energy demand is expected to rise in terms of mtoe from 1060 in 1987 to 1370 in 2010, suggesting a long-run rate of 1.1% p.a.. The demand for all fuels will increase in absolute quantities, but, in percentage share, that of oil is expected to decrease while nuclear will increase.

The main growth area for oil will be transportation (increasing from 39% of oil's share of primary energy demand to 50% by 2010) while the growth area for solid fuels is expected to be power generation, with three-quarters of the solid fuel being burnt in power stations in 2010. While gas demand will increase from 185 mtoe in 1985 to 250 mtoe in 2010, the structure of the demand is not predicted to change - unless more of it is burned in power stations.

The Community's indigenous energy supplies

In the long-run, indigenous Community energy supply should remain constant, but the structure of this supply could alter with a decline of 2% and 1.7% per annum in coal and oil. These reductions would be compensated by an annual increase in nuclear's contribution by 2.5% and the development of new and renewable sources (5% p.a.). However, in volume terms, nuclear could add 100 mtoe while the net contribution of renewables would account for 4 mtoe. Statistically, however, the contribution of renewable energy is very substantially under-estimated, because much of it is not put on the commercial market and thus not recorded.

Oil production, while it is very difficult to estimate because it depends not only on physical factors but also on price levels, could reduce gradually from 150 mtoe in 1987 to 125 (1995) to 110 mtoe in 2010. Recent announcements about the UK North Sea suggest that these estimates are likely to prove conservative and that the situation in the mid-90s might not be too different from that of today.

However, the situation for solids production is more difficult. Lignite is likely to remain steady at today's levels but coal and peat will more than likely decline steadily over the period. Overall solids seem likely to decline by 60 mtoe to 110 mtoe in 2010.

The outlook for gas contrasts somewhat with that for oil and coal. Indigenous production will rise steadily to about 135 mtoe for 1995/ 2000 period and on present thinking decline to 120 mtoe in 2010 - 10 mtoe lower than today. However this apparent decline may not occur and one could see a continuation of current levels into the new century.

Major themes

Four major themes emerge from this conventional look at energy futures for the Community. The **internal market** *represents a major initiative to put the Community on a steady growth path. But in achieving this increase in economic welfare we have to safeguard and improve the quality of the* **environment**. *Developments in* **technology** *can help meet these two objectives. But we need also to look to the* **secure supply** *at moderate prices and this will be influenced by developments in global energy. These issues are now addressed.*

The internal market

The completion of the internal market will bring with it many economic benefits including an increase in the Community's GDP growth. We have made allowances for this in our calculations.

In 1988, the Commission drew up an inventory of existing or potential obstacles to a unified European energy market. In order to achieve the internal energy market, it proposed a number of priority actions. These included: the removal of technical and fiscal barriers to trade; the application of Community law in energy markets; the application of the provisions in the Single European Act concerning environmental protection; and the development of further initiatives in the areas of energy prices and energy infrastructures. The implications for future energy growth are not clear and considerable work remains to be done.

There has been much discussion on improved interconnections and increased trade in both the electricity and gas industries. This would make energy produced in, or traded into one country more easily available in another.

The potential for further integration of the electricity and gas sectors are one of the policy areas the Commission is currently focusing on. As mentioned earlier, the internal market can substantially effect the structure of the supply companies but the extent of this impact can be measured only after the details of the proposed actions have been defined and adopted by the Council. This is an ongoing process which will require time, and the impact of which will be felt over the longer term. This process can be illustrated by looking closely at the issues raised in moving towards greater integration of the Community's electricity sector.

- **Electricity integration**

Would the development of closer integration of the electricity sector impact on current long-term expectations? Would the impact be important, and would there be economic gains for the Community?

A special report was commissioned[8] to study the issue of electricity integration in some depth. On the basis of this scenario and applying 2% growth rate to the network comprising the Netherlands, the Federal Republic of Germany, France, Belgium, Spain, Portugal, Italy and the United Kingdom, estimates

8 Modelling Analysis of the Electricity Sector in the Context of the Internal Market: Centre for Operations Research and Econometrics - UCL.

Box B

Impact of tax harmonization

With the aim of evaluating the potential impact of alignment of the VAT rates and excise duties in the European Community on the consumer prices of energy and final energy demand, two methods of harmonization were considered and compared with the case of non-harmonization to the year 2000.

Case 1 : No harmonization, the national taxation systems continue as in the past.
Case 2 : Strict harmonization of VAT rates and excise duties.
Case 3 : Harmonization of VAT rates and excise duties, with a single VAT rate for all fuels (normal rate, 15% minimum), alignment of excise duties on motor fuels at highest level, alignment of the excise duties on heating gasoil in an average bracket, 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 the period 1988-2000, for four countries (Germany, France, the United Kingdom and Italy).

In **Case 2**, the direction of the impact on prices varies according to the country. The price variations of the petroleum products are often strong : 35% increase for petrol prices in Germany, 43% decrease for the price of heating gasoil in Italy.
The effects on energy demands also contrast from one country to another, in direction as well as range. The most significant effects are observed in Germany and in Italy, especially on the demand for oil products (Germany -5%, Italy +7%). These effects being in different directions means that the impact on the energy demand for the four countries as a whole remains moderate.

With the exception of Italy, **Case 3** generally shows rising prices for gasoline, diesel oil, and heating gasoil. The rise is often great (reaching a 75% of price increase for gasoline in Germany). The price of heavy fuel oil decreases everywhere. The price of other energy products changes little, except in the U.K. (important increase in VAT rates), and in Italy where the electricity prices decrease distinctly (as in Case 2).
The demand for petroleum products decreases from 3% (France) to 7% (Germany), involving a moderate fall in the total energy demand.
It should be noted that the reaction of the demand for oil products is relatively weak in regard to the sometimes huge price variations.
On average, for the four countries, energy demand decreases, mainly because of the reduced demand for oil products.

Impact of V.A.T. rates and excise duties harmonisation among member states of the E.C. on final energy demand (% of difference from **Case 1** *)*

		Case 2	Case 3
Germany	*Solids*	1.3 %	0.2 %
	Oil products	-5.1 %	-7.4 %
	Gas	1.7 %	0.5 %
	Electricity	0.5 %	0.4 %
	Total	-1.9 %	-3.4 %
France	*Solids*	0.0 %	-1.6 %
	Oil products	2.6 %	-2.5 %
	Gas	0.8 %	0.4 %
	Electricity	0.0 %	0.0 %
	Total	1.4 %	-1.2 %
U.K.	*Solids*	0.0 %	-2.2 %
	Oil products	-0.7 %	-3.8 %
	Gas	0.8 %	-1.0 %
	Electricity	0.6 %	0.5 %
	Total	0.1 %	-2.0 %
Italy	*Solids*	-0.7 %	-1.6 %
	Oil products	6.7 %	2.7 %
	Gas	3.1 %	1.6 %
	Electricity	0.5 %	0.2 %
	Total	4.4 %	1.9 %
Average	Solids	0.4 %	-1.1 %
	Oil products	0.1 %	-3.4 %
	Gas	1.5 %	0.2 %
	Electricity	0.4 %	0.3 %
	Total	0.6 %	-1.5 %

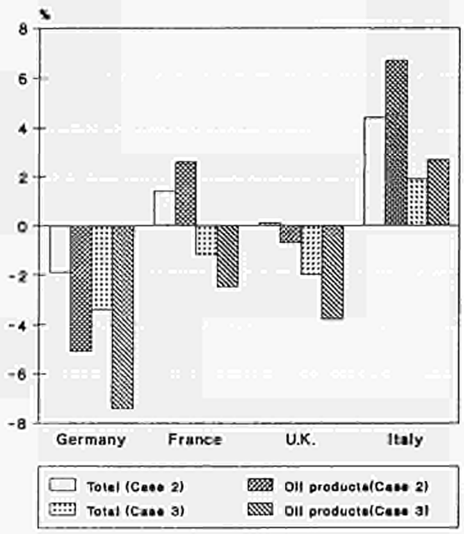


Figure 9 : Tax Harmonisation Impact on final energy demand

were prepared showing potential gains from closer integration of the networks through time. The summary results are shown in table 4 below.

Table 4 : Estimated annual benefits from greater integration

	Short term around 1992	Medium term around 2000	Long term around 2010
In billion ecu	1.3	2.3 to 5.3	6 to 13
% of total operating costs	6%	7% to 16%	12%

These net monetary benefits include savings from both fuel and investment costs, yielding an accumulated 70 b ecu over the period (taking the mid-point in 2000 and 2010).

In terms of investment saving, the benefits under the present practices are estimated at 13 GW to 2000. With greater integration there is an additional benefit of 12 to 15 GW.

Taking into account the continuation of current practices and reinforcing these by greater integration, the Community's electricity park can meet growing electricity demand to 2000 (averaging over 2%) with an increase in physical capacity of under 1% p.a.

In addition to the economic benefit above there is also an "external" benefit of the reduced emissions because of lower consumption of fossil fuels. In the mid-term these could be averaged out at about a five percent reduction in CO_2, SO_2 and NO_x.

Translating these "producer benefits" into reductions in consumer prices is a further step in the integration process. The direction of Commission thinking, other than on price transparency, will emerge over the next year or so. The Commission proposes a detailed study of the way to extend third-party access with Member States and sectoral interests.

Similarly, the issues raised by greater integration of gas networks were also examined[9]. The results suggested that the way forward will be linked with market structures and with network optimization and, as with electricity, the direction of Commission thinking on these structures will only emerge later and can then be better analysed.

- **Harmonisation of taxes**

Harmonisation of taxes, both excise levels and VAT rates, is an important Community initiative which will have direct impact on the energy sector. In 1987 the Commission proposed a directive on the harmonisation of petroleum product excise duties and VAT rates. Discussions on those proposals are in progress and at the time of writing (July 1989) the Commission has indicated possible revisions to its original proposals but details have not yet been decided.

But to illustrate the importance of tax harmonisation the original proposals were analysed for a number of countries and the impacts assessed (see Box B). We have also thought of other possible approaches to taxation and these are also analysed[10].

- **Petroleum products**

Looking at some preliminary conclusions on the effects of the completion of the internal market for petroleum products and the implications for refineries, the effects come from cost reduction and demand generation.

In the market for petroleum products[11], the overall effects on refining at Community level are likely to be small. The competitive nature of this market and the rationalisation carried out in the last decade suggests that there is little scope for "system-wide" gains - the most efficient plants are already being utilised. However the removal of frontier controls will provide scope for significant improvement in the efficiency of distribution systems. Further gains can be expected by 1992 when the oil regimes of Spain, Portugal and Greece will be fully liberalised.

The overall effects on demand will come both from the general increase in economic activity brought about by the completion of the internal market and from the much less important reduction in prices due to efficiency gains.

The effects on relative product prices are likely to be stronger than the effects on the general product price level. Demand is constantly increasing in favour of the lighter distillates, and this will be intensified by the extra demand and increasingly stringent product specifications. At the same time, conversion and

9 Modelling Analysis of the Gas Sector in the Context of the Internal Market: Center of Operations Research and Econometrics - UCL.

10 Study of the Impact of Tax Harmonisation on Energy Consumption: Internal Analysis with the cooperation of Y. Guillaume and V. Detemmerman of DULBEA, and M. Lecloux of DG XVII.

11 Analysis of the Petroleum Products Market in the Context of the Internal Market: R. Bacon, Oxford University.

upgrading refining capacity for these high quality products may well become tighter. Availability of these products in international markets is likely to be limited.

Concern about possible tightness in the supply of motor gasoline arises also from the fact that:

(a) the general move to unleaded gasoline as a result of legislation can only be achieved at satisfactory octane levels with some reduction in the yield of gasoline;

(b) the introduction of progressively higher octane unleaded gasolines by the major companies, as part of their strategy to increase market share, further reduces the yield of gasoline available with existing technologies.

To some extent the switch to diesel, if it continues, will offset these effects, but there are also limits on the domestic production of diesel and these may be intensified if product specification legislation adopts the more stringent standards applicable in some countries.

This shift in demand mix is taking place at a time when demand for transportation fuels is likely to grow steadily (2% to 1995). The effect will be that, in the Community as a whole, there will be a need for more conversion and upgrading capacity. If public authorities delay defining future environmental standards, there could be a risk of shortage of adequate capacity when it is needed.

If and when excise taxes and VAT are harmonized in the Community, price levels in the southern Member States could be lower leading to an increase in consumption. This would have some effect on refining and distribution patterns.

The increased relative demand for lighter distillates, coupled with the small overall effect on the price of oil means that, while there is excess capacity in refining, the price of heavy fuel oil will face downward pressure. Only if national policies change back to encouraging the use of heavy high sulphur fuel oil in power generation will a ready market be found. This has implications for coal in that it will become even harder for coal to compete in this end-use.

▪ **Other dimensions of the internal market**

In addition to gas and electricity trade, tax harmonisation and oil product trends, other aspects of both the general actions to achieve the single market (including public tendering, freeing of capital movements, removal of technical barriers), more rigorous application of some provisions of the Treaties (e.g. coal aids, oil monopolies) and specific actions under the internal energy market (price transparency, tariff structures) will impact on the energy sector through the time horizon of this analysis.

Part of the impact will influence costs and consumer prices - leading in some cases to convergence of costs (public tendering, abolishing state monopolies) and prices (transparency and possible tariff structure proposals). Other actions will impact on actor behaviour (more competitive mentality) - subjective factors outside the scope of quantitative analysis.

What is clear is that the internal energy market as it is gradually defined, will change the parameters of future energy policy structures.

Energy and the environment

A subject which could dominate energy policy and planning in the years to come. This is an area in which technology can only achieve so much without a major change in our life-style and the ways in which we use our energy. Emissions of most pollutants will increase. The "greenhouse effect" will be a source of increasing concern. There is no "quick fix".

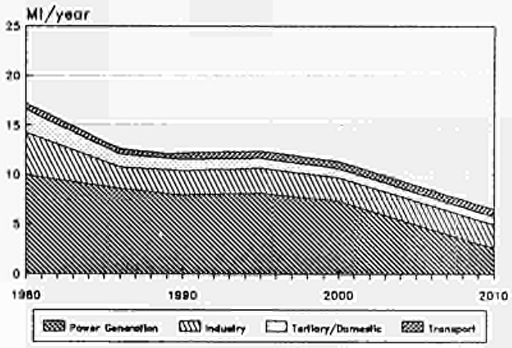
There is a strong link between energy and the environment. The production and use of energy does generate a great deal of atmospheric pollution. In its Conclusion on the internal energy market in November 1988, the Council of Energy Ministers of the Community made it clear that "the achievement of a satisfactory balance between energy and the environment - in accordance with the Single Act - must constitute a major goal of the Community's work".

To facilitate a better understanding of the links between energy production and consumption, emission balances have been prepared for each of the corresponding energy scenarios in the analysis. This way one may see the environmental consequence of a particular level or structure of consumption. The emission balances used are based on existing legislation.

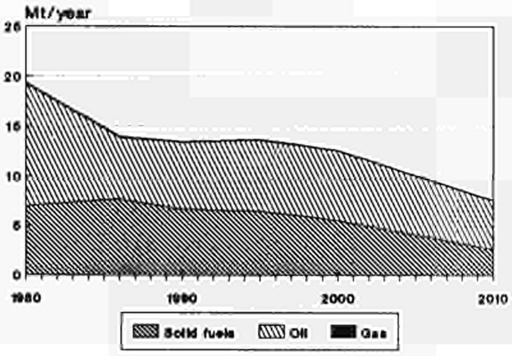
For sulphur dioxide (SO_2) a reduction of 55% is expected between 1987 and 2010. Emissions from power generation will decline by 6 million tonnes. But emissions from final sectors will remain constant - around 4 million tonnes because, while those in the domestic and tertiary sector will decline, and industry remain broadly constant, transportation emissions will increase.

Figure 10
SO_2 Emissions for Europe12

By sector



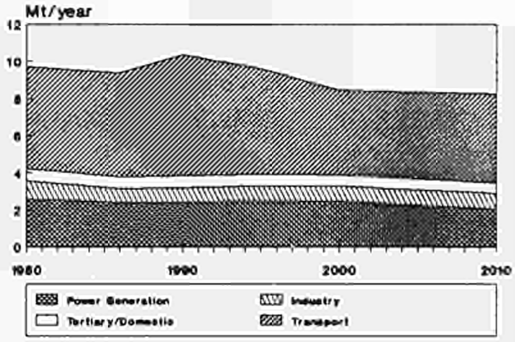
By fuel



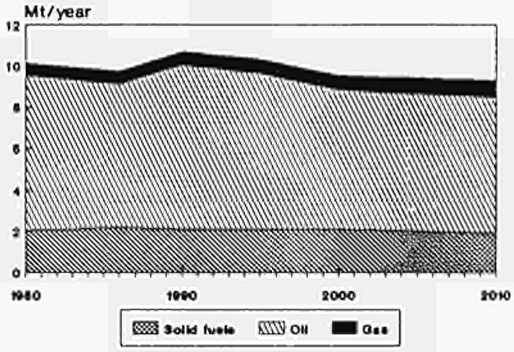
Nitrogen oxides (NO_x) could decline by one million tonnes to 8.6 million tonnes by 2010: about 12%. During the period there will be substantial decrease in the unit output, particularly for power generation and transport but this is compensated by increased activity. Overall transport emissions will decline by 15% or so.

Figure 11
NO_x Emissions for Europe12

By sector



By fuel

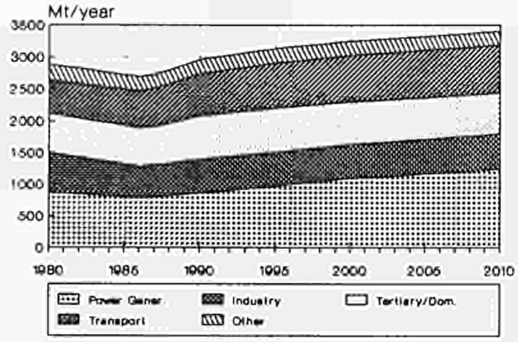


Emissions of carbon dioxide (CO_2) could increase in 2010 by 24% from 2.7 to 3.4 billion tonnes with power generation (36%) and transportation (22%) representing about 60% of CO_2 emissions. The industry and domestic/tertiary sectors contribute 16% and 19% respectively to total emissions.

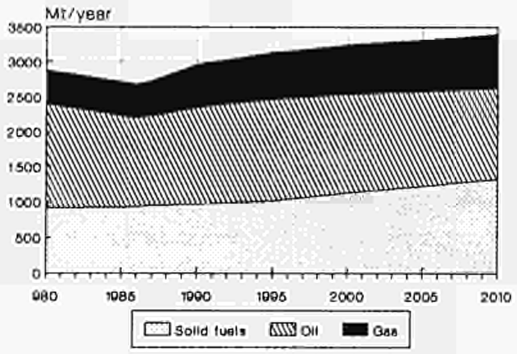
The "greenhouse effect" is coming to the fore as one of the major global issues. Concentrations of the "greenhouse gases" - CO_2, methane CH_4, nitrous oxide N_2O, ozone O_3 and chloro-fluro-carbons CFCs - are increasing due to human activities. This is modifying the composition of the atmosphere at an unprecedented rate. The thermal balance of the earth is being modified so global warming and associated climatic changes could follow. There is considerable uncertainty as to exactly what changes could take place - but they are likely to be important.

Figure 12 :
CO_2 Emissions for Europe12

By sector



By fuel



It has been calculated that 55% of the greenhouse effect is caused by CO_2, 15% by methane and a further 5% by N_2O and O_3. Between 70% and 90% of the CO_2 comes from the burning of fossil fuels. Of this total the power generation sector accounts today for about 30% of the Community's emissions of CO_2. The Community now accounts for around 15% of the world's CO_2 emissions. In terms of CO_2 emissions per capita, the US and the German Democratic Republic lead the world with 4.9 tonnes of carbon each year. In the Community we have five countries producing between 2 and 3 t/year with the others below this. The world average is 1t/year.

We have studied the emissions from electricity generating stations. However transport, for example, accounts for around a quarter of our CO_2 emissions - not to mention other gases and particulates. We must not just focus on power generation.

Technological improvements and energy saving

In making our estimates of future energy demand we have taken into account in every sector the possibilities of technological advances which usually lead to more efficient use.

The degree to which such efficient equipment enters the market will influence substantially the rate of growth in consumption. As mentioned earlier, the argument is not about what "could" happen as to what "is likely" to happen. The rate of penetration of efficient technology both in end use and in production is one of the key policy variables.

For example, we expect a 20-30% increase in efficiency of car engines. The average consumption per 100 km in 1985 was 9.5 litres. We expect this to improve to 7.5 litres by 2000 and to 6.8 litres by 2010. These numbers are conservative as "current best technology" (prototype) could achieve 5 litres per 100 km and the technology exists which could achieve 3 litres/100 km. However, we have to take into account the probability that people will upgrade their cars - i.e. change to cars with larger engine capacity - and that the introduction of some anti-pollution devices could limit energy saving. In addition the increasing vehicle density will mean more congestion on our roads - more traffic jams - with higher consumption caused by more time spent in lower gears.

Heavy industry is another important area for concern. Table 5 below presents the view adopted in this scenario - a 16% improvement in specific consumption in steel production with a corresponding decrease of 22% in cement production over the period 1985 to 2010. But many argue that many of the potential savings are already achieved and that further improvements are less likely, particularly with present fuel prices.

Table 5 :
Specific energy consumption
Europe 12: Scenario 1

Heavy Industry	1985	1995	2000	2010
Steel Production				
toe/tonne	0.4	0.35	0.34	0.31
Cement				
toe/tonne	0.09	0.08	0.08	0.07

Similar arguments could be put forward about domestic appliances. In the case of refrigerators, we expect that people will offset the advantage of lower energy consumption per litre of space by buying bigger fridges.

In summary, technological developments will continue and these will enter the market and impact on demand. However, because the improvements are usually incremental, their economic benefits not apparent, and they may themselves encourage increased use of the equipment in which they are incorporated, they will only slowly bring about a saving in energy demand. There is no major technological development on the horizon which could result in very large energy savings - at relatively low cost. Nor - with the present energy market - is there a great incentive to make the investments required to look for one.

Given the importance of this question of efficiency, two special studies were commissioned to examine what the potential for both end use and production efficiencies and the rate at which these might penetrate into the market. This scenario does foresee, particularly after 1995, a strong growth in energy efficiency - twice the current rate of increase.

Energy security

If the resources exist and can be produced in sufficient quantities to meet demand, what needs to be said about supply of energy resources to the Community? The answer depends on the individual fuel, but we will need to consider if supplies will actually be available to us and at what price.

This raises the issue of security of supply, which, especially since 1973, has been a central theme of any developed or developing country's energy policy. The Community is a net importer of energy. Only one of our Member States, the U.K., is a net exporter. There is no possibility in the foreseeable future that the Community will be energy independent.

Throughout the 1970s and early 1980s we reduced our dependence on imported energy by reducing our dependence on imported oil so that by 1985 our net oil imports were below 32% of our total energy consumption and our total energy imports only a little over 43%. Even then, we were importing nearly 70% of our oil - and over 30% of both our coal and gas. Now all the percentages have started to slowly increase and the Community's import dependence will continue to rise throughout the period under study - for all fuels. By the mid-90's we may be importing over 50% of our energy - about 650 mtoe. By the end of century we could be importing 450 mtoe of oil (85% of our needs), 150 mtoe of coal (56% of needs) and 110 mtoe of gas (45%) - and the volumes will continue to grow - leaving imports by 2010 at just under 60% of total primary energy requirements.

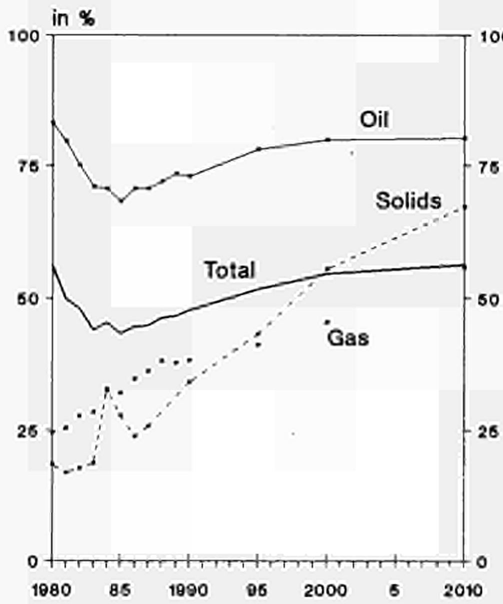


Figure 13: Call on imports
Europe12: Scenario 1

When looking to the future, perceptions about energy resources are important. In the 1970s "conventional wisdom" suggested imminent depletion of energy resources. In the 1980s the common perception is of no physical resource scarcity well into the new century. Views on resources are important and in preparing this report a special review was commissioned which looked in detail at current expectations for coal, oil, gas and uranium.

Linked to the issue of resources is the cost and market price of oil. While coal may indeed develop substantially as a world trade commodity all the indications are that oil will remain the leading price indicator.

Views about future oil prices have always differed and current perceptions about prices which could prevail over the next twenty years respect this tradition. Yet the range of oil prices in current debate are lower than those suggested in the early 1980's - then influenced no doubt by the recent experience of USD 40 oil in 1979/80. An overview of current thinking would suggest that prices will remain volatile but with, in the medium term, a return to pre-1986 prices unlikely. Equally a "low" price in single digit figures is not expected.

Table 6 : **World Oil Market - 3 Scenarios**

in mbd	1985	1988	1990	1995 Scen 1	1995 Scen 2/3	2010 Scen 1	2010 Scen 2	2010 Scen 3
CONSUMPTION								
OECD	*34.4*	*36.9*	*38.0*	*39.8*	*41.0*	*39.4*	*40.6*	*35.7*
LDCs	*12.4*	*13.9*	*15.0*	*17.5*	*17.6*	*23.5*	*22.9*	*21.4*
TOTAL	46.8	50.8	53.0	57.3	58.5	62.8	63.5	57.1
SUPPLY								
NON OPEC	*25.6*	*26.0*	*26.5*	*27.3*	*27.3*	*26.8*	*27.8*	*26.7*
Processing gains	*1.1*	*1.1*	*1.2*	*1.2*	*1.2*	*1.3*	*1.3*	*1.3*
CPEs-Net exports	*1.8*	*2.2*	*2.1*	*1.5*	*1.5*	*0.0*	*0.0*	*0.0*
OPEC	*17.5*	*21.4*	*23.3*	*27.4*	*28.5*	*34.7*	*34.4*	*29.1*
(of which: Crude)	*16.0*	*19.6*	*21.5*	*25.5*	*26.6*	*32.5*	*32.2*	*26.9*
TOTAL	46.0	50.7	53.1	57.3	58.5	62.8	63.5	57.1
Stock changes	*-0.8*	*-0.1*	*0.1*	*0*	*0*	*0*	*0*	*0*

While there is no consensus, two distinct schools of thought can be discerned; one argues prices in the USD 25 - USD 30 range by 2000 (largely supported by institutional economists) while the other view is of prices in the USD 15 - USD 20 range (prices in 1987/8 terms in both cases) and this view tends to be supported by those closer to the oil markets.

While price levels are important so also is the **fluctuation** of prices and the resulting **uncertainties** caused by major swings. Over the longer-term the magnitude of price movements depends both on the extent to which supply and demand growth ratio diverge and the sensitivity of the system to these imbalances.

The potential for price instability in oil continues to exist although its importance will change as the supply/demand picture changes for other fuels.

But we have a reasonable diversification of fuels and fuel suppliers, we have in place policies to reduce the impact of any interruptions and we have stocks of fuel. Moreover, we have good and improving relations with most of our suppliers to whom we are a major, or the major, trading partner and there is an increasing amount of industrial investment in the Community by some of the larger producers. So while supply security must remain a major part of Community energy policy - especially with growing dependence on external suppliers - we should continue to encourage better relations with our trading partners.

Community demand in a global context

The Community's primary energy consumption will grow at the same rate as that of the rest of the developed world but will be much slower than in developing countries. We are entering a new era - one in which the energy consumption of the developing and Centrally Planned Economies countries become the major factor in energy demand.

The arguments about the oil price should of course be undertaken in a global context. World supply and demand together with geopolitics are the actors which on the world's stage determine the drama of oil prices. Looking at a possible futures for oil, and following the logic of this scenario the world balance might resemble the following:

Under this view of the market, call on OPEC grows steadily to 28 mbd by 2000 and to about 35 mbd by 2010. Is such a market for OPEC oil consistent with the price of USD 30 a barrel in 2010 (1987 prices)[12,13,14]? This subject is taken up again in Chapter 3.

12 World Oil Supply and Demand Outlook: Internal analysis, N. Deimezis.

13 World Energy Supply and Demand Outlook: Internal analysis, N. Deimezis, J. Neto and M. Camos.

14 World Economic Outlook to 2005: CISI Wharton, 1986.

World energy supply and demand

We have estimated world energy consumption (including non-commercial energies) at about 7,800 mtoe. The Community share is 14% of the total, but the Community's nuclear park represents one-third of world nuclear capacity. The corresponding share of the US is 27%.

By region, OECD accounts for just under 50% of total world energy; centrally planned economies about 30% and developing countries 20%. By fuels, the CPE's are heavily dependent on solids (50%) with LDC's dependent on non-commercial fuels (2/3 of world supply) and oil (which represents 55% of their commercial energy supply).

Looking to the future, world energy demand could grow by 2.2%/year to 2010, increasing consumption from 7,800 mtoe to 13,500 mtoe. OECD's growth rate will probably be half of that for the world, resulting in its share of world consumption declining from 50% to 40% in 2010. The developing countries will account for 25% in 2010 (today 20%). Their consumption may increase from 1,500 mtoe to 3,500 mtoe; that for CPE's from 2,500 mtoe to 4,700 mtoe.

The fuel mix will change also with gas replacing oil (gas today represents 19% and could rise to 26%; that for oil is currently 37%, declining to 30%). Essentially the share of solids and nuclear will remain constant.

Carbon emissions seem likely to rise by 4 billion tonnes between 1987 and 2010. While the Community's share declines in percentage terms from 12% to 9%, in absolute terms annual emissions could grow from 740 to 930 million tones. (In terms of CO_2 this is an increase from 2.7 billion tonnes today to 3.4 billion tonnes in 2010).

By world region, centrally planned economies' emissions could equal those of OECD (at 3.6 billion tonnes) in 2010, while those from the LDCs could more than double from 1.2 to just under 2.8 billion tonnes. In all, carbon emissions could increase by 60% over the period to 2010.

Table 7 : **1985 - World Primary Energy Consumption**
in Millions of Toe

Mtoe	Solids	Oil(1)	Gas	Nuclear	Hydro(2)	Other(3)	TOTAL	TOTAL in %
EUROPE-12	*239.0*	*489.2*	*184.7*	*123.6*	*42.7*	*1.7*	*1080.9*	13.9
USA	*440.5*	*721.7*	*449.4*	*102.9*	*65.6*	*66.5*	*1846.6*	23.7
Rest of OECD	*156.1*	*378.1*	*103.6*	*81.0*	*148.1*	*8.4*	*875.3*	11.2
OECD	*835.6*	*1589.0*	*737.7*	*307.5*	*256.4*	*76.6*	*3802.8*	48.8
CPE	*1019.8*	*658.1*	*569.1*	*54.4*	*92.1*	*93.9*	*2487.4*	31.9
LDC	*234.1*	*640.1*	*167.9*	*16.5*	*107.0*	*331.5*	*1497.1*	19.2
WORLD	2089.5	2887.2	1474.7	378.4	455.5	502.0	7787.3	100.0
Part of EUROPE-12 in Total World in %	*11.4*	*16.9*	*12.5*	*32.7*	*9.4*	*0.3*	*13.9*	

(1) Including bunkers
(2) Including geothermal and net electricity imports
(3) Including non-commercial energy

Sources: CEC-SOEC, CEC-DG XVII/A2, BP, OECD, IEA, UN

Table 8 :
1985-2010 World primary energy demand and CO_2 emissions

A. Primary energy demand

In Mtoe	1985	1987	1995	1995/87 %	2000	2000/95 %	2010	2010/00 %	2010/87 %
EUROPE 12	*1080.9*	*1116.9*	*1282.9*	*1.7*	*1334.8*	*0.8*	*1434.1*	*0.7*	*1.1*
USA	*1846.6*	*1904.0*	*2198.6*	*1.8*	*2335.3*	*1.2*	*2578.0*	*1.0*	*1.3*
CANADA	*234.1*	*241.0*	*289.1*	*2.3*	*314.1*	*1.7*	*357.2*	*1.3*	*1.7*
JAPAN	*373.3*	*378.9*	*464.0*	*2.6*	*500.9*	*1.5*	*568.1*	*1.3*	*1.8*
Rest of OECD	*267.9*	*301.5*	*354.3*	*2.0*	*374.4*	*1.1*	*408.7*	*0.9*	*1.3*
TOTAL OECD	3802.8	3942.3	4588.9	1.9	4859.5	1.2	5346.1	1.0	1.3
CPE	*2487.5*	*2636.6*	*3323.9*	*2.9*	*3784.8*	*2.6*	*4717.8*	*2.2*	*2.6*
LDC	*1497.0*	*1609.1*	*2164.7*	*3.8*	*2560.3*	*3.4*	*3500.5*	*3.2*	*3.4*
WORLD	7787.3	8188.0	10077.5	2.6	11204.6	2.1	13564.4	1.9	2.2
Part of EUROPE-12 in Total World in %	*13.9*	*13.6*	*12.7*		*11.9*		*10.6*		

B. CO_2 Emissions

In Mt of C	1985	1987	1995	1995/87 %	2000	2000/95 %	2010	2010/00 %	2010/87 %
EUROPE 12	*741*	*746*	*854*	*1.7*	*886*	*0.7*	*928*	*0.5*	*1.0*
USA	*1355*	*1395*	*1602*	*1.7*	*1716*	*1.4*	*1915*	*1.1*	*1.4*
CANADA	*120*	*122*	*144*	*2.1*	*160*	*2.1*	*184*	*1.4*	*1.8*
JAPAN	*261*	*260*	*310*	*2.2*	*321*	*0.7*	*343*	*0.7*	*1.2*
Rest of OECD	*153*	*180*	*220*	*2.5*	*238*	*1.6*	*281*	*1.7*	*2.0*
TOTAL OECD	2630	2703	3130	1.9	3321	1.2	3651	1.0	1.3
CPE	*2112*	*2228*	*2708*	*2.5*	*3022*	*2.2*	*3646*	*1.9*	*2.2*
LDC	*1213*	*1299*	*1730*	*3.6*	*2034*	*3.3*	*2775*	*3.2*	*3.4*
WORLD	5955	6230	7568	2.5	8377	2.1	10072	1.9	2.1
Part of EUROPE-12 in Total World in %	*12.4*	*12.0*	*11.3*		*10.6*		*9.2*		

Note: Includes non-commercial energy

BOX C

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).

Chapter 3

A conventional view of the future revisited or «how things could go wrong» - Scenario 2

Introduction

If we had higher economic growth with heavy industry continuing to play an important role, and if we over-estimated the improvements in energy intensities in Scenario 1 (which after 1995 are bullish) then combined with growing transport congestion the results of the "conventional wisdom" scenario would underestimate the level of energy consumption.

While energy efficiency could, from a technical view point, continue to improve, and probably accelerate, because of the increase in economic activity, its net penetration into the market could be less than we thought. In the transport sector, for example, traffic conditions could be such that the actual use of higher efficiency vehicles would yield specific consumption rates far above their engineering potential. Replacing old cars with new, but larger-cylinder cars, could more than offset the engineering efficiencies gained in the design of the new car fleet. This "trading-up factor" linked to deteriorating traffic conditions both in towns and on major highways could more than compensate for technical improvements leading to higher consumption in the transport sector than foreseen. Emission abatement techniques are also likely to increase specific consumption.

«Driving into tensions» - Scenario

During the initial round of contacts with experts, there was evidence that perhaps economic growth could increase faster, and for more sustained periods, than prevailing wisdom might suggest. Looking back over the past three decades there has indeed been a number of cycles; between 1961 and 1973 growth increased at just under 5%. But of course during the oil shock periods of 1974-1986 economic growth was down to about 2% per annum. However, since 1986 growth is running at 3% p.a.

Indeed, some economic leaders argue that we are now entering a new growth cycle and, even if they do not foresee growth of the same order as that of the 1960s, they believe it should be higher than the 2% experienced in the recent period. We have taken for this scenario a growth rate of 3.5%, running from 1990 to 2000 but falling to 2½% from then to 2010.

Is this a plausible assumption; under what conditions would it prevail? The internal market is certainly capable of generating stronger economic growth in the Community and the international trading consequence of this growth, together with an improvement in world trading conditions could indeed lead to a higher level of world economic growth, ranging at around 4% as against 3.2% assumed earlier. There would indeed be consequences for developing countries and, to be coherent, growth in these countries would average about 4.5% from 1990 to 2000, declining slightly to 3½% from 2000 to 2010. For OECD as a whole, the average would be 3.5%, falling in the later period to just over 2½%.

Within the Community the internal market could generate another 1% GDP growth. From a sectoral point of view it does assume some continuation of existing high levels of output from energy intensive industries, e.g., chemicals, steel and non-metallic production, and this might continue during the 1990s, stabilizing towards the beginning of the new century. The tertiary sector would of course continue to develop, as indeed would the domestic sector with higher disposable income being available.

Energy use behaviour from 1990 to 2000 would probably see a continuation of a "no concern" attitude, leading to a partial, if not a large loss of the potential efficiency gains available from the introduction of more technically-efficient equipment. In the transport sector, the modal split between the different forms of transport would remain essentially the same - primarily favouring the private car. There would be no new initiatives or major change in traffic management; rather a continuation of existing policies which, while providing for some improvement in transportation flows, would most likely be insufficient to solve urban congestion problems.

Thus market forces drive the system. But of course a return to higher oil prices would tend to slow down demand, particularly towards the first decade of the 21st century.

Energy consequences

Simulating the energy sector, in response to the economic framework outlined in this scenario, suggests that primary energy demand could grow at about 1.7% p.a. with the final sectors growing at about 1.4% p.a.. This compares with 1% and 0.6% respectively in the "conventional wisdom" scenario.

By sector, transport would grow at about 1.4% and would add 75 toe to the incremental demand of 264 mtoe this scenario requires over 1987 levels of consumption. Similarly, industry, with a growth rate of 1.5%, would add under 90 mtoe. The domestic and tertiary sector would add another 100 mtoe to incremental demand.

Table 9 : **Incremental final energy**

Europe 12: Scenario 2
(Mtoe)

	Industry	Transport	Domestic +tertiary	Final demand
Solids	+ 1		- 8	- 7
Oil		+72	-20	+ 52
Gas	+37		+61	+ 98
Electr.	+46	+ 3	+62	+111
Heat	+ 4		+ 3	+ 7
Renewable			+ 3	+ 3
Total	+88	+75	+101	+264

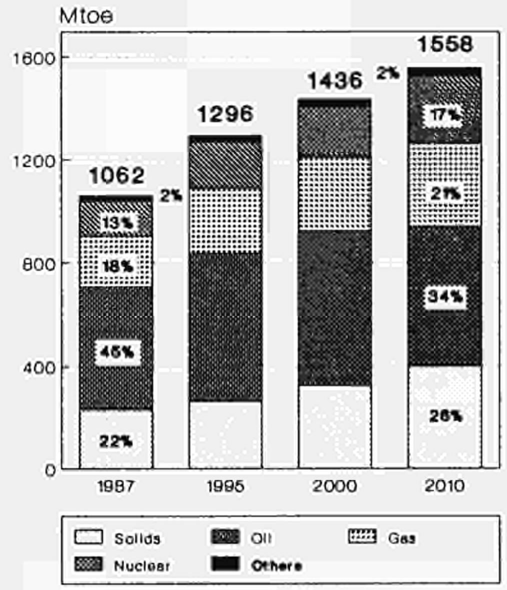
The incremental increase in **primary energy demand** of about 500 mtoe would be supplied from an increase in solids of 170 mtoe, with oil, gas and nuclear increasing by the order of 60, 130 and 125 mtoe respectively. Power generation would account for 195 of the 500 additional mtoe required to meet incremental primary energy demand.

On a per capita basis, consumption would increase from 2.2 toe to 3 toe by 2010 in final demand. Energy intensity would, however, continue to improve, but at a slightly slower rate and could register an improvement of 32% as against 35% in scenario 1.

The call on imports would rise, with under 60% of all fuel consumed being imported by 2000. This compares with 54% in the first scenario. By this year some 70% of coal, 76% of oil and 60% of gas would be imported. The long-run growth rate in imports will be running at 1.2% p.a. over the period to 2010.

The profile through time of all of these various growth rates would be faster to the mid-1990s - primary energy demand in this period growing annually at 2.5%, slowing in the later period to 1.2%. Power generation could grow by 3.5% to the mid-1990s, slowing down later to 2.6% to give an average for the full period of 3%.

Figure 14 :
Primary Energy Demand
Europe 12 : Scenario 2



Transportation could also experience a very fast growth, up to 3% to the mid-1990s, declining subsequently to much more modest rates. Given also the emphasis on heavy industry, industrial consumption might also show very strong growth in the initial period (around 2%), slowing in the later period to just 1% p.a.

The scenario does foresee improvements in energy intensities for coal, oil and gas, both in the primary energy and final sector requirements.

The long-run improvements in intensity for primary and final demand are -1.4% and -1.7% respectively.

With the faster economic growth resulting from this scenario assumption it is clear that car fleets, as indeed the capital stock of equipment in other sectors, will be renewed more quickly than under a slower growth rate. Similarly, the scenario has the dynamic element inbuilt, whereby technology does continue to improve.

The transport sector

While technological improvements will take place a change will also be required in transport infrastructure if the technical potentials are to be realized in practice. Taking three countries, Belgium, Spain and Portugal, as an example, the studies show that through better car technology an improvement in energy consumption of between 6 and 8% over the period could be expected (here it is assumed that performance was improved 10-15%). But if traffic management (better infrastructure, signalling etc.) did not accompany and support better car technology, then the consumption gains would be substantially reduced - by an order of 40% in the period 1995-2000.

Table 10 : **Lost Potential**

Belgium/Spain/Portugal	1995	2000	2015
i) Better car technology	- 6%	- 7%	- 8%
ii) But without improved traffic management	-3½%	- 4%	- 6%
iii) Leading to a loss of potential efficiency gains	40%	43%	25%

Efficiency improvements on their own will not be sufficient to realize the full engineering potential. In this case transportation infrastructure and its management has an important role to play in achieving lower specific consumption of the vehicle fleet. Similarly, the situation may be repeated in industry, where new technology (e.g., heat pumps) are introduced. But unless the environment within which they are placed, in terms of servicing and skills, develop simultaneously then the engineering potential will be lost in these sectors also.

Electricity generation

The implications for power generation of higher economic growth, and sustained output in the heavy industrial sector, would be very important. The long-run growth rate might be of the order of 3% but with higher rates of growth to the mid-1990s - perhaps 3½%, falling in the latter period to just over 2.20%. Gross production could increase from 1650 to 3100 TWh. Electricity planners would be placed in a dilemma.

There is existing spare capacity and in Scenario 1 it is an important source of supply in meeting additional demand in the early 1990s. Should the demand be higher, planners would need additional capacity for the mid-1990s, a capacity perhaps justified if they believed that the medium-term pressures would continue for the life of the asset.

But there is uncertainty about demand levels over the longer term. Even within this scenario's logic, the longer-run growth rate in the latter period of the analysis is substantially below the early growth anticipated. Consequently, there is a danger that by responding to medium-term demand pressures, long-term spare capacity could be created. This is without a major decline in electricity demand over the longer period.

During earlier discussions with utilities, two issues were dominant. The first related to the long-term growth rate in electricity, with German electricians suggesting that this would be, in historic terms, very modest. Nonetheless, many utilities were facing higher growth rates during the 1980s than they had anticipated and while the long-term thinking explained in the German situation was echoed by other planners, the pressures during the 1980s and those foreseen in the early 1990s raise doubts about the level and shape of future demand patterns.

Compounding these uncertainties on the demand side are concerns regarding supply side preferences. Clearly, the nuclear option in the 1990s will not be one available to many of the utilities concerned. Other fuel choices also pose difficulties. Concern with SO_2 and CO_2 cast a shadow over the coal choice. Similarly, the attractiveness of gas as a fuel will be offset by questions as to the cost and contract terms which might be available for the supply of this fuel to the power generating sector.

The table below estimates the generating capacity implied by this scenario and compares it with that in Scenario 1.

Table 11 :
Total electricity generating capacities in GW

	1987	1995	2000	2010
Scenario 1	411	441	467	537
Scenario 2	411	455	527	640
Additional capacity	0	14	60	103

The Community's energy supplies

Essentially, the additional supplies required to meet the increase in demand will come from imports with net imports of solids in the order of 280 mtoe, oil 530 and gas 145 mtoe in 2000.

Major themes

Internal Market

Given the important impacts of increased economic growth a more integrated market could be facilitated. The air of optimism and budgetary flexibility resulting from higher economic activity would most probably assist fuller implementation of the internal market. Fuel input costs would tend to converge with tax harmonisation (although the details have not yet been defined) and with the growing role of imports as the source of additional supply, i.e., prices are determined on the world market. This convergence on the supply side could be matched on the demand side with greater transparency of prices and with liberalisation of existing monopolies, leading overall to more convergence in end-user prices than exists today. The result could be some rationalization in the supply systems. Similarly, convergence of investment costs could result from the implementation of the public procurement directive, and this, linked to freeing of capital movements, could act as an incentive towards capital cost convergence.

Energy and the environment

Under this scenario, annual CO_2 emissions are likely to increase substantially from 2.7 billion tonnes in 1987 to 4 billion tonnes in 2010. The difference between emissions for Scenario 1 and 2 in 2010 would be 600 million tonnes of CO_2. Of this net difference between the two scenarios, power generation would account for 350 million tonnes, transports 60 million tonnes and industry 60 million tonnes.

Technology improvement and energy saving

It is clear that with higher economic growth there is much more probability of faster turnover of capital stock. Given the normal evolution in improved technical features in, for example, cars, refrigerators, televisions, etc., these should penetrate the markets more quickly than with the level of economic activity envisaged in Scenario 1.

Even if the technical efficiency improves, the behaviour of users and the comfort levels sought are not expected to change in comparison to that under the "conventional wisdom" scenario. If anything, because the ratio between relative price increases, and relative increase in income is likely to move in favour of the latter, the end-user is probably more indifferent to energy savings. The comfort levels sought, the trading-up to the next level of equipment, and the lack of attention to energy savings as such, suggests that, notwithstanding the engineering efficiency gains, the actual gains in use will decline. Indeed the analysis suggests that these engineering gains will be offset by behaviour and comfort level requirements.

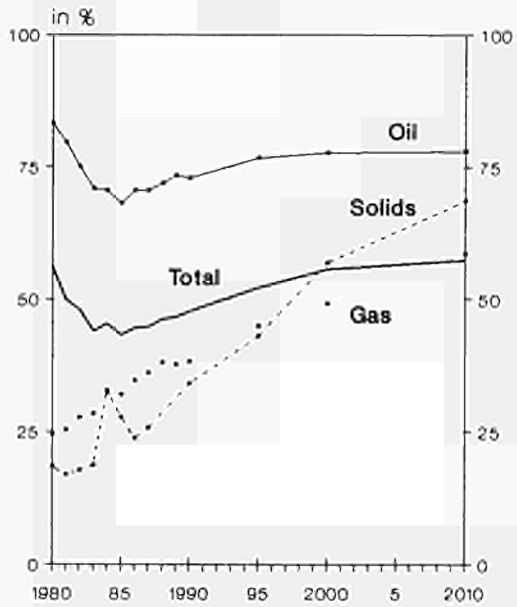
Thus, as for Scenario 1, the full potential from existing know-how is unlikely to be realized under such an economic environment.

Energy security

The increase in consumption associated with this scenario, "driving into tensions", puts the greatest pressure on the energy security dimension and particularly that for oil. At world level, incremental demand for oil could rise by 14 mbd (for the Community the corresponding increase is 1 mbd).

The call on imports of all fuels could increase the Community import dependency from just over 40% to nearly 60%.

Figure 15



Call on imports
Europe 12 : Scenario 2

Non-OPEC supply, which is largely exogenous up to 2000 (depending on decisions already made), increases between 1 mbd and 2 mbd to 2000, and only by 0.5 mbd by 2010. But this might be an under-estimate of the longer term non-OPEC possibilities.

Conclusion

Higher energy consumption is plausible - and indeed a real possibility. The current underlying growth in consumption could lead to the high levels of demand which are suggested here for 1995. This consumption is driven by economic forces, with, in the medium term, little or no policy restraint. Emission levels will rise and will fuel the controversy about the polluting nature of energy production.

Pressure on world oil prices must increase. Of course this does not automatically mean another oil shock, but the trading system is exposed should the political environment sour.

Finally, perhaps the most disappointing result would be the failure to benefit from the real technical progress made in recent years - letting energy wastage continue.

BOX D

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 stability 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 nothwith-standing 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.

Chapter 4

Another view - Sustaining high economic growth in a clean environment - Scenario 3

Scenarios 1 and 2 develop energy futures axed on a conventional approach. This is not a static view - the expectations from technology are great. But it assumes that the prevailing concerns with energy (to the extent that there are any) are limited to choices internal to each sector. Again they are dynamic in that they take note of gradually changing attitudes to the environment, the impact of the internal market and a changing geopolitical framework.

What would be the effect if we wanted a radical reduction in how much energy we consume, keeping, or indeed increasing, our economic welfare? Are the desires to have increasing economic growth, a clean environment and secure and moderately priced energy mutually compatible? This scenario seeks to explore this possibility.

Economic framework

The internal market could have an important economic effect, increasing the growth potential. But this would complement an improving world economy. On average, world growth is taken at 4% p.a. between 1990 and 2000 and 3½% from then to 2010. The average Community GDP is 3½% to 2000 and, because this rate could lead to some tensions, there is a slowing down after 2000 to 3% p.a.

By sector, heavy energy intensive industry could continue as in scenario 2 to 1995, stabilising from then to 2010. Other industrial sectors would sustain their level of output (mainly equipment goods and specialised chemicals). The tertiary sector would expand after 1995 compensating for the slowing down of heavy industry. The domestic sector income would grow at 3% on average to 2000, declining to 2.5% over the period 2000 to 2010.

From the early nineties, technology would, due to decisions taken before 1992, show strong innovations in equipment, with high capital turn-over leading to more economic and energy efficiency. Behaviour would change reflecting the decision to reduce emissions (a wish endorsed across the political spectrum). Consumer behaviour would become more rational - responding to better equipment and infrastructure.

Given the structure of the scenario, with more economic growth and a clear political consensus, progress is achieved in establishing the internal energy market - tax harmonisation, integration of gas and electricity networks and with prices and costs of different fuels tending to converge.

Concern with the level of emissions could lead, after 1992, to much stricter environmental standards.

Energy policy

Given growing concern over energy's impact on the environment, there is a renewed focus on energy policy with emphasis on:

- stricter environmental regulation;
- stricter and mandatory technological gains as well as encouragement of rational use;
- diversification of fuels avoiding oil but more use of gas, with nuclear growing after 2000 and new technologies in end use and production.

A realistic scenario ?

If we really want to reduce emissions we need to improve consumption. We can consume less by cutting economic growth but this, for many, is unacceptable (zero growth means a permanently lower standard of living for large parts of our populations). The other way of improving consumption is to be much more rational in how we organise our economies and how we use energy. What is described in this scenario is normative but realistic, in that it does not rely on some miracle technology. It is perhaps radical in that we already have the means within our grasp - we need to have the will.

Transport engineering has developed a car with low specific energy consumption - of the order of 5 litres per 100 kilometre. Growing incomes provide the resources for ensuring such technology penetrates the market. Better domestic appliances are possible. New buildings can be energy efficient in construction, and older ones can be economically refitted.

Emission abatement techniques are developing: SO_2 emissions can decline substantially, NO_x can be further reduced, but CO_2 poses a technical problem - the solutions for which could be expensive (at least, as we understand the current state of the art). Nuclear has a role in the fuel mix for power generation, as does gas, but the most cost-efficient answer probably lies in improving efficiencies and lowering demand by more rational and technically efficient use.

Using estimates of the state of the art technology, new estimates of consumption levels have been calcuated sector by sector and fuel by fuel, on the basis of the growth rates described above.

Final energy demand

The corresponding long-term final demand growth could be zero to 2010; with the period after 1995 compensating for the rather robust growth before then (over 2.4% reducing to -1.2% p.a.).

Incremental industrial demand could be 23 mtoe compared with 50 and 114 mtoe in Scenarios 1 and 2. Value-added in the chemical and equipment sectors would be 7-10% higher compared to Scenario 1 but would have an energy intensity 20% less. Steel and cement production could be 5-6% lower. The specific energy consumption in these sectors could decline by 10% compared with Scenario 1.

The domestic and tertiary sectors could also show important differences between scenarios. Incremental final demand in this scenario in 2010 might be 20 mtoe compared with 53 mtoe and 104 mtoe in Scenarios 1 and 2 respectively.

Table 12 :
Incremental final energy demand 1987-2010

Europe 12: Scenario 3
(Mtoe)

	Industry	Transport	Domestic +tertiary	Final demand
Solids	- 16		- 11	- 27
Oil	- 11	- 46	- 33	- 90
Gas	+22		+31	+53
Electr.	+21	+ 6	+29	+56
Heat	+ 4		+ 2	+ 6
Renewable			+ 5	+ 5
Total	+20	- 40	+23	+ 3

The transport sector

Traffic volumes are expected to increase substantially to 2010 - overall by 60% - on the basis of the existing modal-split. The number of kilometres travelled by passenger car, could increase by 64%, guided rail by 36% and air transport could double.

Freight transport could also grow by over 60%, with road growing by nearly 80% and rail and inland waterways by 40% and 70% respectively in tonne/kilometre terms.

Clearly, by the mid-nineties congestion would grow. Relieving this congestion by new infrastructure would probably not be sufficient - a change in modal split, moving from individual to collective transport, would be required.

The same "transport service levels" are assumed in this scenario but these journeys are supplied by a different mix of individual cars and public transport (a relative decline of 15% for cars and an increase of 90% for guided rail over the modal-split pattern in "conventional wisdom").

Similarly, a transfer from road to rail and inland waterways would be required for freight traffic, with the relative share of road declining by 25%, and that of rail and inland waterway increasing by a third and a fifth respectively.

The net effect on energy consumption of a change in modal split, better traffic management, and lower specific consumption would be about 40% lower consumption in Scenario 3 compared with that in "conventional wisdom". Total energy requirements in the transport sector would be 95 mtoe lower than that required in 1987; notwithstanding the impressive increase in journeys!

Power generation

The long-run growth rate for electricity could be 1.7% with high growth to the mid-nineties (3.5%), slowing down (0.7%) but remaining positive to 2010.

To meet this demand gross production in TWh should increase from 1650 to 2430; implying an additional 100 GW of capacity. This compares with 230 GW required in Scenario 2 - a scenario based on similar levels of economic activity. The difference in required capacity is due to lower actual electricity demand, and because of fuller integration of the Community's networks. Integration allows better optimisation of the network in responding to Community demand, and can be serviced more efficiently with integrated planning and operation than would be the case with continuing practices.

Table 13 :
Possible Structure of Electricity Generating Capacities (net) in GW

	1987	1995	2000	2010
Nuclear	*90*	*112*	*119*	*202*
Solids	*138*	*145*	*144*	*85*
Gas	*18*	*21*	*30*	*60*
Others	*165*	*177*	*174*	*155*
Total	411	455	467	510

Primary energy demand

Because the impact of the policy approach outlined requires time to be effective, primary demand could continue to grow to the mid-1990s by over 3% p.a. - a growth rate similar to that of Scenario 2. But as the policies begin to take effect, the rate of growth would become negative as we approach the new century, yielding on average a total long-run growth in primary energy demand of 0.4% from now to 2010.

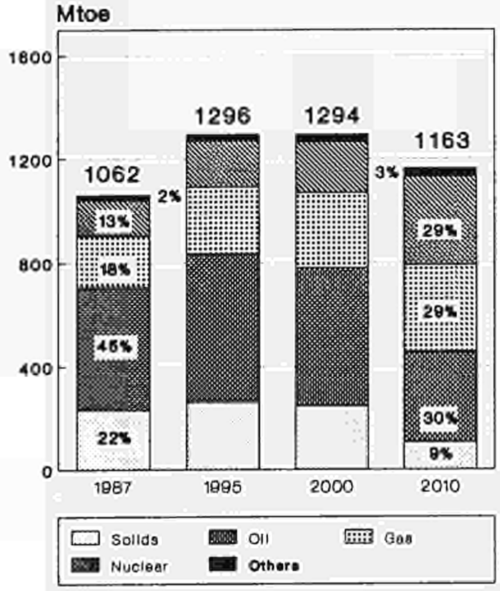


Figure 16
Primary energy demand
Europe 12 : Scenario 3

During this latter period every sector except power generation could decline. Power generation would continue to grow at 0.7% - but at a third of that estimated in the corresponding economic scenario (Scenario `2). Primary consumption could be 100 mtoe higher than in 1987; but economic activity could be 65% higher.

Major themes

Energy and environment

Detailed analysis on SO_2 and NO_x estimates will be available later. For the present, the analysis is based on CO_2 emissions. Given that one of the driving forces behind this scenario is to cut such emissions as far as possible, consistent with the other objectives of continuing growth and moderate energy prices, we have looked carefully at how CO_2 levels could be radically cut. The result suggests that by 2010 CO_2 emissions could be around 2.3 billion tonnes - some 470 million lower than in 1987. This is a result that corresponds to the 1988 Toronto Declaration.

Compared with Scenario 2 the results are impressive - given similar economic growth - the corresponding CO_2 emissions in that scenario are 4 billion. The difference of 1.7 billion tonnes is a measure of the importance of the policy choice. Around half a billion tonnes results from better demand management and another billion tonnes from changes in the fuel mix in power generation.

The incremental changes in electricity inputs in 2010, resulting from this scenario, and comparing the 2010 results with the current situation, indicates a replacement by gas and nuclear (some 70 and 200 mtoe respectively) for coal and oil (a decline of 20 and 15 mtoe). The net additional requirement to meet the production level is 150 mtoe. This is facilitated also by an increase in thermal efficiencies.

Energy security

Import dependency in 2010 could be around 40%, compared with 55 and 62% in Scenarios 1 and 2. Coal requirements could be about 25 mtoe (17 mtoe), oil 5/6 mbd (260 mtoe) and gas 230 billion cubic metres (210 mtoe). Clearly the security implication from such a scenario are more favourable to the Community and the risks discussed in Scenario 2 are correspondingly reduced. But further reflection is needed to check the consistency of such high gas imports at the price levels assumed in the scenario.

Conclusions

Clearly the will to achieve such reductions in consumption levels must be present - the magnitude of such a change in behaviour would be considerable, but the capacity, in engineering terms and in management skills, are to hand. The illustrations offered here in no way exhaust the different possibilities, nor do they imply a judgement between fuels. They do, however, offer a direction along which further reflections and discussions could be explored.

Chapter 5
The choices to be made

Introduction

The efficiency with which we produce and use energy is the key to future levels of primary energy consumption. The energy intensity we will have during the coming decades will be the product of a complex inter-action between prices (often determined on the world market), technology (a function of a myriad of individual decisions), the level of disposal income (with taxation playing an important role) and nuisance (in the form of traffic congestion, emissions from burning hydro-carbons, radiation fears and siting large-scale energy installations).

Our attitude to energy, and the balance we attribute to its benefits versus inconveniences, depends on the economic and social cycles at play. After the war the need was for energy as such - coal provided the basis of the reconstruction period to the mid-1950's and little concern was expressed about secondary effects. Oil fuelled the 1960's - extending the freedom of transport and providing more efficient means of industrial production. The fear of losing this fuel changed attitudes fundamentally during the 1970's; energy scarcity dominated thinking. Gradually this view yielded to a more relaxed attitude towards resources - they were perceived to be more plentiful than was thought. As we enter the 1990's, growing interest and concern with the environment, both locally and globally, will probably be the "leit motif" of the last decade of the 20th century.

The common denominator to these different phases in Europe, phases which are currently being repeated in different parts of the world, is the desire to have access to sufficient energy sources, moderately priced and clean in their use. The weighting given to each parameter may differ through time or place but they remain the energy policy issue.

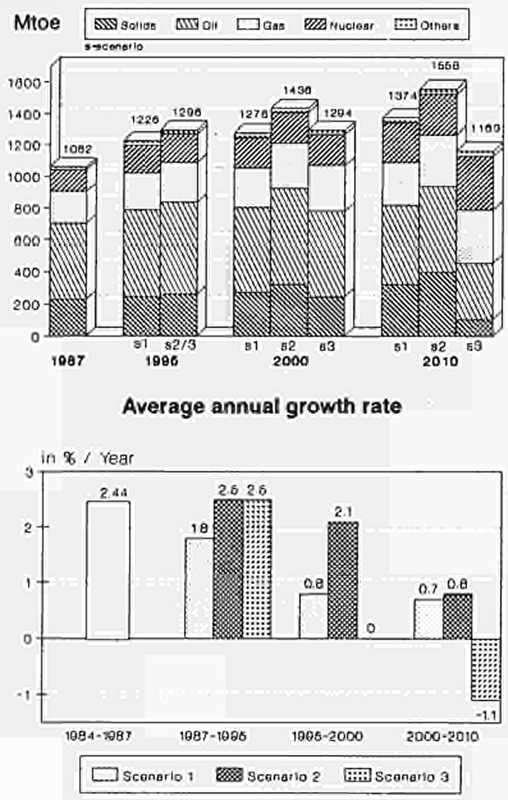
The three scenarios explored reflect prevailing concerns. They would have been defined differently ten years ago and most certainly will be different at the end of the century. There is a need to be aware of other concerns which may arise, but as we end the 1980s the scenarios probably reflect prevailing interests. What is important are the insights they offer to those who must take decisions in the near future - but where the effects of these decisions will last into the new century.

The differences between Scenarios 1 and 2 on the one hand and Scenario 3 indicate the wide scope of choice facing decision-makers. The time for decision is drawing close because the impacts may not be felt until early in the new century.

The range of choice

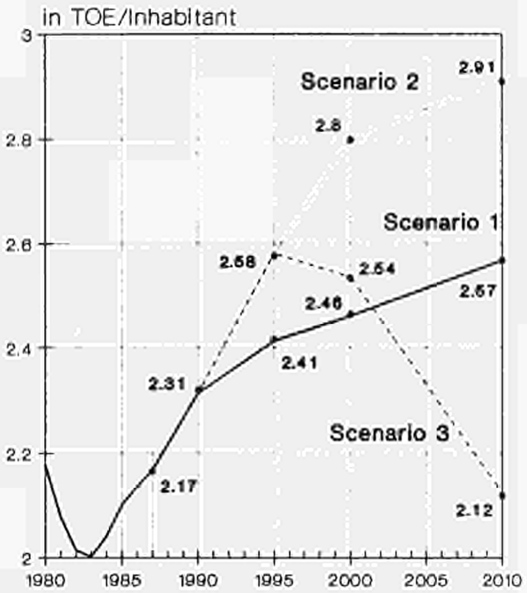
In 2010 final energy demand could, under Scenario 2, be of the order of 970 mtoe. Following the logic of Scenario 3 it might be 700 mtoe. This 40% difference in the results reflects the magnitude of the strategic decisions which must be made in the early 1990s. Do we follow the route of energy and emission conservation or the more traditional paths?

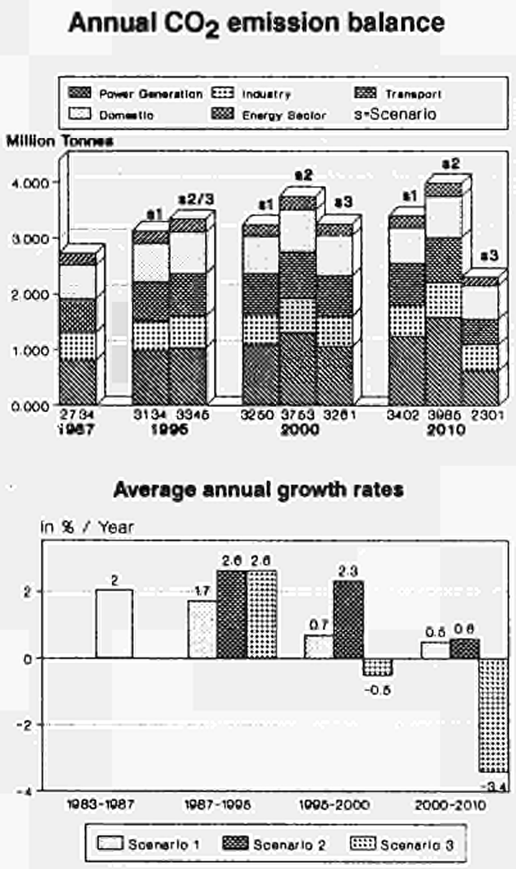
Figure 17
Primary energy demand
Europe 12 : 3 scenarios



Better management of energy consumption, even with high levels of economic activity, can substantially slow the growth in demand by the late 1990s and even reverse consumption patterns in the early years of the new century (Scenario 3).

Figure 18
Final energy demand per capita
Europe 12 : 3 scenarios





Europe 12 : 3 scenarios

Figure 19

Improvements in energy intensity could range from 40-60% depending on the scenario chosen - leading to lower than prevailing energy needs per head of population.

Emissions of CO_2 could range in 2010 from 2.3 (today they are estimated at 2.7) to 4 billion tonnes.

Energy intensity, (today O.2; defined as Ktoe/Mecu 1985) could fall between 0.08 and 0.13 - a 60% or 40% improvement.

Under Scenario 3, overall economic activity could nearly double by 2010, with primary energy consumption rising by less than 100 mtoe (1%). CO_2 emission levels could be lower than todays' and the balance of payments in constant terms could stay around present levels.

What is to be done ?

The outcome depends on decisions in key areas:

- Energy efficiency;
- Power generation;
- Transportation; and
- Secure supplies.

Energy efficiency

The technology is already available to achieve substantial savings in energy use - what has to change are attitudes and behaviour. Without a fundamental desire to change, the potential of our technical capacities will not be realised - nor will we move as quickly to develop new technology. The will to implement changes is determined outside the energy sector, but its impact on the amount of energy we consume to meet our needs can be considerable.

There are good possibilities to meet these higher needs at lower consumption levels - by 60% if we really want to!

Power generation

Electricity intensity could be 30% lower. How efficiently this is generated will depend on the degree of integration of the Community's networks (the gains could be substantial - between 6-13 billion ECU p.a. around 2010) and the choices between fuel preferences. Today there are fundamental questions about the fuel mix.

Many utilities find that, in their local situation, fuel choices are limited beyond technical considerations.

Figure 20
Final energy intensity
Europe 12 : 3 scenarios

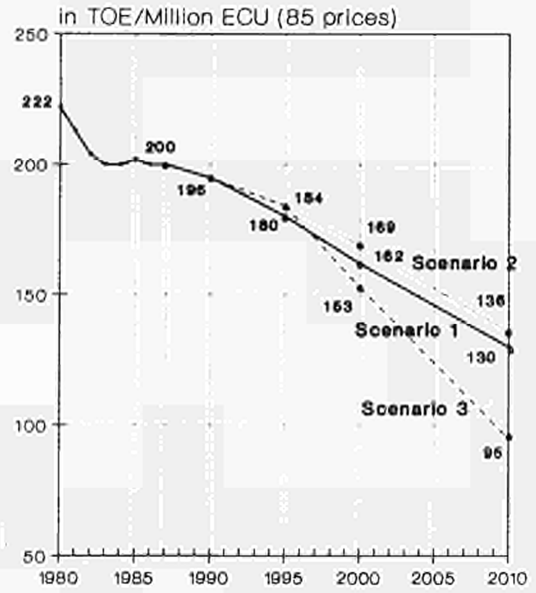
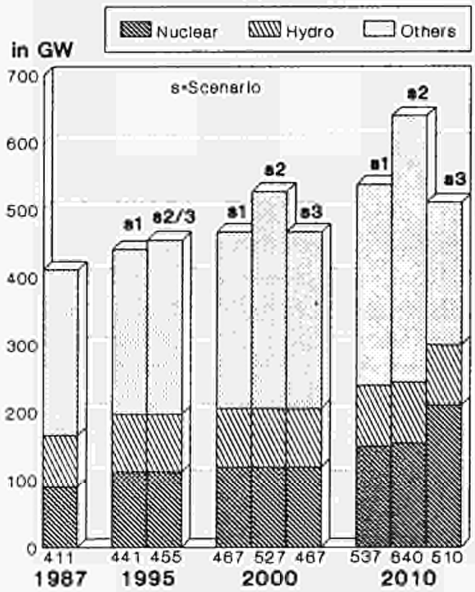
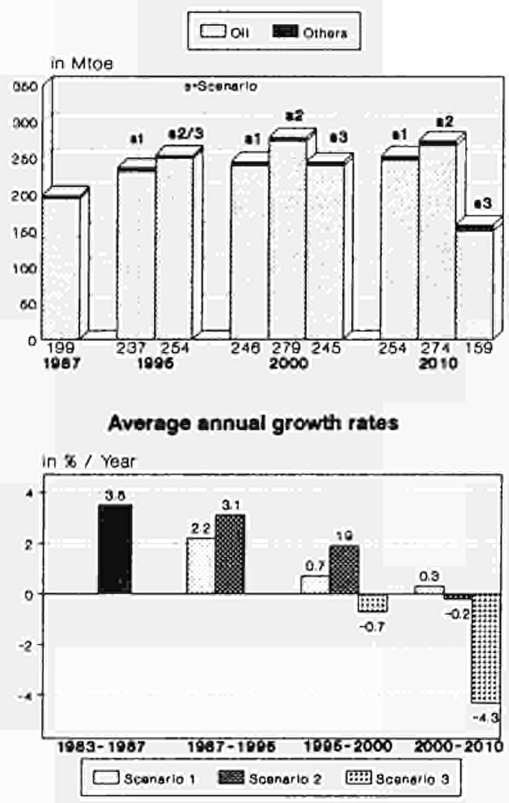


Figure 21
Electricity generating capacities
Europe 12 : 3 scenarios



Transport



Europe 12 : 3 scenarios

Figure 22

Some utilities, cannot use nuclear power to supply electricity. Some other utilities are required to give preference to local sources - sources which are often more expensive.

Many of these decisions are political rather than economic in origin, and changes will come as public concern about non-energy issues develop.

Utilities' attitudes do matter - do they meet "service level" requirements or electricity demand? They have considerable resources and expertise to develop energy efficiency programmes. Will they develop gradually to become service companies?

Transportation

Technical progress is possible - specific energy consumption can be decreased. Whether this will happen depends on our will to do so. We can have, in engineering terms, much more fuel- and emission-efficient cars. Even if we develop a more efficient fleet, how, when and where we use the car will be important. We also have to look at the basic transport infrastructure and the provision of improved public transport. Change will not come easily. Today, public expenditures are being reduced and in many instances these reductions require cuts in public transport levels. Equally, enticing the motorist from his car for some of his journeys is a challenge. But can we allow our cities to continue to deteriorate? Again the decision is wider than that of energy considerations, but the effects on consumption will be important.

Secure supplies

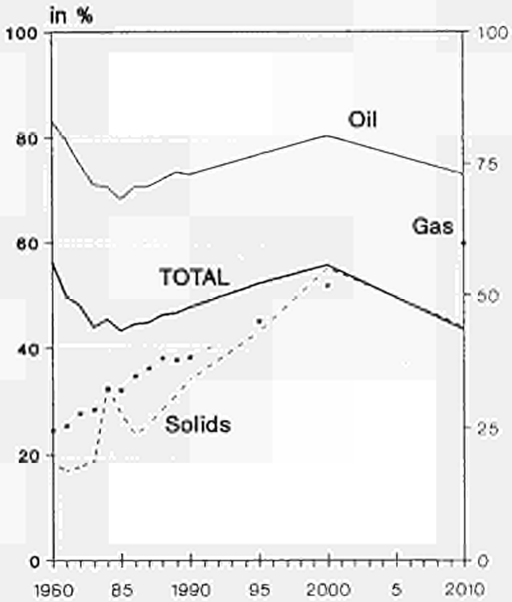
Our import dependency is growing. The extent of this dependency depends on consumption levels. The range again is important.

Depending on the scenario, in 2010 we could require:

Coal : 25-400 mtce.
Oil : 6-9 million barrels a day.
Gas : 170-220 billion cubic metres.

Our suppliers need clear indications. The ranges are too wide to be of assistance to our partners in planning their own economic development.

Figure 23
Call on imports
Europe 12 : Scenario 3



The need for a Community energy policy

The more uncertainty, the greater the need for a policy framework. But the uncertainty is not a "forecasting" phenomenon; it reflects the basic choices which must be made and the determination with which we persue our choice. There are uncertainties within each "energy path", but the ranges of consumption, intensities and import requirements reflect more than the normal spread - the choice of route is political, reflecting the desires, ambitions, hopes and fears of our populations.

In the foreword three questions were posed:

How can growing demand for energy services be reconciled with the need to improve the quality of the environment?

Can we realise the internal market in the energy sector without putting at risk our security of supply?

Are the objectives of strong economic growth, a clean environment and moderately priced secure energy supply compatible?

It is reasonable to believe that energy production and use can be reconciled with improving the quality of the environment.

The internal market will increase economic activity and foster a more enterprising climate. It also provides the framework for developing technology through higher economic growth, facilitating its penetration into the markets and helping to reduce consumption, and thus emissions, through more rational use of energy.

The three objectives of sustaining economic growth, having a clean environment with secure and moderately priced energy supply are not incompatible, but matching them does need an energy policy.

Annex I

The world oil market

This annex presents three possible views on the world oil market, associated with the three scenarios presented in the main text. Oil price and GDP assumptions are shown in Figures I-1 and I-2. Results are presented in Table I-1.

In the first scenario (conventional wisdom) the oil price increases smoothly to USD 20/bbl (1987 dollars) in 2000 and USD 30/bbl by 2010. In that case, OECD demand is assumed to grow by 1% up to 1995, then to slow down and decrease after 2000 (Figure I-3). LDC demand grows steadily (Figure I-4).

In all scenarios, CPE net exports are assumed positive until 2010 where they become nil. Given a non-OPEC supply of about 27 mbd, the call on OPEC crude, increases smoothly to 32.5 mbd by 2010. (Figure I-5).

In Scenario 2, higher GDP leads to higher OECD demand and higher prices. In that case, a "mini-shock" is possible, depending on OPEC reactions.

In Scenario 3, we assume important savings of energy and a fast substitution of oil in the OECD zone (see main text). In that case, OECD demand by 2010 could be around present levels, while prices could be around USD 20/bbl.

Table I-1 : The three scenarios - Oil supply and demand

In mbd	1973	1979	1985	1988	1990	1995 S 1	1995 S 2/3	2000 S 1	2000 S 2	2000 S 3	2010 S 1	2010 S 2	2010 S 3
Consumption													
OECD	40.5	41.8	34.4	36.9	38.0	39.8	41.0	40.2	42.1	41.0	39.4	40.6	35.7
LDCs	7.5	10.6	12.4	13.9	15.0	17.5	17.6	19.7	19.8	19.4	23.5	22.9	21.4
Total	*48.0*	*52.4*	*46.8*	*50.8*	*53.0*	*57.3*	*58.5*	*59.9*	*61.9*	*60.5*	*62.8*	*63.5*	*57.1*
Supply													
NON OPEC	17.2	19.9	25.6	26.0	26.5	27.3	27.3	27.3	27.6	27.6	26.8	27.8	26.7
Processing gains	0.6	0.8	1.1	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.3
CPEs-Net exports	0.4	1.2	1.8	2.2	2.1	1.5	1.5	1.0	1.0	1.0	0.0	0.0	0.0
OPEC	31.2	31.5	17.5	21.4	23.3	27.4	28.5	30.4	32.1	30.7	34.7	34.4	29.1
(of which: Crude)	30.8	30.6	16.0	19.6	21.5	25.5	26.6	28.4	30.1	28.7	32.5	32.2	26.9
Total	*49.4*	*53.4*	*46.0*	*50.7*	*53.1*	*57.3*	*58.5*	*59.9*	*61.9*	*60.5*	*62.8*	*63.5*	*57.1*
Stock changes	1.4	1.0	-0.8	-0.1	0.1	0	0	0	0	0	0	0	0

In %	1973	1979	1985	1988	1990	1995 S 1	1995 S 2/3	2000 S 1	2000 S 2	2000 S 3	2010 S 1	2010 S 2	2010 S 3
Consumption													
OECD		0.5	-3.2	2.3	1.5	1.0	1.5	0.2	0.5	0.0	-0.2	-0.4	-1.4
LDCs		5.9	2.6	3.9	3.9	3.1	3.2	2.4	2.4	2.0	1.8	1.4	1.0
Total		*1.5*	*-1.9*	*2.8*	*2.1*	*1.6*	*2.0*	*0.9*	*1.1*	*0.6*	*0.5*	*0.2*	*-0.6*
Supply													
NON OPEC		2.5	4.3	0.5	1.0	0.6	0.6	0.0	0.2	0.2	-0.2	0.1	-0.3
OPEC		0.2	-9.3	6.9	4.3	3.3	4.1	2.1	2.4	1.5	1.3	0.7	-0.5
(of which: Crude)		-0.1	-10.2	7.0	4.6	3.5	4.4	2.2	2.5	1.5	1.4	0.7	-0.6
Total		*1.3*	*-2.5*	*3.3*	*2.3*	*1.5*	*2.0*	*0.9*	*1.1*	*0.6*	*0.5*	*0.2*	*-0.6*

S1 = Scenario 1 , S2 = Scenario 2 , S3 = Scenario 3

Figure I-1 :

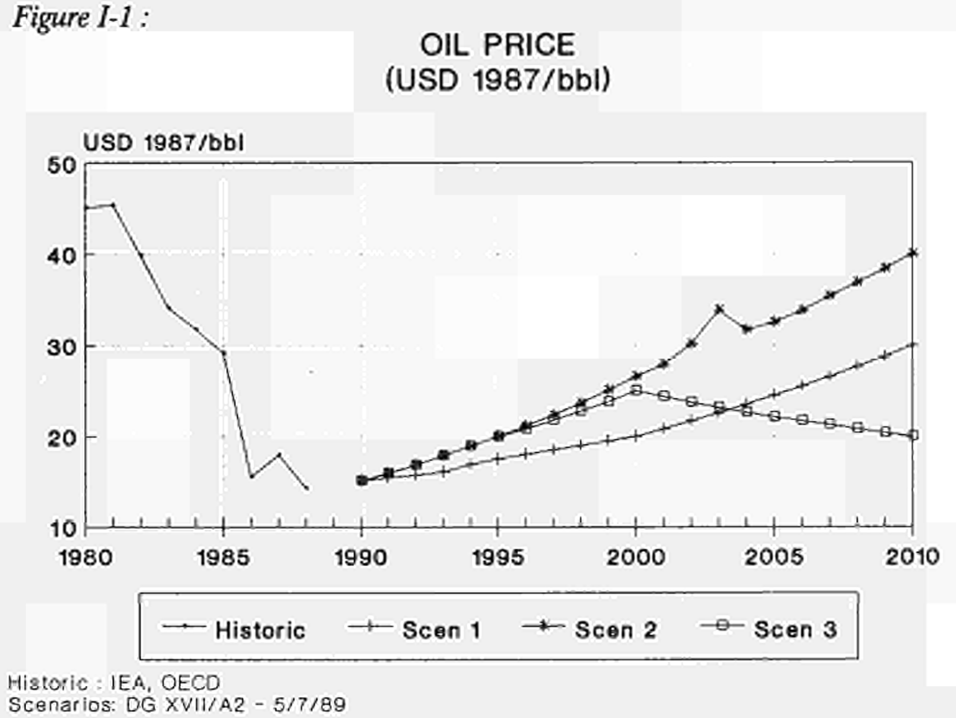


Figure I-2 :

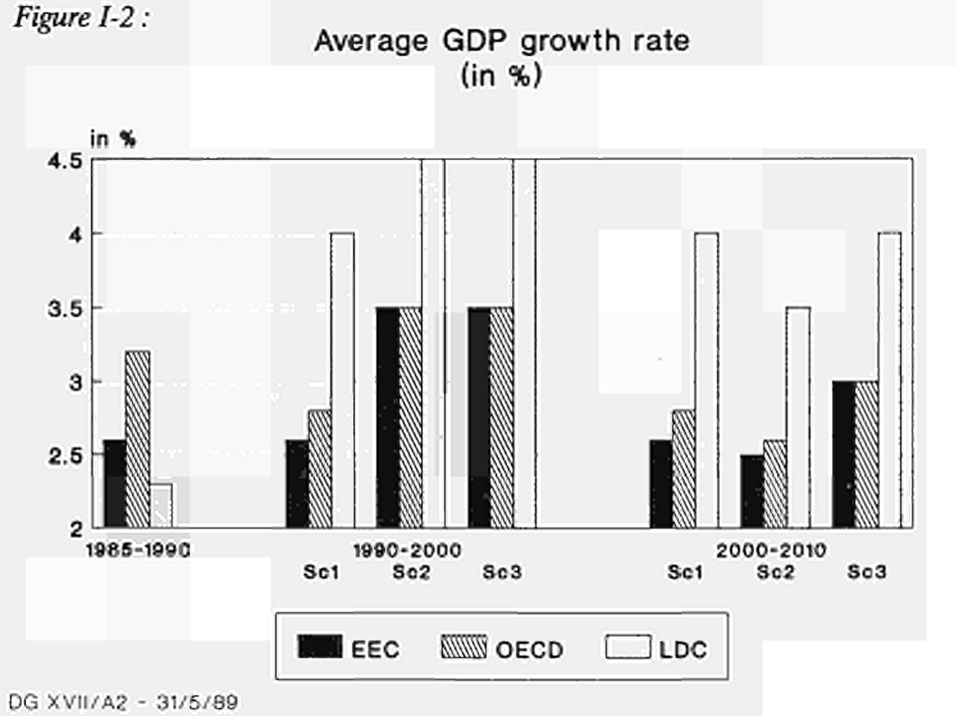


Figure I-3 :

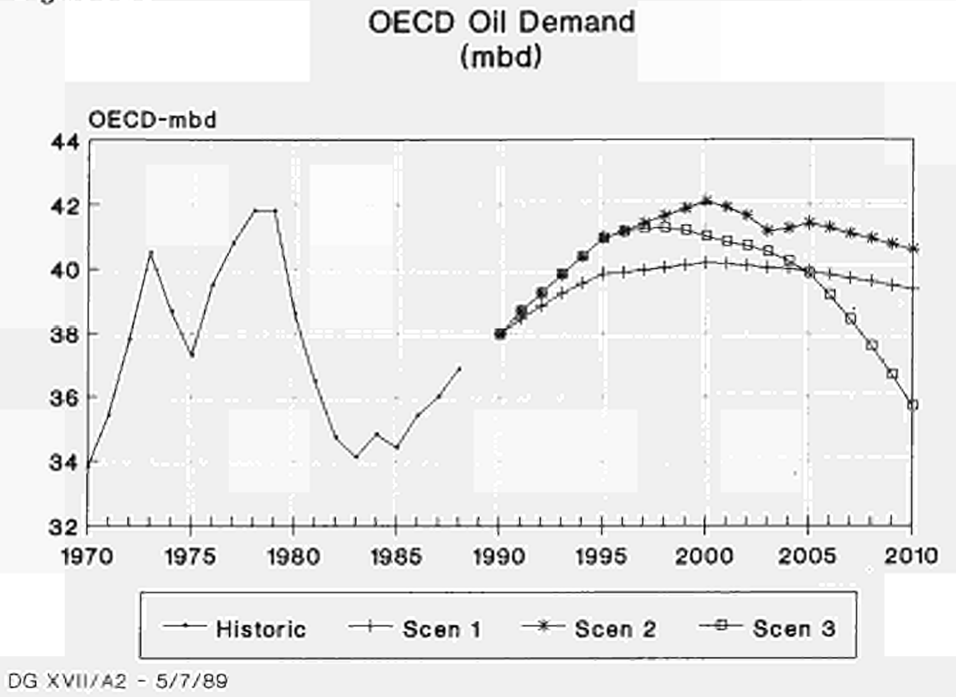


Figure I-4 :

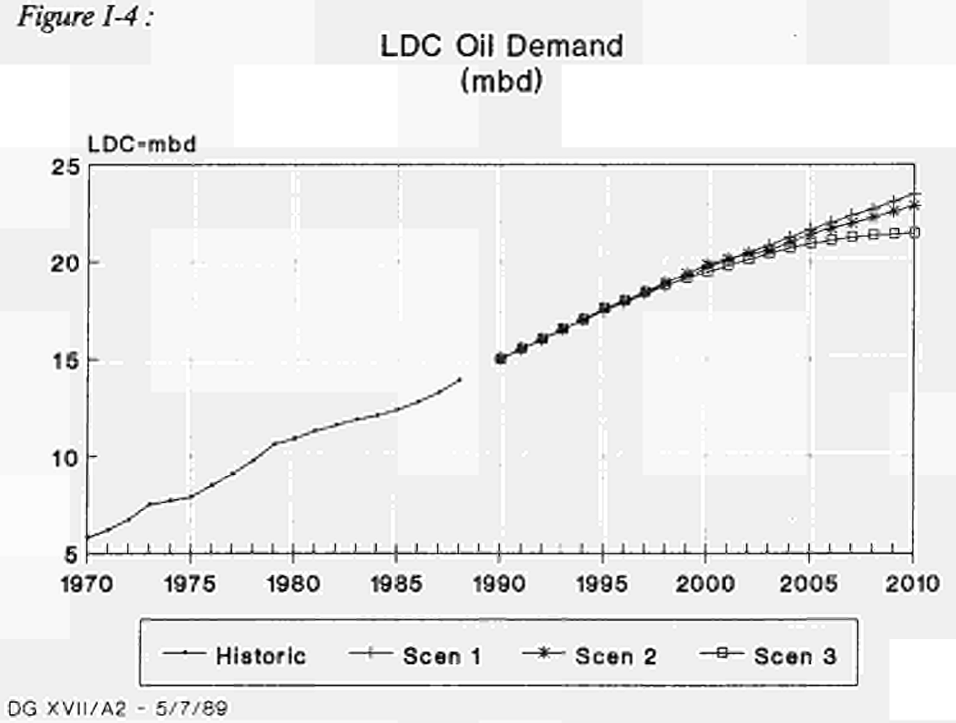
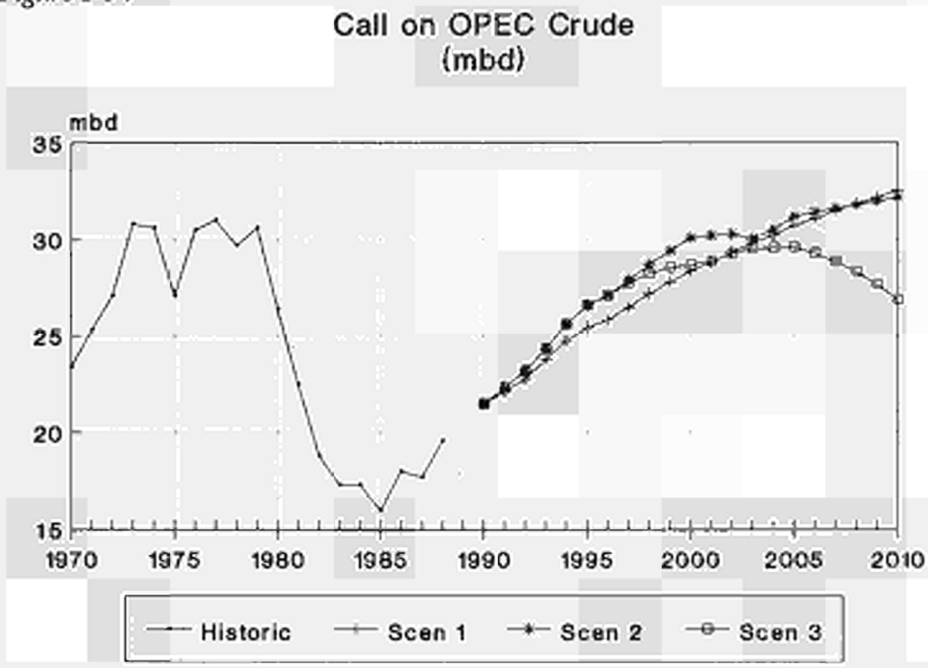


Figure I-5 :



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Annex II

World Energy Outlook - Scenario 1

This annex presents the main points of the world energy outlook under the "conventional wisdom" scenario, discussed in Chapter 2, of the main text.

The world is divided into the following zones:
- OECD : Europe-12, U.S.A., Canada, Japan, Rest of the OECD.
- CPE : USSR, Eastern Europe, China, North Korea, Vietnam.
- LDC : All the other countries.

Hydro electricity is treated according to the IEA methodology and for this reason the Europe-12 figures do not correspond totally with the balance sheets presented in Annex III.

- Table II-1 summarizes the main assumptions concerning GDP and energy prices for the scenario.
- Table II-2 presents the detailed primary energy demand by zone and by fuel.
- Table II-3 gives a summary of the world's final energy demand.
- Table II-4 summarizes the electricity production and fuel mix.
- Table II-5 compares our results for primary energy demand growth with some other projections, including the WEC.

The CO_2 emissions associated with this scenario are presented in Table 8 in the main text.

Table II-1: Main assumptions

A. GDP growth - in %	1990/87	1995/90	2000/95	2010/00
EUROPE-12	3.2	2.7	2.7	2.7
USA	2.8	2.5	2.4	2.4
CANADA	3.3	2.8	2.8	2.8
JAPAN	4.5	3.8	3.8	3.8
OECD	3.2	2.8	2.8	2.8
CPE	2.6	2.7	2.7	2.7
LDC	4.3	4.0	4.0	4.0
WORLD	3.5	3.2	3.2	3.2

B. Prices	1987	1990	1995	2000	2010
Oil (1987 USD/bbl)	*18.0*	*17.3*	*17.5*	*20.0*	*30.0*
Coal (1987 USD/t)	*41.0*	*41.3*	*42.3*	*43.3*	*51.9*

Table II-2: Primary energy demand

In Mtoe	1985	1987	1990	1995	2000	2005	2010
Solid fuels							
EUROPE-12	239.0	230.2	237.1	248.2	276.1	302.9	323.3
USA	440.5	452.9	483.3	532.0	578.1	626.5	676.4
CANADA	29.3	33.4	33.8	39.7	48.2	53.8	60.4
JAPAN	73.7	68.5	80.9	88.6	95.0	100.2	106.1
Rest OECD	53.1	70.6	77.6	90.4	104.7	122.0	138.0
OECD	835.6	855.6	912.7	998.9	1102.1	1205.4	1304.2
CPE	1019.8	1073.6	1132.2	1218.5	1303.9	1377.1	1435.2
LDC	234.1	264.3	311.6	406.1	520.8	670.6	835.8
WORLD	2089.5	2193.5	2356.5	2623.5	2926.8	3253.1	3575.2
Oil							
EUROPE-12	489.2	506.3	544.8	569.6	557.2	539.3	522.1
USA	721.7	763.4	796.4	837.1	870.4	883.8	886.0
CANADA	68.5	69.4	73.9	79.8	82.1	82.8	82.5
JAPAN	203.4	208.1	216.2	225.0	220.6	216.5	209.7
Rest OECD	106.2	111.7	118.6	124.5	121.8	117.8	114.1
OECD	1589.0	1658.9	1749.9	1836.0	1852.1	1840.2	1814.4
CPE	658.1	679.0	735.3	817.7	889.4	954.6	1014.3
LDC	640.1	682.2	769.6	895.6	1008.8	1109.9	1202.9
WORLD	2887.2	3020.1	3254.8	3549.3	3750.3	3904.7	4031.6
Natural gas							
EUROPE-12	184.7	198.2	212.4	232.3	248.7	262.2	276.1
USA	449.4	431.9	480.0	524.1	569.4	613.5	662.0
CANADA	44.8	41.2	44.7	51.2	58.1	64.8	72.3
JAPAN	35.9	36.4	45.2	55.4	66.0	77.2	90.4
Rest OECD	22.9	26.7	32.8	40.8	48.0	55.7	63.2
OECD	737.7	734.4	815.1	903.8	990.2	1073.4	1164.0
CPE	569.1	632.1	719.5	930.7	1173.3	1442.5	1745.6
LDC	167.9	189.3	223.2	291.3	377.8	491.5	625.5
WORLD	1474.7	1555.8	1757.8	2125.8	2541.3	3007.4	3535.1
Nuclear Energy							
EUROPE-12	123.6	136.2	160.6	179.6	196.1	220.1	251.5
USA	102.9	122.1	145.6	156.8	163.6	173.6	189.8
CANADA	15.3	19.6	26.4	30.0	31.4	32.9	34.3
JAPAN	40.4	47.5	54.7	70.5	90.8	110.5	128.1
Rest OECD	25.3	27.9	28.6	28.6	26.5	18.4	12.8
OECD	307.5	353.3	415.9	465.5	508.4	555.5	616.5
CPE	54.4	63.3	81.7	125.7	160.4	185.9	215.6
LDC	16.5	23.4	30.3	46.6	71.7	96.0	128.4
WORLD	378.4	440.0	527.9	637.8	740.5	837.4	960.5
Hydro etc.							
EUROPE-12	42.7	43.8	47.2	50.2	52.8	53.9	54.7
USA	65.6	58.9	67.8	70.1	73.0	75.3	78.0
CANADA	67.8	70.6	73.4	81.3	87.0	93.5	99.9
JAPAN	19.9	18.4	21.8	24.5	28.5	31.1	33.8
Rest OECD	60.4	64.6	66.5	70.0	73.4	77.0	80.6
OECD	256.4	256.3	276.7	296.1	314.7	330.8	347.0
CPE	92.1	95.1	106.1	126.6	148.0	170.2	193.9
LDC	107.0	112.6	126.5	154.0	187.3	227.7	264.1
WORLD	455.5	464.0	509.3	576.7	650.0	728.7	805.0
Total Conventional							
EUROPE-12	1079.2	1114.7	1202.1	1279.9	1330.9	1378.4	1427.7
USA	1780.1	1829.2	1973.1	2120.1	2254.5	2372.7	2492.2
CANADA	225.7	234.2	252.2	282.0	306.8	327.8	349.4
JAPAN	373.3	378.9	418.8	464.0	500.9	535.5	568.1
Rest OECD	267.9	301.5	324.1	354.3	374.4	390.9	408.7
OECD	3726.2	3858.5	4170.3	4500.3	4767.5	5005.3	5246.1
CPE	2393.5	2543.1	2774.8	3219.2	3675.0	4130.3	4604.6
LDC	1165.6	1271.8	1461.2	1793.6	2166.4	2595.7	3056.7
WORLD	7285.3	7673.4	8406.3	9513.1	10608.9	11731.3	12907.4
Renewables and non commercial							
EUROPE-12	1.7	2.2	2.0	3.0	3.9	5.0	6.4
USA	66.5	74.8	76.2	78.5	80.8	83.3	85.8
CANADA	8.4	6.8	6.9	7.1	7.3	7.6	7.8
OECD	76.6	83.8	85.1	88.6	92.0	95.9	100.0
CPE	93.9	93.5	97.7	104.7	109.8	112.4	113.2
LDC	331.5	337.3	349.5	371.1	393.9	418.1	443.8
WORLD	502.0	514.6	532.3	564.4	595.7	626.4	657.0
TOTAL							
EUROPE-12	1080.9	1116.9	1204.1	1282.9	1334.8	1383.4	1434.1
USA	1846.6	1904.0	2049.3	2198.6	2335.3	2456.0	2578.0
CANADA	234.1	241.0	259.1	289.1	314.1	335.4	357.2
JAPAN	373.3	378.9	418.8	464.0	500.9	535.5	568.1
Rest OECD	267.9	301.5	324.1	354.3	374.4	390.9	408.7
OECD	3802.8	3942.3	4255.4	4588.9	4859.5	5101.2	5346.1
CPE	2487.4	2636.6	2872.5	3323.9	3784.8	4242.7	4717.8
LDC	1497.1	1609.1	1810.7	2164.7	2560.3	3013.8	3500.5
WORLD	7787.3	8188.0	8938.6	10077.5	11204.6	12357.7	13564.4

Table II-3: World Final Energy Demand

In Mtoe	1985	1987	1990	1995	2000	2005	2010
Solids	921.8	910.2	954.8	1013.3	1036.1	1036.1	1029.1
Oil	2323.9	2449.8	2643.6	2884.6	3063.7	3229.6	3373.0
Gas	894.5	946.4	1080.7	1240.6	1431.7	1628.1	1852.9
Electricity	702.8	759.1	848.8	1011.0	1186.7	1376.4	1580.8
Heat	179.3	184.5	199.0	220.7	247.5	272.9	295.2
Others	500.3	512.4	530.4	562.3	593.1	623.3	653.4
TOTAL	5522.6	5762.4	6257.3	6932.5	7558.8	8166.4	8784.4

In %	1985	1987	1990	1995	2000	2005	2010
Solids	16.7	15.8	15.3	14.6	13.7	12.7	11.7
Oil	42.1	42.5	42.2	41.6	40.5	39.5	38.4
Gas	16.2	16.4	17.3	17.9	18.9	19.9	21.1
Electricity	12.7	13.2	13.6	14.6	15.7	16.9	18.0
Heat	3.2	3.2	3.2	3.2	3.3	3.3	3.4
Others	9.1	8.9	8.5	8.1	7.8	7.6	7.4
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table II-4: Electricity

A. Electricity gross production

In TWh	1985	1987	1990	1995	2000	2005	2010
EUROPE-12	1572.7	1659.2	1812.8	2051.2	2255.8	2440.7	2634.9
USA	2621.9	2732.5	3016.3	3446.5	3873.3	4301.2	4753.5
CANADA	459.0	496.4	534.9	618.6	698.8	769.8	848.8
JAPAN	672.0	719.1	810.5	927.9	1052.3	1179.1	1309.3
Rest OECD	577.6	625.1	669.8	748.8	824.4	896.5	974.4
OECD	5903.2	6232.3	6844.2	7793.0	8704.7	9587.2	10520.9
CPE	2558.8	2793.4	3093.0	3723.3	4396.5	5088.4	5814.0
LDC	1379.1	1554.0	1891.9	2580.2	3453.5	4534.9	5732.6
WORLD	9841.1	10579.7	11829.1	14096.5	16554.7	19210.5	22067.4
of which:							
Hydro etc	2067.3	2104.4	2305.8	2610.5	2940.7	3296.5	3640.7
In %	21.0	19.9	19.5	18.5	17.8	17.2	16.5
Nuclear	1492.0	1739.1	2087.2	2522.1	2927.9	3310.5	3797.7
In %	15.2	16.4	17.6	17.9	17.7	17.2	17.2
Thermal	6281.8	6736.2	7436.0	8964.0	10686.0	12603.5	14629.1
In %	63.8	63.7	62.9	63.6	64.6	65.6	66.3

B. Inputs to Thermal power stations

In Mtoe	1985	1987	1990	1995	2000	2005	2010
Solids	1042.0	1116.3	1227.7	1428.6	1700.8	2017.4	2335.6
Oil	320.7	319.8	343.2	379.4	389.3	367.8	342.4
Gas	369.2	398.4	461.1	639.4	831.9	1070.3	1339.7
Others	1.7	2.2	1.9	2.1	2.6	3.1	3.6
TOTAL	1733.6	1836.7	2033.9	2449.5	2924.6	3458.6	4021.3
Electricity	540.2	579.3	639.5	770.9	919.0	1083.9	1258.1
Effic-In %	31.2	31.5	31.4	31.5	31.4	31.3	31.3

In %	1985	1987	1990	1995	2000	2005	2010
Solids	60.1	60.8	60.4	58.3	58.2	58.3	58.1
Oil	18.5	17.4	16.9	15.5	13.3	10.6	8.5
Gas	21.3	21.7	22.7	26.1	28.4	30.9	33.3
Others	0.1	0.1	0.1	0.1	0.1	0.1	0.1
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table II-5: World Primary Energy Demand Growth
Comparison with other projections

in %	1995/87	2000/85	2005/95	2005/87	2010/85	2020/85
CEC-DG XVII/A2						
Solids	2.3	2.3	2.2	2.2	2.2	
Oil	2.0	1.8	1.0	1.4	1.3	
Gas	4.0	3.7	3.5	3.7	3.6	
Nuclear	4.7	4.6	2.8	3.6	3.8	
TOTAL	2.6	2.5	2.1	2.3	2.2	
IEA-June 89						
Solids	2.1		2.7	2.4		
Oil	1.9		1.4	1.6		
Gas	3.3		4.1	3.7		
Nuclear	4.1		1.9	2.9		
TOTAL	2.4		2.5	2.4		
WEC/M-1989						
Solids		1.9				1.9
Oil		1.4				1.0
Gas		2.4				1.5
Nuclear		4.6				3.4
TOTAL		2.0				1.6
MITI-1989						
Solids					2.6	
Oil					1.5	
Gas					2.8	
Nuclear					2.9	
TOTAL					2.3	

Annex III

Annual Energy Balances - Europe 12

Annual energy balance - 1987
Mtoe

1987	Solids	Oil	Gas	Nuclear	Hydro	Electr.	Heat	Renew.	TOTAL
Domestic Production	168.9	150.9	129.0	136.3	14.9	0.0	2.3	2.2	604.5
Net Imports	59.2	357.4	71.6	0.0	0.0	1.6	0.0	0.0	489.7
Bunkers	0.0	29.7	0.0	0.0	0.0	0.0	0.0	0.0	29.7
Primary Demand	230.2	476.6	198.2	136.3	14.9	1.6	2.3	2.2	1062.3
Energy Sector	171.6	67.8	19.4	136.3	14.9	-118.5	-2.9	2.2	290.8
Total Final	59.5	408.4	178.3	0.0	0.0	120.1	5.2	0.0	771.5
Non Energy Uses	1.3	57.1	11.5	0.0	0.0	0.0	0.0	0.0	69.9
Final Energy	58.2	351.3	166.8	0.0	0.0	120.1	5.2	0.0	701.6
of which:									
Industry	40.8	50.3	68.0	0.0	0.0	52.0	2.8	0.0	213.8
Transportation	0.1	195.6	0.2	0.0	0.0	2.8	0.0	0.0	198.8
Domestic\Tertiary	17.3	105.4	98.6	0.0	0.0	65.2	2.5	0.0	289.0
Stock change	-2.0	2.0	2.3	0.0	0.0	0.0	0.0	0.0	2.3
Stat. Error	-0.9	0.4	0.5	0.0	0.0	0.0	0.0	0.0	0.0

Source: SOEC

Scenario 1 - Annual Energy Balance - 1995
Mtoe

1995	Solids	Oil	Gas	Nuclear	Hydro	Electr.	Heat	Renew.	TOTAL
Domestic Production	140.9	125.2	136.8	179.6	16.8	0.0	3.4	3.0	605.7
Net Imports	107.2	444.4	95.4	0.0	0.0	1.9	0.0	0.0	649.0
Bunkers	0.0	28.6	0.0	0.0	0.0	0.0	0.0	0.0	28.6
Primary Demand	248.1	541.0	232.3	179.6	16.8	1.9	3.4	3.0	1226.1
Energy Sector	194.7	89.4	25.2	179.6	16.8	-146.9	-4.4	2.1	356.6
Total Final	53.4	451.6	207.1	0.0	0.0	148.8	7.8	0.9	869.6
Non Energy Uses	1.3	61.1	13.6	0.0	0.0	0.0	0.0	0.0	76.0
Final Energy	52.1	390.5	193.4	0.0	0.0	148.8	7.8	0.9	793.5
of which:									
Industry	38.1	54.1	78.0	0.0	0.0	61.7	4.5	0.0	236.4
Transportation	0.1	232.7	0.2	0.0	0.0	4.2	0.0	0.0	237.2
Domestic\Tertiary	13.9	103.7	115.3	0.0	0.0	82.9	3.3	0.9	319.9

Scenario 1 - Annual Energy Balance - 2000
Mtoe

2000	Solids	Oil	Gas	Nuclear	Hydro	Electr.	Heat	Renew.	TOTAL
Domestic Production	122.9	111.9	135.9	196.1	17.4	0.0	4.6	3.9	592.6
Net Imports	153.3	445.3	113.0	0.0	0.0	1.7	0.0	0.0	713.2
Bunkers	0.0	29.0	0.0	0.0	0.0	0.0	0.0	0.0	29.0
Primary Demand	276.1	528.2	248.8	196.1	17.4	1.7	4.6	3.9	1276.8
Energy Sector	225.5	79.9	31.6	196.1	17.4	-162.4	-5.8	2.7	384.8
Total Final	50.7	448.4	217.3	0.0	0.0	164.0	10.5	1.3	892.0
Non Energy Uses	1.2	62.6	14.1	0.0	0.0	0.0	0.0	0.0	77.9
Final Energy	49.4	385.8	203.2	0.0	0.0	164.0	10.5	1.3	814.1
of which:									
Industry	37.9	51.4	80.9	0.0	0.0	66.5	6.2	0.0	243.0
Transportation	0.1	240.6	0.2	0.0	0.0	4.9	0.0	0.0	245.7
Domestic\Tertiary	11.5	93.8	122.0	0.0	0.0	92.7	4.2	1.3	325.4

Scenario 1 - Annual Energy Balance - 2010
Mtoe

2010	Solids	Oil	Gas	Nuclear	Hydro	Electr.	Heat	Renew.	TOTAL
Domestic Production	105.6	103.3	121.7	251.5	18.0	0.0	5.4	6.4	611.9
Net Imports	217.6	418.8	154.4	0.0	0.0	1.2	0.0	0.0	792.1
Bunkers	0.0	29.1	0.0	0.0	0.0	0.0	0.0	0.0	29.1
Primary Demand	323.2	493.1	276.1	251.5	18.0	1.2	5.4	6.4	1374.8
Energy Sector	273.2	51.4	42.2	251.5	18.0	-190.9	-6.4	3.6	442.7
Total Final	50.0	441.7	233.9	0.0	0.0	192.1	11.8	2.7	932.2
Non Energy Uses	1.2	65.6	14.9	0.0	0.0	0.0	0.0	0.0	81.7
Final Energy	48.8	376.1	218.9	0.0	0.0	192.1	11.8	2.7	850.5
of which:									
Industry	39.7	49.5	88.0	0.0	0.0	78.4	7.0	0.0	262.6
Transportation	0.0	247.4	0.2	0.0	0.0	6.1	0.0	0.0	253.8
Domestic\Tertiary	9.2	79.3	130.7	0.0	0.0	107.5	4.8	2.7	334.1

Scenarios 2 and 3 - Annual Energy Balance - 1995
Mtoe

1995	Solids	Oil	Gas	Nuclear	Hydro	Electr.	Heat	Renew.	TOTAL
Domestic Production	150.0	140.0	140.0	179.6	16.8	0.0	3.4	4.0	633.8
Net Imports	113.2	461.6	114.4	0.0	0.0	1.9	0.0	0.0	691.1
Bunkers	0.0	28.6	0.0	0.0	0.0	0.0	0.0.	0.0	28.6
Primary Demand	263.2	573.0	254.4	179.6	16.8	1.9	3.4	4.0	1296.3
Energy Sector	206.8	93.7	29.3	179.6	16.8	-156.7	-4.7	3.1	368.0
Total Final	56.4	479.2	225.1	0.0	0.0	158.6	8.1	0.9	928.3
Non Energy Uses	1.3	63.7	14.9	0.0	0.0	0.0	0.0	0.0	79.9
Final Energy	55.1	415.5	210.2	0.0	0.0	158.6	8.1	0.9	848.4
of which:									
Industry	39.0	56.5	85.0	0.0	0.0	67.5	4.5	0.0	252.5
Transportation	0.1	250.0	0.2	0.0	0.0	4.1	0.0	0.0	254.4
Domestic\Tertiary	16.0	109.0	125.0	0.0	0.0	87.0	3.6	0.9	341.5

Scenario 2 - Annual Energy Balance - 2010
Mtoe

2010	Solids	Oil	Gas	Nuclear	Hydro	Electr.	Heat	Renew.	TOTAL
Domestic Production	125.0	125.0	135.0	260.0	18.0	0.0	5.4	7.1	675.5
Net Imports	274.7	441.7	192.2	0.0	0.0	3.2	0.0	0.0	911.9
Bunkers	0.0	29.1	0.0	0.0	0.0	0.0	0.0	0.0	29.1
Primary Demand	399.7	537.6	327.2	260.0	18.0	3.2	5.4	7.1	1558.3
Energy Sector	347.3	68.3	44.2	260.0	18.0	-228.3	-6.6	4.3	507.2
Total Final	52.5	469.3	283.1	0.0	0.0	231.5	12.0	2.8	1051.1
Non Energy Uses	1.5	66.3	17.9	0.0	0.0	0.0	0.0	0.0	85.6
Final Energy	51.0	403.0	265.2	0.0	0.0	231.5	12.0	2.8	965.5
of wich:									
Industry	42.0	50.0	105.0	0.0	0.0	97.5	7.0	0.0	301.5
Transportation	0.0	268.0	0.2	0.0	0.0	6.0	0.0	0.0	274.2
Domestic\Tertiary	9.0	85.0	160.0	0.0	0.0	128.0	5.0	2.8	389.8

Scenario 3 - Annual Energy Balance - 2010
Mtoe

2010	Solids	Oil	Gas	Nuclear	Hydro	Electr.	Heat	Renew.	TOTAL
Domestic Production	60.0	100.0	135.0	340.0	18.0	0.0	5.4	9.5	667.9
Net Imports	47.4	268.7	200.0	0.0	0.0	-1.1	0.0	0.0	515.0
Bunkers	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0
Primary Demand	107.4	348.7	335.0	340.0	18.0	-1.1	5.4	9.5	1162.9
Energy Sector	75.6	41.7	100.4	340.0	18.0	-177.1	-5.6	4.5	397.5
Total Final	31.8	307.0	234.6	0.0	0.0	176.0	11.0	5.0	765.4
Non Energy Uses	0.8	46.0	14.4	0.0	0.0	0.0	0.0	0.0	61.2
Final Energy	31.0	261.0	220.2	0.0	0.0	176.0	11.0	5.0	704.2
of which:									
Industry	25.0	39.0	90.0	0.0	0.0	73.0	7.0	0.0	234.0
Transportation	0.0	150.0	0.2	0.0	0.0	8.5	0.0	0.0	158.7
Domestic\Tertiary	6.0	72.0	130.0	0.0	0.0	94.5	4.0	5.0	311.5

Annex IV

Emission balances - Europe 12

Scenario 1
Annual SO_2 Emissions Balance
(1000 tonnes)

1986	Solids	Oil	Gas	Total
Energy sector of which:				
Power generation	6508	2081	21	8610
Other conversions	23	1313	39	1375
Final demand of which:				
Industry	699	1404	55	2158
Transport	0	559	0	559
Other sectors	502	794	1	1297
Total	7732	6151	116	13999

1995	Solids	Oil	Gas	Total
Energy sector of which:				
Power generation	5532	2596	22	8150
Other conversions	7	1281	0	1288
Final demand of which:				
Industry	599	1835	48	2482
Transport	0	715	0	715
Other sectors	353	689	1	1043
Total	6491	7116	71	13678

2000	Solids	Oil	Gas	Total
Energy sector of which:				
Power generation	4622	2673	20	7315
Other conversions	6	1267	0	1273
Final demand of which:				
Industry	635	1697	45	2377
Transport	0	755	0	755
Other sectors	289	624	1	914
Total	5552	7016	66	12634

2010	Solids	Oil	Gas	Total
Energy sector of which:				
Power generation	1609	983	17	2609
Other conversions	5	1064	0	1069
Final demand of which:				
Industry	745	1573	41	2359
Transport	0	802	0	802
Other sectors	236	528	1	765
Total	2595	4950	59	7604

Scenario 1
Annual NO_x Emissions Balance
(1000 tonnes)

1986	Solids	Oil	Gas	Total
Energy sector of which:				
Power generation	1894	337	165	2396
Other conversions	23	1313	39	1375
Final demand of which:				
Industry	699	1404	55	2158
Transport	0	559	0	559
Other sectors	501	794	1	1296
Total	3117	4407	260	7784

1995	Solids	Oil	Gas	Total
Energy sector of which:				
Power generation	1838	470	172	2480
Other conversions	3	347	9	359
Final demand of which:				
Industry	206	323	285	814
Transport	0	6060	0	6060
Other sectors	54	330	239	623
Total	2101	7530	705	10336

2000	Solids	Oil	Gas	Total
Energy sector of which:				
Power generation	1853	455	159	2467
Other conversions	3	343	10	356
Final demand of which:				
Industry	213	301	299	813
Transport	0	5320	0	5320
Other sectors	43	302	253	598
Total	2112	6721	721	9554

2010	Solids	Oil	Gas	Total
Energy sector of which:				
Power generation	1640	172	217	2029
Other conversions	2	320	10	332
Final demand of which:				
Industry	240	282	334	856
Transport	0	5533	0	5533
Other sectors	33	254	271	558
Total	1915	6561	832	9308

Scenario 1
Annual CO_2 Emissions Balance
(million tonnes)

1987	Solids	Oil	Gas	Total
Energy sector of which:				
Power generation	603	109	89	801
Other conversions	104	94	24	222
Final demand of which:				
Industry	168	153	188	509
Transport	1	602	0	603
Other sectors	71	322	206	599
Total	947	1280	507	2734

1995	Solids	Oil	Gas	Total
Energy sector of which:				
Power generation	704	167	102	973
Other conversions	98	103	28	229
Final demand of which:				
Industry	157	164	215	534
Transport	0	706	1	707
Other sectors	57	314	318	689
Total	1016	1454	664	3134

2000	Solids	Oil	Gas	Total
Energy sector of which:				
Power generation	837	140	117	1094
Other conversions	92	101	29	222
Final demand of which:				
Industry	156	156	224	536
Transport	0	730	1	731
Other sectors	47	284	336	667
Total	1132	1411	707	3250

2010	Solids	Oil	Gas	Total
Energy sector of which:				
Power generation	1033	63	145	1241
Other conversions	92	91	30	214
Final demand of which:				
Industry	164	150	243	557
Transport	0	751	1	752
Other sectors	38	240	360	638
Total	1327	1296	779	3402

Scenario 2
Annual CO_2 Emissions Balance
(million tonnes)

1987	Solids	Oil	Gas	Total
Energy sector of which:				
Power generation	603	109	89	801
Other conversions	104	94	24	222
Final demand of which:				
Industry	168	153	188	509
Transport	1	602	0	603
Other sectors	71	322	206	599
Total	947	1280	507	2734

1995	Solids	Oil	Gas	Total
Energy sector of which:				
Power generation	751	173	114	1038
Other conversions	101	109	30	240
Final demand of which:				
Industry	161	171	234	566
Transport	0	758	1	759
Other sectors	66	331	345	742
Total	1079	1542	724	3345

2000	Solids	Oil	Gas	Total
Energy sector of which:				
Power generation	1012	174	129	1315
Other conversions	97	113	33	243
Final demand of which:				
Industry	165	179	256	600
Transport	0	831	1	832
Other sectors	58	319	386	763
Total	1332	1616	805	3753

2010	Solids	Oil	Gas	Total
Energy sector of which:				
Power generation	1333	108	148	1589
Other conversions	98	97	36	231
Final demand of which:				
Industry	173	152	290	615
Transport	0	813	1	814
Other sectors	37	258	441	736
Total	1641	1428	916	3985

Scenario 3
Annual CO_2 Emissions Balance
(million tonnes)

1987	Solids	Oil	Gas	Total
Energy sector of which:				
Power generation	*603*	*109*	*89*	801
Other conversions	*104*	*94*	*24*	222
Final demand of which:				
Industry	*168*	*153*	*188*	509
Transport	*1*	*602*	*0*	603
Other sectors	*71*	*322*	*206*	599
Total	947	1280	507	2734

1995	Solids	Oil	Gas	Total
Energy sector of which:				
Power generation	*751*	*173*	*114*	1038
Other conversions	*101*	*109*	*30*	240
Final demand of which:				
Industry	*161*	*171*	*234*	566
Transport	*0*	*758*	*1*	759
Other sectors	*66*	*331*	*345*	742
Total	1079	1542	724	3345

2000	Solids	Oil	Gas	Total
Energy sector of which:				
Power generation	*736*	*134*	*185*	1055
Other conversions	*83*	*102*	*31*	216
Final demand of which:				
Industry	*140*	*164*	*243*	547
Transport	*0*	*728*	*1*	729
Other sectors	*47*	*309*	*358*	714
Total	1006	1437	818	3261

2010	Solids	Oil	Gas	Total
Energy sector of which:				
Power generation	*253*	*62*	*308*	623
Other conversions	*58*	*64*	*30*	152
Final demand of which:				
Industry	*103*	*118*	*248*	469
Transport	*0*	*455*	*1*	456
Other sectors	*25*	*218*	*358*	601
Total	439	917	945	2301

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The project is directed by Kevin Leydon, Head of Analyses and Forecasting Division of DG XVII.

The following persons contributed to the project:

DG XVII	J Carvalho Neto	**DG XII**	P Valette
	M Camos Grau		
	N Deimezis		
	D M Taylor	**Experts**	A Dumort (BETEP)
	M Lecloux		JF Guilmot (ESAP)
	GC Scorsoni		Y Guillaume (ULB)
	J Karman		V Detemmerman (ULB)
	W Selders		Y Smeers (UCL)
	D Lottefier		J Boucher (UCL)
	D Koch		D Gousbin (UCL)
	N Hallihan		M Grenon
	C De Meyere		R Bacon (Oxford University)
	L Palombo		
	S Reynolds.		

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