

FOIA MARKER

This is not a textual record. This is used as an administrative marker by the William J. Clinton Presidential Library Staff.

Collection/Record Group: Clinton Presidential Records
Subgroup/Office of Origin: Council of Economic Advisers
Series/Staff Member: Subject Files
Subseries:

OA/ID Number: 21609
FolderID:

Folder Title:
Europe Global Climate Change--Europe [Binder] [2]

Stack:	Row:	Section:	Shelf:	Position:
S	21	4	11	1

Commission Staff Working Paper

Climate change - Analysis of proposed EU emission reduction objectives for Kyoto

Table of Contents

1. INTRODUCTION
2. THE GENERAL FRAMEWORK
3. TRANSPORT
 - 3.1 Background
 - 3.2 Reduction potential
 - 3.3 Costs
 - 3.4 Policy instruments
 - 3.5 Other measures
4. INDUSTRY
 - 4.1 Reduction potential
 - 4.2 Costs
 - 4.3 Policy instruments
5. ENERGY INDUSTRY
 - 5.1 Reduction potential
 - 5.2 Costs
 - 5.3 Policy instruments
6. DOMESTIC AND TERTIARY SECTORS
 - 6.1 Introduction
 - 6.2 Domestic and commercial sectors - appliances
 - 6.3 Buildings
7. POWER/HEAT PRODUCTION
 - 7.1 Introduction
 - 7.2 Thermal efficiency
 - 7.3 Fuel switching
 - 7.4 Co-generation
 - 7.5 Electricity and renewables
8. RENEWABLES
 - 8.1 Reduction potential
 - 8.2 Costs
 - 8.3 Policy instruments
9. CROSS SECTORAL POLICIES
 - 9.1 Removal of fossil fuel subsidies
 - 9.2 Taxation of Energy Products
 - 9.3 Research and Development EU-Policy
 - 9.4 CO₂ emission trading in the EU
 - 9.5 Joint implementation
10. OTHER GREENHOUSE GASES
 - 10.1 Methane emissions
 - 10.2 Nitrous oxide emissions
 - 10.3 HFC, PFC and SF₆ emissions
11. OVERALL ASSESSMENT OF REDUCTION TARGET

12. OVERALL ASSESSMENT OF COSTS

12.1 Introduction

12.2 Compliance costs

12.3 Macro-economic impacts

12.4 Distribution of costs

12.5 Environmental benefits

13. CONCLUSIONS

Annex: Analysis of Costs

Commission Staff Working Paper

Climate Change - Analysis of proposed EU emission reduction objectives for Kyoto

1. INTRODUCTION

1. On 3 March 1997 the EU Council of Environment Ministers adopted a negotiating position on climate change that, *inter alia*, established a quantified emission reduction objective for inclusion in the Community's protocol proposal to the UN Framework Convention on Climate Change (UNFCCC). This proposal sets a 15% reduction of emissions for three greenhouse gases (CO₂, CH₄, N₂O) by 2010, individually or jointly, compared to 1990 for all industrialised countries that are parties to the Convention. At the 19/20 June Environment Council Ministers also agreed to include in the EU's negotiating proposal an intermediate reduction objective of at least 7.5% for 2005. The EU commitment to reduce greenhouse gases is consistent with scientific findings pointing to a discernable human influence on climate and indicating that climate change could lead to adverse ecological and socio-economic impacts.
2. This Commission Staff Working Paper analyses the potential for achieving these proposed emission reductions for the EU economy by looking at five sectors, -transport, industry, domestic and tertiary and power/heat. This is done by first, examining the available technical potential which can be realized only with additional policy measures. This part of the technical potential is what remains after the so-called base-line or autonomous reduction in intensity has been estimated and deducted. Where available, these are specified for all sectors by using bottom-up approaches which identify the disaggregated economic costs of realising the remaining available technical potential. This technical potential takes into account existing energy-efficient technology and technology which can be ready for commercialisation during the given timespan of thirteen years.
3. Secondly, proposed policies and measures or those under development for realizing the given technical potentials are listed. Measures and policies that cut across all sectors, such as fiscal ones, are also evaluated. Finally, a comprehensive assessment is made of the overall cost of achieving the EU negotiating objective by using a number of bottom-up and top-down economic models developed by the Commission.

2. THE GENERAL FRAMEWORK

4. The EU's negotiating position on quantified reduction objectives includes three greenhouse gases carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) based on a weighted total, using global warming potential (GWP) with 100 year time horizon). The Council has agreed to add the fluorocarbon gases HFC, PFC and SF₆ to the existing basket of gases by the year 2000. By far the most important of the three gases in the basket is CO₂, responsible for approximately 80 % of the impact when the gases are weighted according to their so-called "global warming potential". CO₂ emissions are also the most difficult to reduce since, unlike other emissions arising from fossil fuel use such as NO_x and SO₂, there are as yet no end of pipe solutions for CO₂. Business-as-usual scenarios for CH₄ and N₂O

indicate a likely reduction of emissions and the possibility even for a significant reduction. This implies that a cost-effective reduction of the overall emission of the three gases might include a higher reduction of CH₄ and N₂O emissions than 15 % and a lower reduction than 15 % for CO₂. However, because of the high relative weight of CO₂ it will still be necessary to achieve a reduction of CO₂ above 10% in order to meet a 15 % overall target.

5. Analysis of climate change has, therefore, generally focused on CO₂. In May of this year, the Commission adopted a Communication on the energy dimension of climate change (COM(97) 196 final) on which the Energy Council adopted conclusions on the 27 May 1997. The Commission was invited to prepare an action programme in the field of energy and climate change for the post-Kyoto period and to develop initiatives for increasing the share of renewables; the application of combined Heat and Power and for the improvement of the efficiency of products and industrial processes.
6. Current estimates indicate that energy related CO₂ emissions of the EU-15 in 1990 amounted to around 3200 Mtonnes. If estimates of CH₄ and N₂O are taken into account the CO₂ equivalent of the basket of three gases is around 3900 Mtonnes in 1990. In the absence of new policies and measures to address climate change, emissions can be expected to increase. A number of studies and models on future CO₂ developments in the EU (pre-Kyoto scenario used in the Commission's Communication - *The Energy Dimension of Climate Change*¹, continuing Commission work on a Kyoto Advanced Technology Scenario using the PRIMES + POLES and GEM - E3 analysis² and work undertaken by the University of Utrecht for the Council Ad-Hoc Group) estimate that the increase in total EU CO₂ emissions on a business-as-usual (BAU) basis - no change in policies by 2010 compared to 1990 - could be of the order of 5 to 10%. This range reflects the different assumptions used in the models. For the analysis in this Communication the pre-Kyoto scenario is used which assumes an 8% increase in total CO₂ emissions by 2010 compared to 1990.
7. CH₄ emissions, however, may drop by around 13 % to 15% in 2010 compared to 1990 with current developments (BAU) according to a Commission Communication on methane³ whereas N₂O emissions might stabilise. Taking into account the global warming potential⁴ of these two gases, this would mean that on a BAU basis overall emissions of the three gases (in CO₂ equivalents) would increase by only 5% in 2010 compared to 1990.
8. A cost-effective strategy to reduce by 2010 the global warming potential of green house gases by 15 per cent compared to 1990 requires a multi-gas approach. There are indications that on average abatement costs for reducing CO₂-equivalent emissions from CH₄ and N₂O are lower than those for CO₂. If, for practical reasons, the focus of this Paper is on CO₂ it is because the volume of emission reductions achieved with respect to this gas is crucial to the success of a comprehensive climate policy. Assuming an 8 % increase in CO₂ emission by 2010 under the pre-Kyoto scenario, the EU will need to reduce its CO₂ emissions by around 740 Mtonnes by 2010 if it is to meet its objective.
9. Table I shows, the pre-Kyoto projection in which energy related total CO₂ emissions increase by 8% from 1990 to 2010 and the sectoral distribution of this increase which will

¹ Com (97)196 final of 14.5.97.

² P. Capros, E. Kokkolakis, L. Mantzos and P. Valette (1997) Evaluation of EU Policies and Measures for Kyoto Targets. May. NTUA/CEC, Athens/Brussels.

³ Strategy Paper for reducing methane emissions (COM(96) 577 final) of 15.11.96.

⁴ GWP of 11 for CH₄ 270 for N₂O for a 100 year time horizon is used (IPCC) Scientific Assessment Climate Change 1992. The Supplementary Report; CUP, Cambridge, UK).

be used as the reference in discussing below each sector's emissions. The sectoral distribution in the table is made according to Eurostat categories. The transport sector includes all types of transport - rail, road, air and inland navigation; industry includes all branches with the exception of the energy sector; electricity and heat production covers all fossil fuel electricity production including auto-production by industry and cogeneration and district heating; the household/tertiary sector includes households, agriculture, small industry, commerce and administration etc and finally the energy industry covers internal energy use in mines and power stations and refineries. It should be noted that it is not possible to allocate the emissions in a precise sectoral basis, for instance a part of transport emissions, notably freight, could be attributed to other activities such as industry. It will be a task of the specialised services to strengthen and broaden this analysis, particularly in the light of the outcome of the Kyoto Conference in December. Following an analysis of CO₂ emissions in these sectors, possible reductions in other greenhouse gases, particularly CH₄ and N₂O, are then discussed.

Table I - Sectoral Distribution of energy-related CO₂ emissions - Mtonnes

Sector/year	1990	2010	% inc/dec
Transport	743	1032	+ 39%
Industry	626	532	- 15%
Energy Industry	141	158	+ 12%
Domestic/Tertiary	654	680	+ 4%
Electricity/Heat Production	1036	1057	+ 2%
Total emissions	3200	3459	+ 8%

Source: Pre-Kyoto scenario based on Eurostat data (Excludes international marine bunkers but includes international air transport)

3. TRANSPORT

3.1. Background

10. The transport sector which currently accounts for about 26% of total EU CO₂ emissions is expected to experience a further increase in CO₂ emissions by 2010. In the pre-Kyoto scenario, an increase of around 39% between 1990 and 2010 is predicted. This makes transport the fastest growing source of EU-wide increases in CO₂ predicted emissions over this period. The assumed 39 % increase in transport CO₂ emissions in the pre-Kyoto scenario by 2010 could be overestimated. There is evidence that before 2010 traffic growth will flatten out as traffic saturation approaches in a number of major European regions and this is not taken into account in the pre-Kyoto scenario.
11. The CO₂ growth trend for transport is mainly linked to the expected increase in traffic volumes, particularly in road and in air transport, which have a relatively high CO₂ emissions per unit of transport. In this situation, technical improvements, operational measures and a shift towards more energy-efficient transport modes, as well as transport demand management will be necessary. For measures addressing traffic volumes and the

balance between different transport modes, there can be a significant potential for "win-win" for environment and for transport.

12. Transport is to a large extent a derived demand based on commuting and industrial practices, the development of the single market and growth in tourism. If no policy action is taken, the expected economic growth and other changes in those sectors will translate into a significant expansion of freight and passenger transport services and fuel use. This must be taken into account in assessing emissions from transport.

3.2. Reduction potential

energy efficiency and passenger cars

13. Passenger cars account for about half of transport-related CO₂ emissions, and a strong growth in CO₂ emissions from cars is forecast. The Community has set the objective of an average CO₂ emission figure for new cars of 120 g/km by 2005 and at the latest by 2010.
14. If an intermediate objective of 130 g/km CO₂ were to be reached by 2005 and the final objective of 120 g/km by 2010, a reduction of around 19% in the average CO₂ emissions of the passenger car fleet can be achieved by 2010 (situation in the pre-Kyoto scenario in 2010) with normal changes in the average vehicle fleet composition. This means that the increase in CO₂ emissions from the passenger car fleet between 1990 and 2010 could be limited to 12 to 13%.
15. Overall, and with the various assumptions which have been made above, it is estimated that the measures included above have a potential for reducing CO₂ emissions from transport in the EU by about 15% (155 Mtonnes) by 2010 over the pre-Kyoto scenario. This would mean that transport CO₂ emissions would increase by about 18% by 2010 (over 1990) instead of by 39%. In quantitative terms this means an increase in CO₂ emissions of 134 Mtonnes instead of 289 Mtonnes under the pre-Kyoto scenario - a saving of around 155 Mtonnes.

common transport policy

16. A shift towards a more energy efficient transport system could, if fully implemented lead to a significant reduction in the growth rate of CO₂ emissions from transport because the measures used generally aim at removing inefficiencies in the transport system. This is particularly true for a shift from road and air to rail or combined transport. The intensification of the current policy approach aimed at achieving sustainable mobility holds, therefore, significant potential for cutting transport CO₂ emissions.
17. The Commission believes that the above policies, especially from road transport to rail and combined transport are expected to reduce CO₂ emissions by around 5% in relation to the expected emissions in 2010 under the pre-Kyoto scenario.

3.3. Costs

18. As regards passenger cars, there is a significant fuel-efficiency improvement potential in which additional costs for those improvements are likely to be more than balanced by fuel savings. The first steps in this process are likely to be at negative costs since fuel savings will more than offset the investments required for increased efficiency. However, further fuel efficiency gains will require more engineering and could, therefore, be more costly. Overall, however, the 19% reduction in CO₂ is achievable at low costs since the fuel costs

saving tend to outweigh the additional investment costs.⁵ This economic consideration needs to be reflected in the decisions on future fuel efficiency of cars.

19. The Common Transport Policy is developed for a number of policy reasons. These transport policies are aimed at improving the efficiency and accessibility of the transport system and are likely to have ancillary CO₂ benefits which are difficult to quantify. A swift implementation of the Common Transport Policy could have significant low cost benefits for reducing CO₂ emission from transport. This will also produce other benefit for society such as less congestion and noise, fewer accidents and a reduction in emissions of other gases.

3.4. Policy instruments

20. As regards emission reduction from passenger cars, one approach is to significantly increase the cost of car use through taxation measures but these would have to be substantial to achieve the full exploitation of the economic potential. The full exploitation of the existing economic potential will only be achieved by specific policies to address the manufacturers and/or the market. This will need the full implementation of all the elements of the Community strategy, i.e. an effective and ambitious agreement with the automobile industry, fiscal measures and fuel-economy labeling.⁶
21. The Community has embarked on a number of policies in the context of the Common Transport Policy over the past few years which are expected to make a significant contribution to the reduction of CO₂ emissions.
- **Revitalisation and liberalisation of the railway sector:** This policy has been pursued with a number of Council Directives⁷ which give increased managerial independence to railway undertakings, make an important step towards opening the railway market to competition and will improve the inter-operability of the European high-speed rail system. The Commission has set out the next steps in this effort with its *White Paper on a Strategy for Revitalising the Community's Railways* (COM(96) 421 final).
 - **Improved intermodality:** Special emphasis is put on rail transport and combined transport as an alternative to road and air transport, and on the interconnection of different modal networks. With its *Communication on Short Sea Shipping* (COM(95) 317 final), the Commission has launched an action programme to improve the potential of this sector. Further progress in developing combined transport for freight will be made through the development of European Rail Freight Freeways (COM(96) 421 final; COM(97) 242), and an action programme to improve intermodality as a mode-independent door-to-door service based on a variety of modal transport alternatives (COM(97) 243 final).
 - **Fair and efficient pricing:** Based on the Commission's *Green Paper on Fair and Efficient Pricing in Transport* (COM(95) 691 final), a debate has been launched on a better internalisation of the true costs, including environmental damage of transport in order to establish better patterns and future sustainability. Specifically for the reduction of CO₂ emission from cars, the Commission Communication (COM(95)689 final) discusses different options.

⁵ See: Capros et al. footnote 2 and Andrews, G., H. Kirby and M. Page (1996) Fuel consumption: Modelling Trends and the effects of technological change, Report to the Department of Transport for the Vehicle Market Model Project.

⁶ Commission Communication COM(95) 689 final; Council conclusions of 25.6.1996.

⁷ 91/440/EEC, 95/18/EC, 95/19/EC and 96/48/EC.

3.5. Other measures

22. There are also other measures which could make a significant contribution to constraining CO₂ emission growth in sectors within transport which are a major source of CO₂ emissions and/or exhibit strong growth in CO₂ emissions, i.e. urban transport, road freight transport and aviation. More specifically, integrated strategies including improved public transport, pricing instruments and other transport demand management measures in urban transport, and improved efficiency through better routing and logistics and higher loading rates in road haulage can deliver significant reductions in transport CO₂ emissions. In terms of European Support for RTD, the Commission has focussed efforts through the Task force - "The car for tomorrow". In aviation, energy efficiency improvements appear to be possible through technical and operational improvements if the appropriate incentives are given. The Commission is examining the implications of kerosene taxation for reducing CO₂ emissions from aviation and will report back to the Council in 1998.
23. In conclusion, the above analysis shows that a reduction potential of 155 Mtonnes, mainly coming from increased vehicle efficiency and modal shifts towards railways, combined transport and public transport which is not reflected in the pre-Kyoto scenario, is available.

Other measures, together with a likely flattening out of growth in traffic, could provide significant additional reduction potential, not all of this will be achieved and so only a modest reduction potential (25 Mtonnes) is estimated. This gives an estimated overall reduction potential of 180 Mtonnes from transport.

4. INDUSTRY

4.1. Reduction potential

24. Industry accounted for 626 Mtonnes of CO₂ in 1990 in the pre-Kyoto scenario, derived from direct consumption of fossil fuels, plus a share of the emissions from the use of electricity and heat from the power sector. There are uncertainties in earmarking this last element so it is difficult to establish an accurate figure for total CO₂ emissions from this sector but, given that industry accounts for over a third of EU final energy consumption, for the purpose of this analysis total CO₂ emissions from industry are estimated to be around 1150 Mtonnes.
25. CO₂ emissions of heavy industry⁸ which in this sector is a large consumer of energy are estimated to be around 570 Mtonnes (1992)⁹. Average energy efficiency improvement rates of the industries vary across sectors and between Member States. Firms in this sector have a strong interest in energy efficiency improvements since it is a major way in which to improve their competitiveness. In spite of such continuous improvements, there are a number of studies that have identified considerable technical and economic potential for further energy efficiency improvements of between 15 to 23% based on the adoption of best-practice technologies that have been used in a number of Member States across the EU¹⁰. The best example here is the Netherlands where industry, in a number of sectors

⁸ This category includes the iron and steel, non-ferrous, chemical, building materials and pulp and paper industries.

⁹ Blok and Phylipsen - Common Policies and measures for greenhouse gas emission limitation and reduction.; for Dublin Workshop, September 1996, Utrecht University, NL 1996

¹⁰ The reduction of specific energy consumption means the reduction of energy input per tonne of product

covering 90% of energy consumption, has agreed to Long-Term Agreements aimed at improving energy efficiency (reduction of energy consumption per tonne of product) by 20% over 10 years.

26. A stepping up of the rate of efficiency improvement to say 2% per annum by the adoption of such best practices, similar to those adopted in the Netherlands, may require some additional investment above normal replacement but these will often be recovered in the lifetime of the equipment through lower fuel costs. Bottom-up models based on technical economic potential, indicate that with annual efficiency improvements, reduction potential of 110 to 130 Mtonnes of CO₂ is available from heavy industry alone. These estimates probably cover the upper end of the range of emission reduction potential and a realistic assessment of the reduction potential for heavy industry would be around 80 Mtonnes of CO₂. When other industrial sectors such as cement, food production, textiles, transport equipment and engineering are included in the assessment, sectors which also have some reduction potential then a reduction potential of 100 Mtonnes of CO₂ for industry in general is not unreasonable.

4.2. Costs

27. Lifecycle analysis generally shows that the direct economic benefits of energy efficiency improvements using best technologies available in industry are often greater than the costs, i.e. the net CO₂ reduction costs are negative. This analysis is based on the assumption that there are no dramatic movements in energy prices either up or down. Further information is required on equipment costs if the least-cost technological potential is to be identified.

4.3. Policy Instruments

28. In order to achieve a reduction in emissions of 100 Mtonnes it would be necessary to have more effective policies. Industry is cautious about committing itself if the problems of "free riders" and carbon leakage - the move of industrial activities outside the EU - are not addressed. Action should be taken in co-operation with industry, in order to prevent such competitive distortions and could include:
- long-term Environmental and Energy Efficiency Agreements based on eg sectoral performance in the form of target values for products, market shares for efficient products, etc
 - the inclusion of energy efficiency among the basic obligations of industrial operators under Council Directive 96/61/EC on Integrated Pollution Prevention and Control (IPPC) and as an element in the definition of Best Available Techniques (BAT)
 - energy efficiency standards labelling and procurement guidelines for industrial and integrated processes/electric motors pump, fans compressors lighting and ventilation system and energy using components in industry. These are activities presently being carried out or being planned under the auspices of the SAVE programme.
 - the inclusion of energy, management, savings and choice in the eco-management and audit scheme (EMAS)
 - energy efficiency obligations in the new Large Combustion Plant Directive
-

- mechanism for information sharing and monitoring
 - wide implementation of Demand Side Management (DSM)
 - RTD efforts and innovative policy initiatives to ensure cleaner and more efficient technologies in the market. The Fourth RTD Framework Programme (in particular JOULE THERMIE) and the Fifth RTD Framework Programme are expected to meet these issue
 - the promotion by governments and private enterprise of financial instruments such as third party financing contracts for industry
29. There is also a need for co-ordination of some of these initiatives at the international level in order to avoid competitiveness problems, particularly for those sectors which are the most energy and carbon intensive and are export oriented. For this reason a broad commitment by industrialised countries to common policies is required.

5. ENERGY INDUSTRY

5.1. Reduction potential

30. The energy industry (refineries and energy use in mines and power stations), which accounted for only 141 Mtonnes of CO₂ in 1990, provides energy for final end-use in industry, transport and the domestic tertiary sectors. The fossil fuel consumption and emissions are, in the main, related to refineries producing fuels for the transport sector. To the extent that emissions are reduced in the transport sector through greater fuel efficiency and less fuel is needed from refineries, there would be a positive impact on emissions from the energy sector. Moreover, If there were to be some rationalisation and adjustment in this sector which is suffering from over-capacity it is likely that the more inefficient and higher emitting plants will be the ones in line for rationalisation. Although it is not possible to quantify exactly the reduction potential of rationalisation and the use of Best Practice technologies, if one takes this factor into account together with reduced demand for motor fuel compared to BAU some analysts estimate that a reduction of around 20 Mtonnes of CO₂ could be achieved from this sector. This potential could, however, be less if further reductions in the sulphur content of oil products are factored in.

5.2. Costs

31. Detailed cost estimates on emission reducing measures in the refinery sector are difficult to obtain. Some of the measures such as eliminating flaring can be achieved with simple low cost measures. Other steps that require the use of more advanced technology in the form of improved manufacturing and separation processes that use less energy will require investments and could be more costly. It is also difficult to factor in the fact that cleaner fuels, for instance, lower sulphur levels, currently require more energy at the manufacturing stage in refineries.

5.3. Policy instruments

32. In the Netherlands, for example, oil companies have entered into a voluntary agreement ensuring that, between 1989 and 2000, there will be an improvement in the energy consumption per unit of output of fuels with year 2000 specifications as compared with the

energy they would have needed back in 1989 in order to produce fuels with the same (year 2000) specifications. This agreed improvement amounts to a total of 10% for the whole of the period. This type of voluntary agreement could also be established in other Member States, particularly those where new investments are required in the short and medium term. Measures similar to those listed in section 4.3 dealing with industry could also be used to realise emission reductions from this sector.

6. DOMESTIC AND TERTIARY SECTORS

6.1. Introduction

33. This sector which covers the residential, commercial and public service sectors accounted in 1990 for approximately 650 Mtonnes of CO₂ emissions from direct fossil fuel inputs. This sector is also the largest consumer of electricity and so indirectly accounts for a large share of emissions from the power sector, estimated at 500 Mtonnes in 1990 for the purpose of this analysis. CO₂ emissions will continue to increase in this sector over the forecast period. As in the transport sector a number of studies indicate that significant reduction potentials exist with respect to domestic and tertiary sectors¹¹.

6.2. Domestic and commercial sectors - appliances

6.2.1. Reduction potential

34. Household electrical appliances account for nearly 50% of residential electricity consumption which is equivalent to over 100 Mtonnes of CO₂. The most energy efficient equipment sold can often use 50% less energy than the average stock. In the commercial sector considerable potential exists for reducing energy use with respect to office equipment, lighting, heating and cooling. As regards commercial enterprises where energy is often not a major cost input, the scope for reduction is more limited. Nevertheless, there is considerable potential for energy saving through the use of more efficient equipment such as lighting, heating and cooling and electric motors¹². Although the analysis focuses on electrical appliances there is also scope for energy saving and emission reduction by the use of more efficient appliances for cooking, heating and wash-drying using primary energy such as gas.

¹¹ Energy Efficient Office Technologies in Europe DG XVII 31/1/'94.
Megawatt power: The cost and potential of electrical efficiency Western Europe, (Energy Power in the Greenhouse.) Krause, Olivier and Koomey
GEA studies 1993/95 on energy efficiency standards for domestic refrigerators, washing machines, driers and dishwashers (DG XVII).

¹² It is estimated that there is a 30 % efficiency potential since electric motors are used in most processes. More efficient motors have the potential to save around 15 Mtonnes of CO₂ (30 TWh) in the industrial sector and 20 Mtons of CO₂ in the tertiary sector by 2010. The overall reduction potential in this sector is difficult to estimate but could be of the order of 60 Mtonnes.

6.2.2. Costs

35. The private financial return of more efficient appliances due to fuel saving is generally positive but the users are often insensitive to gains which are not directly perceptible and spread out over a long time into the future. In this context, it is necessary to act together with the manufacturers. The major difficulty here is that the perceived impact, of such energy efficiency measures on appliance manufacturers' competitiveness is often much larger than the actual economic effect as is demonstrated by discussions on efficiency standards for refrigerators. The impact of such energy efficiency measures on the overall economy is generally positive.

6.2.3. Policy instruments

36. Energy efficiency standards and labeling schemes for appliances and equipment can play an important role in meeting the EU's CO₂ reduction objective but standards set so far do not fully exploit the reduction potential. The EU has already developed a mandatory energy efficiency labeling scheme which covers the principal "white goods", and has also developed mandatory standards for refrigerators/freezers in a directive and is now in the process of negotiating agreements on energy efficiency for a more extensive product range - TVs and VCRs, personal computers, washing machines, dryers etc. A dynamic set of efficiency standards has to be adapted for all the major energy consuming domestic and commercial appliances (refrigerators, washing machines, electric water heaters, electric motors etc.) The level of efficiency has to be based on the minimum of Life Cycle Cost (LCC) analysis and should be periodically reviewed to take into account technological progress. A combination of policies and measures, including standards, labeling, technology procurement and incentives is needed to transform the markets of such efficient products. This was successfully demonstrated by the experience in the USA. The potential for reduction in CO₂ from more efficient standards can be realised if more effective policy mechanisms are implemented such as
- establishment of dynamic efficiency standards/based on Life Cycle Cost analysis either through regulation or negotiated agreement
 - technology procurement for energy-efficient products
 - favourable legislative framework for utilities to carry out demand-side management programmes as foreseen by the proposed Rational Planning Techniques Directive
 - information programmes and dissemination of best practice and best available technologies
 - additional RTD efforts focussing on renewable energy resources, especially windpower, biomass and hydropower as described in chapter 8.
37. Moreover, appropriate measures, including the alteration of fiscal instruments, will have to be considered in case the forthcoming deregulation of the electricity industry jeopardises an effective climate policy.

6.3. Buildings

6.3.1. Reduction potential

38. Energy use in the residential and commercial sectors, in particular for space heating and hot water, accounts for around 30% of all energy use in the Union. Energy use for space heating and water heating in residential housing and commercial buildings can be substantially reduced with state of the art techniques such as high efficiency windows; improved insulation, heat pumps and passive solar energy, thereby reducing emissions from this sector by at least 50%. In the KATren analysis, savings of around 41 Mtonnes of CO₂ are estimated as possible in the period up to 2010.

6.3.2 Costs

39. As regards improvements of energy efficiency in existing buildings such as through improved insulation, better regulated boilers, double glazing, the capital costs are more than offset by savings in fuel even with increases in comfort levels. Other improvements such as improved efficiency standards in new buildings and high performance boilers can be more costly but even these investments also have attractive pay back periods.

6.3.3 Policy instruments

40. However, given the low natural rate of turnover in the building stock, 1% per annum in the EU, new policy initiatives are required that could accelerate the process of improving energy efficiency in buildings through renovation schemes. Such energy efficiency improvements which on their own could in some cases prove costly could be done in the framework of general upgrading of building stock which aim at improving overall building standards which currently do not fully exploit the reduction potential. At Community level these could include
- implementation of SAVE Directive 93/76 EEC which requires Member States' programmes for the promotion and implementation of energy certification in buildings, individual metering of energy and hot water consumption, third party financing in the public sector, thermal insulation of new buildings, regular inspection of boilers larger than 15 kw. and energy audits in industry
 - incentives for installation of cost effective energy equipment and material in buildings
 - development of codes and standards in lighting, HVAC, hot-water heating and other important energy use in buildings
 - developing links between land planning and the promotion of CHP
 - financial/fiscal incentives.
 - additional RTD actions
 - promotion of energy service companies in building sector
 - development of planning technologies for the promotion of CHP, district heating and other energy efficient and environmentally friendly heating and cooling systems.
41. In conclusion, studies show that a significant reduction potential exists for electricity use in the domestic and tertiary sector which amounts to around 180 Mtonnes of CO₂ emission reduction. There is also considerable potential in the building sector and in the direct use of fossil fuels by the domestic and tertiary sectors. If other end users, such as small and medium-sized industry, agriculture and the public sector, are included, the total reduction potential is well over 200 Mtonnes of CO₂. The whole of the reduction potential is unlikely to be fully exploited in the 2010 perspective but assuming only 50 % of the potential is realised this would lead to at least a saving of 100 Mtonnes of CO₂. There are well documented studies that show that most energy saving measures are economically attractive at current energy prices (negative costs) and others are low cost. Policy instruments that could achieve a speedy improvement in energy efficiency need to focus on removing the barriers identified in these studies and on strengthening incentives. In this context there would also be scope for developing a comprehensive approach to promote sustainable consumption patterns. To facilitate such a reorientation of consumer behaviour and choice, it is necessary to promote consumer awareness and to provide them with appropriate education, reliable information and advice

7. POWER/HEAT PRODUCTION

7.1. Introduction

42. CO₂ emissions from the electricity/power sector accounted for almost a third of EU CO₂ emissions in 1990. "In the pre-Kyoto scenario, growing electricity and heat demand gives rise to increasing CO₂ emissions from the power generation sector. However, CO₂ growth in this sector is smaller than the average growth of emissions of all sectors. This is due to fuel switching, improvements in the efficiency of electricity and heat generation and to some extent a decoupling of electricity and heat demand from GDP growth. Nevertheless, in 2010 electricity and heat production could still account for some 30% of total energy related CO₂ emissions. Although it is recognised that the EU negotiating position for Kyoto requires a significant contribution from power and heat generation, the increasing role of electricity for modern production and communication processes needs to be taken into account. Increasing electricity use can be compatible with overall CO₂ emission reduction to the extent that this helps decrease the material and energy intensity of economic activities eg electric arc steelmaking . If the EU reduction objective is to be achieved it is evident that this sector will have to make a significant contribution.
43. As indicated above in the sections on industry and the domestic/tertiary sector one of the most effective ways in which to reduce CO₂ emissions from the power sector is to reduce end-use electricity demand. The electricity industry can play an important role here by developing energy services and demand management options. In an increasingly competitive market, firms in this sector may find such options a profitable way of developing business. A major factor in the reduction of greenhouse gas emissions from the power sector will be the implications of competitive and liberalised energy markets in the Union.
44. Additional reductions of CO₂ emissions in this sector can also be achieved by actions on the supply side supporting, notably
- higher average thermal efficiencies in power generation
 - fuel switching leading to a lower level of carbon intensity in fuel inputs
 - co-generation of power and heat
 - greater use of renewables in electricity generation

7.2. Thermal efficiency

7.2.1. Reduction potential

45. Some of the potential arising from fuel switching, higher average thermal efficiencies and co-generation is already included in the pre-Kyoto scenario, which explains the expected low increase in CO₂ emissions from the power sector between 1990 to 2010. However, there still remains considerable technical reduction potential in this sector.
46. In a increasingly competitive and liberalised energy market there are pressures on the industry to reduce costs and maximise efficiency on the supply side which could bring benefits for reductions in CO₂. For the EU as a whole due to improvements in load efficiency and changes in the fuel mix (greater use of gas and an increasing penetration of combined cycle gas turbine (CCGT) production) the average thermal efficiency has been pushed up from around 36 % to 38 % between 1985 and 1994. This means that many power plants are currently operating at below 38% efficiency which is low compared to state of the art technologies.

47. In the pre-Kyoto scenario average thermal efficiency of fossil based power plants is expected to increase to over 41% by 2010. The substitution of old plants that have a low efficiency and high CO₂ emissions by new power plants with thermal efficiencies of around 50 % could significantly boost the average thermal efficiency of power plant in the EU even further. This has been the case in the UK which between 1990 and 1995 succeeded in achieving a much higher thermal efficiency and significantly reducing CO₂ emissions from power generation due to a switch to gas away from coal and with new efficient generating technologies such as CCGT plants and co-generation. An average thermal efficiency of 45% in the EU by 2010 is achievable and is estimated that this could save around 50 Mtonnes of CO₂¹³. This saving has to be seen in conjunction with the future development of co-generation in the EU which is analysed in section 7.4 below.

7.2.2. Costs

48. New power generation, depending on the availability of gas, is likely to be in the form of CCGT gas fired plants which have a capital cost per Kw of around half that of conventional plants. Achieving higher thermal efficiencies in existing plants through retrofitting or accelerating the retirement of less efficient fossil fired fuel power plants could be more costly. However, it should be noted that in the UK power producers have been able to reduce electricity prices to industrial customers over the last five years even though the industry has scrapped plant earlier than anticipated or invested to improve the efficiency of many existing coal-fired power plants. As well as benefits from reduced CO₂ emissions these developments have also brought other benefits in particular a reduction in acidifying pollutants.

7.2.3. Policy Instruments

49. The Commission should encourage in its dialogue with the industry, *inter alia*, the development and the introduction of the most efficient technologies so as to ensure that the level of thermal efficiency is substantially increased in the period to 2010. Negotiated agreements or other mechanisms need to be explored in the on-going dialogue with the electricity industry that would for instance aim at obtaining certain minimum levels of thermal efficiency by 2010. RTD efforts also need to be pursued taking into consideration both competitiveness and CO₂ emission reduction objectives.

7.3. Fuel switching

7.3.1. Reduction potential

50. Fuel switching in the power sector to lower carbon intensity fuels in the perspective of 2010 involves essentially switching from coal to gas. Nuclear produces about a third of the EU's electricity is not considered since major increases in nuclear capacity are not foreseen up to 2010. This situation will have to be reviewed in the post- 2010 period as existing nuclear power plants come due for replacement. Currently around two thirds of the fuel supply of thermal power stations comes from solid fuels with oil and gas accounting for around 15% and 17% respectively. According to the pre-Kyoto scenario the share of gas in this sector could increase to around 31% by 2010 particularly given the framework of increasing competition in both the electricity and gas sectors in the EU which gives power generators the option to switch from coal to gas using in many cases gas fired combined cycle technology which has a much greater efficiency than existing conventional thermal power stations. A significant element of fuel switching is already incorporated into the pre-Kyoto scenario with the factoring in of an important element of co-generation, however, it

¹³ OECD coal fired power generation-trends in the 1990s. - IEA coal research (IEAPER/33, April 1997).

is estimated that an additional reduction potential of 50 Mtonnes of CO₂ is available from this switch in conjunction with increased use of CHP in particular for district heating and increased use of gas in industrial sectors.

7.3.2. Costs

51. The switch to gas from other fossil fuels will in the main develop because the economies of increased gas use, particularly in power generation is more attractive. The availability of competitively priced gas in Europe in the near future taken together with liberalisation of gas systems is likely to produce a gas price that will ensure the growing role of gas in most new power system investments. The development of Trans European Networks (TEN's) for gas will be facilitated in certain Member States by the use of EU financial instruments.

7.3.3. Policy instruments

52. In order to help achieve an even greater penetration of gas the EU should develop the gas infrastructure in the EU through the TEN programmes and secure competition into the gas industry.

7.4. Cogeneration

7.4.1. Reduction potential

53. Co-generation - the production of both electricity and heat (CHP) - accounts for around 10% of EU electricity production, although in three Member States it is already around 30%. Combined cycle technology can produce electricity with an efficiency of about 55% and by using also the heat, efficiencies of up to 80% can be secured. In order to secure the full energy efficiency benefits, the starting point should be the heat demand so that the electricity becomes the by-product. If co-generation were to take a larger share of the EU electricity market, large savings in CO₂ would be possible. It has been estimated that if CHP achieved a 30% share up to 290 Mtonnes of CO₂ would be saved. Part of this reduction has been factored into the pre-Kyoto scenario but a substantial potential still remains to be developed if an EU average of 30% were to be achieved. Since this would probably be based on gas it would include some of the benefits from fuel switching mentioned above. However, even on a conservative estimate of an increase from 9% to 18% of co-generations share in electricity production by 2010, it would produce an additional saving of around 100 Mtonnes of CO₂.

7.4.2. Costs

54. For industrial cogeneration preliminary research indicates that for baseload power production and taking all costs into account a 75 MWe industrial CHP plant would produce electricity at a unit cost around 40% below the unit cost of a 500 MWe coal plant. The cost differential is smaller when comparing CHP with CCGT generating plant, but it is still in CHP's favour by about 10 % to 20 %. Overall, it is reasonable to assume that industrial co-generation is a low-cost option in reducing CO₂ emissions in a more liberalised market where prices reflect costs. Co-generation linked with district heating is likely to be more expensive due to the investments required, although in this category decentralised systems are more economic than centralised systems

7.4.3. Policy instruments

55. To date co-generation has not been able to make more rapid progress due to a number of technical and institutional barriers, particularly as regards tariffs. It is essential, therefore, that in developing the regulatory regime for a more liberalised and competitive electricity market fair rules encouraging co-generation are developed.¹⁴ A Communication from the Commission on a EU strategy to promote co-generation is now in the final stages of preparation. Some extended RTD efforts need to be developed for example in the JOULE-THERMIE Programme.

7.5. Electricity and renewables

7.5.1. Reduction potential

56. The Commission in its Green Paper - *Energy for the Future. Renewable Sources of Energy*¹⁵ has taken the view that the doubling of renewable energy sources from 6% to 12% by 2010 is a realistic objective. If through the more rapid penetration of windpower and biomass, which are now close to being competitive with electricity generation from fossil fuels, half of this increase in renewables (3%) was in electricity production then this would increase renewable production by around 90 TWH in 2010. If electricity production from renewables displaces the most inefficient plants, which are likely to be conventional coal fired power plants, the saving in CO₂ emissions could at least be 100 Mtonnes. In a longer perspective, renewables would, however, find it more difficult to compete with state of the art CCGT power plants.

7.5.2. Costs

57. Forecasts for costs of electricity from centralised and decentralised renewable energy technologies show that wind, small hydro and biomass, including waste, are competitive with conventional systems¹⁶. The rapid development of renewable energy technologies and the prospect for further cost reduction, so that they can compete even with electricity production from CCGT power plants, will ensure that the cost of support measures, if required, will be small if they are well designed.

7.5.3. Policy instruments

58. The penetration of competitive or near competitive renewables into the energy sector depends a great deal on the development of Community instruments. This is possible through the use of instruments such as carbon taxes, emission trading integrated resource planning and demand side management mechanisms and negotiated agreements¹⁷. This option can be expected to lead to significant cost savings and are in line with electricity market liberalisation since they give the sector the choice to pick the most cost-effective set of measures. These options should also ensure that the emission reduction objectives are met if appropriate monitoring and enforcement mechanisms are set up. The potential applicability and positive cost/benefit analysis of small-scale heat and power production

¹⁴ An assessment of the impact of liberalisation of the European Electricity and Gas Market on Cogeneration, Energy Efficiency and the Environment. Cogen Europe, December 1996

¹⁵ COM(96) 576 of 20 November 1996

¹⁶ The European Renewable Energy Study II - Prospects for Renewable Energy in 30 European countries 1995-2020 - DG XVII, 1996.

¹⁷ The Commission has proposed a Directive related to Integrated Resources Planning

from biomass should also be encouraged through Community instruments. European RTD efforts are already linked to these issues but should be reinforced.

59. In conclusion, the analysis shows that power generating industry has a reduction potential of at least 300 Mtonnes of CO₂ which can be achieved at low cost. However, the realisation of this potential is highly dependent on policies, in particular the progressive liberalisation of the electricity and gas systems.

8. RENEWABLES

8.1. Reduction potential

60. Renewable energy resources which currently only play a small role in the EU's energy system have the potential to make a significant contribution to reducing the Community's CO₂ emissions since they use energy resources that release relatively little carbon in net terms. The stocks of some renewables, such as forests and forest products, can also act as carbon sinks if they increase. The Community has a forest strategy which includes measures to enlarge the forest area and vitalise forests thereby enhancing their ability to assimilate CO₂. Some indication has been given above of the contribution renewables could make to reducing emissions from the electricity sector. Renewables can also make an important contribution to other Community goals such as regional development and employment since most renewables are by definition local energies, they are often more labour intensive than technologies based on conventional technologies and many less developed regions in the Community have considerable potential for the development of renewables.
61. Some of these renewable energies, such as hydro, biomass and wind, are already well-developed in some of the Member States. Hydropower and biomass currently account for 96% of renewable energy production. However, in spite of the development of appropriate and well-developed technologies that in some areas are cost-competitive, (for instance, wind and biomass for electricity, solar energy for water heating), the current share of renewable energies in the Community's total primary energy consumption is only around 6% due in the main to the existence of a number of market and structural barriers.
62. The Commission in its recent Green Paper on a strategy to increase the penetration of renewables in the Community market argues that their share of gross inland energy consumption can be doubled to 12% by 2010 if these barriers can be overcome and if, in some cases, assistance is given to kick-start these technologies. It is estimated that this doubling of renewables in the EU would represent a saving of around 200 Mtonnes of CO₂. If a Best Practices approach, as advocated in the TERES II report, was followed a reduction of 500 Mtonnes of CO₂ would be possible, albeit by 2020.

8.2. Costs

63. Cost estimates of renewable technologies vary widely due to different assumptions made in calculations and the form of final energy delivered by the renewable energy. Some renewable energies such as wind and biomass for electricity have made remarkable advances in reducing costs and are now competitive with conventional power production. Other renewables such as photovoltaics or biomass for biofuels still have to make progress in becoming competitive and may not develop substantially before 2010, however, for small scale decentralized applications they may still be as cheap as conventional options. It

is likely that even a substantial penetration of the most cost effective renewables by 2010, such as a doubling of their share in EU gross inland energy consumption, would entail some costs.

8.3. Policy Instruments

64. The Commission's Green paper on renewables has indicated that a doubling of the share of renewables in the EU (to 12%) will require the development of strong policies and measures. A forthcoming White paper, planned for publication before the year-end, will set out the Commission's policy direction for the future development of renewables, together with a comprehensive and detailed action plan. Recent studies¹⁸ have identified numerous policy mechanisms that could be effective for promoting renewables in a liberalised internal energy market such as
- obligations for renewable energy
 - mechanisms for increasing payments for renewables such as the UK Non-Fossil Fuel Obligation (NFFO), renewable energy credits
 - uniform minimum buy back tariffs for renewable energy supplies
 - an increased focus of RTD programmes and resources on renewable energy technologies and particularly their rapid penetration
 - financial engineering to favour renewable energy.
65. In conclusion, section 7.5 on electricity and renewables has already identified that there is at least 100 Mtonnes of reduction potential available in this sector. Wider use of biomass in co-generation and passive solar heating could also make a significant contribution and overall for renewables a 200 Mtonnes of CO₂ reduction potential is estimated. Provided appropriate policies are pursued, the cost of some support measures is unlikely to be large.

9. CROSS SECTORAL POLICIES

9.1. Removal of fossil fuel subsidies

66. Reforming coal and electricity subsidies in the EU can have beneficial impacts for the environment as well the economy as a whole¹⁹. Although the impacts depend heavily on national circumstances A study estimated the decrease in CO₂ emission resulting from the removal of subsidies at 100 Mtonnes CO₂ in 2010. Such reforms some of which are now in place are expected to lead to positive overall economic effects, although there could be some adjustment costs for other sectors. Proposed EU action in this field could consist of ensuring that the measures in place to phase out subsidies that run counter to a cost-effective climate strategy and which create unfair competition are implemented and wherever possible the subsidies are phased out more quickly. In conclusion, removing energy subsidies has a potential for emission reductions. Some of this potential is already

¹⁸ Renewable Energy Strategies for Europe, Vol II M. Grubb and R. Vigotti (RIIA- 1997)
Future support of renewable energy in the UK - options and merits C. Mitchell -Energy and Environment ,Vol. 7, No.3 (1996)

¹⁹ Reforming Coal and Electricity Subsidies. Working Paper Z. Laurie Michaelis OECD July 1996.

included in the reduction potential of the power sector and so to avoid double counting it is not included as a specific item in the overall assessment

67. The monetary equivalent of the subsidies to fossil fuels is estimated at around 9.7 bn Ecu (av 1990-1995) for Germany, UK, and Spain. This is equivalent to 0.1% of the EU's GDP in 2010. As regards the removal of subsidies from coal, account is not taken here of the reduction in methane emissions which could be significant as a result of the decline in deep mined coal production.

9.2. Taxation of Energy Products

68. On 12 March 1997, the Commission adopted a proposal for a Council Directive restructuring the Community framework for the taxation of energy products (COM (97)30). The new proposal enlarges the scope of the Community minimum rate system beyond mineral oils - to cover all energy products, including mineral oils, natural gas and solid fuels and electricity. The main objective is to strengthen the internal market by eliminating distortions between different types of fuels. In addition, it encourages Member States to shift the burden of taxation away from employed labour and towards the use of natural resources which damage the environment.²⁰
69. Even though the proposal has internal market aspects as its driving force it also takes account of environmental policy objectives. Firstly, the expansion of the scope will widen the application of the Community taxation provisions to CO₂ emitting products from 40% to nearly 90%. Under the new proposal the Community minimum levels of taxation on mineral oils (agreed in 1992 and therefore in many cases substantially below the rates applied by Member States) are up-rated and minimum levels are introduced for other energy products than mineral oils. The proposed increases in minimum rates are spread out over a period of four years. In order not to harm the competitiveness of European firms, the proposal contains some mandatory and optional exemptions for energy intensive industries. However, all users (polluters) pay something since exemptions for energy intensive firms only apply to the amount of the tax that exceeds 1% of their sales value.
70. Secondly, the proposal supports Member States if they wish to pursue more ambitious environmental policies. Member States are free to apply taxes on CO₂ emission or other emissions, taxes on energy or excise duties in order to fulfill the minimum level of taxation. The proposal also enables Member States to use differential levels of taxation depending on the environmental quality of products. In addition Member States may also rebate some or all of the tax on electricity generated from renewable sources such as solar, wind, tidal and geothermal or apply exemptions and reductions for various forms of transport.
71. In conclusion the analysis suggests that the proposal will result in a reduction in CO₂ emissions by 0.5% to 1.7% from the year 2002 onwards compared to the pre-Kyoto scenario. The study that is consistent with the pre-Kyoto scenario points to a reduction - equivalent to - around 50 Mtonnes CO₂ in 2010.
72. Estimates on the macro-economic costs of the proposed Directive made by three separate models confirm that when the tax revenues are used in a budget neutral way to reduce

²⁰ White Paper "Growth, Competitiveness, Employment", and more recently in the Commission's "Confidence Pact for Employment" (1995) and the fiscal strategy presented in October 1996 (COM(96)546 of 22.10.96) and endorsed by the European Council in Dublin in December 1996.

employers non-wage costs, the proposal will have positive impacts on GDP and employment. For the EU as a whole, GDP is estimated to be 0.02% to 0.20% higher than without the proposal in the year 2005. Overall employment in the EU is expected to be 150.000 to 450.000 persons higher in the same period.

73. Previous studies on the 1992 tax proposal suggested that more significant reductions in CO₂ emissions of 9 to 10% (around 350 Mtonnes of CO₂), compared to the pre-Kyoto scenario, are indeed achievable and could have more significant positive impacts on employment (0.4 to 0.9%) and GDP (+0.14% to 1.0%) if the revenues are recycled and used to reduce social security contributions. Other options such as non-recycling, reducing VAT or income taxes could lead to a small decrease in GDP (-0.1 to -1.2%) and employment (-0.3 to 0.8%).

9.2.3. Policy instruments

74. Approval of the proposal to the Council will have both positive effects on the EU climate policy and other policy objectives. Moreover, a further proposal to deal with the situation in 2002 and beyond will have to be made which could make a more significant contribution to the climate objective.

9.3. EU-Policy in the Field of Research and Technological Development (RTD)

9.3.1. Reduction potential

75. The EU RTD Framework programme, the overall EU RTD policy instruments, contributes substantially to other Community policies and in particular to the Environment policy. The provision of the scientific and technological bases needed to support sustainable development and environmental protection is mentioned among the major overall scientific and technological objectives of the Fourth Framework programme (1994-98). These objectives are spelled out in more detail across the different specific programmes through which the Framework programme is implemented, in particular in the programmes on Environment and climate, Non-nuclear energy (Joule-Thermie), Industrial and materials technologies, transport and agriculture (FAIR). In order to complement the expertise available within the Union, these objectives were also taken into account in the Copernicus Programme for research cooperation with Central and Eastern Europe and in the INCO-DC Programme for research cooperation with Developing Countries. The Framework Programme addresses especially the Climate Change issue at three levels.
76. In addition to the Framework RTD programme, two other programmes important in the area of realizing reduction potential are the five-year programmes SAVE II and ALTENER. These non-technological programmes are multi-sectoral, and are designed to promote the rational use of energy and renewable energy, respectively. The purpose of the programmes is to create an environment in which investments in energy efficiency and renewables will be accelerated and whereby they will be recognised as market opportunities. ALTENER is the only Community programme which focuses exclusively on renewable energy sources.

9.3.2. Costs

77. The Fourth Framework programme represents a maximum overall amount of 13.1 billions Ecu, of which Ecu 914 millions are allocated to research in Environment and climate, Ecu 1067 millions to Joule-Thermie, Ecu 1833 millions to Industrial and materials technologies and Ecu 263 millions to transport. SAVE II which runs until the end of 2000 has an

indicative budget of 45 MEcu. ALTENER I which concludes at the end of 1997 has a budget of 43.5 MEcu.

9.3.3. Policy Instruments

78. This important contribution from the Fourth Framework programme will be confirmed and extended in the Fifth Framework programme (1998-2002) for which the Commission presented its proposal on 30.4.1997. An overall amount of Ecu 16.3 billions is proposed for three major themes and three horizontal actions. Climate change and other environment related issues are not only substantially covered under the first theme "Unlocking the resources of the living world and the ecosystem" but are also widely taken into account throughout the proposal, in particular under the key-action advanced energy systems and services of the third theme "Competitiveness and sustainable growth". The preservation of the environment is set out as one of the fundamental criteria for selection of priority research areas." SAVE I has for similar reasons been extended for an additional five years in the form of SAVE II after evaluations showed that this relatively small programme in terms of overall budget has had an important effect on general energy policy implementation by Member States. This effect has been the result of directives and of capacity building at national and regional level related to energy efficiency, obtained through pilot projects, studies and network-building. ALTENER II has been proposed with a budget of 30 MEcu for two years to renew ALTENER as it has been shown to play an important role in promoting renewable energy sources in the Community.

9.4 CO₂ emission trading in the EU

79. The analysis has shown that the EU reduction objective for 2010 can be achieved at a acceptable cost with sensible policies and measures. If marginal costs substantially differ then consideration could be given to implementing future CO₂ emissions targets by an emission trading mechanism. The feasibility of an EU wide CO₂ emission trading scheme has been documented in a number of studies²¹. Such a scheme within the EU could be implemented either between firms or between Member States; only emission trading between firms is considered here.
80. The potential cost savings could be significant, especially as policy targets become more stringent. Emission trading schemes within the EU would enable firms with high abatement costs to buy CO₂ abatement obligations from firms with lower marginal costs. By doing so the EU target could be achieved at lower overall cost than only through sectoral policy measures. supplementary to domestic reduction, and would be introduced in sectors in which no policies and measures are foreseen.
81. A EU bubble for various sectors within which individual firms would trade would have to be limited to sectors with a small number of companies to keep transaction costs low. If the scheme were limited to power/heat generation and heavy industry within EU it could cover approximately 50% of current CO₂ emissions in the EU.
82. There are also questions which need to be resolved related to the method of allocating initial quotas and the implications for the EU internal target sharing differentiation and to the monitoring and enforcement of compliance. Furthermore, we need to bear in mind how

²¹ See, for instance, Heister, J. et al. (1992), The use of tradable emission permits for limiting CO₂ emissions, in European Economy, The economics of limiting CO₂ emissions, Special edition N 1 or Grubb, M. et al. (1997), Implementing the European CO₂ Commitment - A Joint Policy Proposal, The Royal Institute of International Affairs, London, 2nd edition

an EU emission trading system could be combined with an eventual international emission trading system or a Joint Implementation scheme.

9.5. Joint implementation

83. The European Union Proposal for a Protocol contains a provision for Joint Implementation (JI). This would allow industrialised country parties, in order to contribute to implementing their reduction objective, to undertake concrete projects with each other and with other parties which have made a notification of their intention to be bound by commitments on emission limitation and reduction objectives. This means that one party can take over part of the emission reduction obligation of another party. The EU proposal sees JI only covering a modest part of the commitments made by industrial countries.
84. JI projects offer the possibility to achieve emission reductions at lower costs through investing in emissions mitigation measures in a country with lower marginal abatement costs²². A number of pilot projects are underway and some of the host countries are Associated countries, an example is the upgrading of the municipal heating system in the City of Decin in the Czech Republic through energy efficiency improvements and boiler conversion financed by Denmark and the U.S.A. The EU position is that JI projects should supplement domestic policies and measures which should provide the main contribution to the overall reduction target of a Party, and shall bring about real, measurable and long term environmental benefits related to the mitigation of climate change. They shall be assessed on a project basis and credits shall be allocated on an annual basis.
85. In carrying out JI projects a set of agreed rules have to be applied. Guide-lines need to be developed and agreed upon on matters such as calculating project baselines, incremental impact of a project on emission levels, and methods for monitoring and verification²³.
86. The potential contribution of JI depends on the differences in abatement costs between the EU and other Parties to the Convention. They also depend on the transaction costs: costs of finding partners, agreeing and obtaining approval. Recent work with the POLES model show that an additional reduction in 2010 of around 200 Mtonnes CO₂ in Associated Countries below the baseline would be cost-effective to achieve a 15% reduction in CO₂ emissions compared to 1990 jointly with the EU-15. This would reduce the costs by 40% from 30 bn down to 18 bn Ecu.
87. More significant reductions in costs could be feasible through JI with the CIS countries but would depend strongly on the assumed baseline.
88. In order to ensure transparency and verification of compliance with the Community reduction commitment a central monitoring of JI projects will be needed. The Commission suggests that this will be done through the existing monitoring mechanism and will propose, if necessary, an appropriate amendment to the Council Decision establishing a Monitoring Mechanism for CO₂ and other greenhouse gas emissions²⁴.
89. The rules for JI should be as clear and simple as possible so as to reduce transaction costs while still guaranteeing that the environmental objectives are met. This can be promoted by

²² See the conclusion of the Workshop "Differentiation, Joint Implementation and Tradable Permits" DG XII, Brussels 3-4 July 1997

²³ A Research Project on these issues "Accounting and accreditation of Activities Implemented and Jointly under the FCCC and Oslo Protocol" is currently being undertaken within the EC RTD Programme on environment and climate

²⁴ Council Decision 93/389/EEC

having clear and transparent ruled for approving JI projects. JI can also be stimulated by allocating a ceiling for emissions up front to specific sectors and individual companies, as is the case in the USA emission trading program for sulphur dioxide, so as to reduce discussions on the baseline for emissions on a project by project basis.

90. A more developed JI mechanism could be of particular interest to the Associated countries since it could provide better access to financial resources that could help them to realise strategic objectives in the development of their infrastructures, especially in the electricity and transport sectors while at the same creating more flexibility for the EU in shaping its pre-accession aid.
91. A certain amount of the Community reduction commitment under the Protocol could be achieved through JI projects provided progress can be made in meeting the concerns mentioned above but this might constitute only a small part of the overall EU effort for 2010.

10. OTHER GREENHOUSE GASES

10.1. Methane emissions

10.1.1. Reduction potential

92. **Methane** is the second most important greenhouse gas in the EU basket. In 1990 agriculture accounted for 45 %, waste 32 % and energy 23 % of EU methane emissions. Calculations, referred to in the Commission's Communication on methane (COM (96) 557), indicate that in 2010 compared to 1990 a reduction of methane emissions of up to 13% to 15% is feasible with current policies. A reduction of 40% over the same period is estimated to be the maximum technically feasible assuming that significant policy changes are made.

10.1.2. Costs

93. The costs of this extra 25% reduction of CH₄ (from around 15% to around 40%), equivalent to around 100 Mtonnes of CO₂, can be estimated at around 20 to 30 Ecu/tonne of CO₂ equivalent reduced which gives an annual cost of around 2bn Ecu to 3bn Ecu. However, this additional 25% (see COM(96) 557 final) methane reduction may allow CO₂ to be reduced by 12% instead of 15%. It should be noted that this additional 25% reduction assumes a 60% reduction of methane emissions in the waste sector and reductions of 34% in agriculture and energy. As far as agriculture is concerned, further analysis is required to ensure that only measures are pursued that are technically feasible, politically acceptable and consistent with other policy objectives. It is therefore uncertain, how much of the reduction potential of methane above 15 % will actually take place.

10.1.3. Policy instruments

94. Policy measures aiming at improved treatment of waste, methane recovery in new and existing landfills, best available recovery techniques in coal mines, minimising emissions in the production on-shore and off-shore of oil and natural gas and minimum leakage standards and more frequent control of gas pipelines need to be pursued. For agriculture, a better storage and treatment of animal manure is a promising option and there is a need for analysing how the Common Agriculture Policy (CAP) and Rural Development policies can

assist such a development, for example, in the form of incentives or investment aid for covered manure storage combined with biogas utilisation, notably at larger intensive animal production units. Research into the possibilities for improved feeding of animals should also be encouraged in the Community's agricultural research programme.

10.2. Nitrous Oxide emissions

10.2.1. Reduction potential

95. Emissions of N₂O in 1990 amounted to 0.9 Mtonnes, equivalent to around 300 Mtonnes of CO₂²⁵. Reductions in N₂O emissions from industry, in particular the nylon producing sector, which accounts for a third of total N₂O emissions can lead to a reduction of 30% in N₂O emissions in the year 2010.²⁶ N₂O emissions from energy use (power stations) will remain stable up to 2010 since most new power plants are likely to be gas fired and the lower N₂O emissions from such plants will more than offset the growth in electricity production. N₂O emissions from agriculture are estimated to fall due to reduced fertilizer use and this trend should be further assisted by enhancing the agri-environmental component of the CAP in the context of Agenda 2000. The reductions in these sectors will more than offset increases in N₂O from transport due to catalytic converters. Consequently, estimated reductions in N₂O could be between 70 to 95 Mtonnes of CO₂ (equivalent).

10.2.2. Costs

96. A 15 % reduction of N₂O (0.285 Mtonnes) could cost around 120 Ecu/ton of N₂O or 0.45 Ecu/ton of CO₂ equivalent, in total 0.03 bn Ecu,²⁷

10.2.3. Policy Instruments

- 97 As regards emissions from industry, steps can be taken to ensure that agreements cover all producers. In agriculture, increased support should be given to environmentally friendly farming practices, such as best practice in fertiliser use. Intensified research in the energy sector to reduce N₂O emissions from fluidised bed combustion and improve catalytic technology is required.

10.3. HFC, PFC and SF₆ emissions

98. Information on these gases is more uncertain than on the previous gases. However, in the Community's negotiating position there is a commitment to develop policies and measures to reduce emissions of these gases. In the work of the ad hoc Council Group a reduction potential equivalent to 200 Mtonnes for CO₂ has been identified.

11. OVERALL ASSESSMENT OF REDUCTION TARGET

²⁵

AEA Interim Report for the Commission on Emission Inventories

²⁶

First Synthesis report of Common Policies and Measures, Expert Group, 27th January 1997

²⁷

Cost Effectiveness of emission reducing measures for nitrous oxides in the Netherlands. D. Jager, K. Blok and M. Van Brummelen. Ecotys, Utrecht, May 1996

99. Table II gives estimates of the potential CO₂ emission reductions possibilities for the main sectors in the EU. It is estimated that there are CO₂ emission reduction possibilities of around 300 Mtonnes in the power sector, 180 Mtonnes in transport, 200 Mtonnes from the end user sectors and 100 Mtonnes from renewables. A larger reduction potential exists, but it may be more difficult to exploit in the 2010 time-scale. About 50 Mtonnes of this overall CO₂ reduction is expected to be achieved as a result of the acceptance of the Commission proposal for a Council Directive restructuring the Community framework for the taxation of energy products (COM (97)30). The quantities reflect the implementation of a series of policies and measures that have been referred to in this Working Paper. For each sub-sector, the reduction that is achievable depends on the detailed formulation of the measures.

Table II - Estimates of possible potential CO₂ emission reductions (Mtonnes CO₂) per sector in EU

Sector	Emission Reduction Possibilities
Transport	180
of which	
- passenger car	100
- intermodal shift	50
- other measures	30
Industry	100
Energy Industry	20
Domestic/Tertiary	100
Renewables/Heat	100
Power generation	300
of which	
- fossil fuel switching	50
- cogeneration/ thermal efficiency	150
- renewables/electricity	100
TOTAL	800

12. OVERALL ASSESSMENT OF COSTS

12.1. Introduction

100. Research efforts into the costs of curbing climate change have intensified over the last years not only within EU but also in the USA, Japan, the OECD and in the framework of the UN/IPCC. This section reflects the state of play with respect to cost estimates (the Annex provides details).

12.2. Compliance costs

101. Compliance costs are the net direct costs incurred in the form of investments, fuel costs and savings and other operating expenses. Estimates suggest that these may range from around 15bn to around 35 bn Ecu/yr in 1990 prices (0.2 to 0.4% of GDP) for a 15% reduction in CO₂ emissions in 2010 compared to 1990. Adding the gases N₂O and CH₄ is not expected to drastically alter this picture²⁸. The large range mainly reflects different assumptions on the existence of zero costs options and on whether or not the EU target is met at minimum cost across all Member States and sectors.
102. The lower cost estimates in the existing studies all have in common that a large part of the reduction can be met at zero or low costs. Such options might be achieved through the introduction of the 5 liter car, extended use of CCGT power plants and cogeneration (with continued availability of gas at low prices) beyond the measures included in the base line and the cheapest tranches of wind and small scale hydro. The low case also presupposes that the EU target is met at least-cost across sectors and Member States. A 15 % uniform reduction of all three greenhouse gases within the EU may not be cost-effective. Costs might be lowered further if more significant reductions of methane and nitrous oxides than for CO₂ are implemented but additional analysis is required
103. The higher estimates assume that the zero cost options are to a large extent already implemented in the reference case, the EU target would not be allocated efficiently over the sectors and Member States or energy prices and GDP growth are unfavorable. Indeed, inefficient ways of allocating emissions reductions across measures and Member States might increase the costs.
104. There is always the possibility that both the higher and the lower estimates of these compliance costs might be overestimated rather than underestimated. Costs might be underestimated since the engineering based costs estimates do not include the so-called transaction costs (the costs of collecting information and implementation). Possible negative impacts on welfare caused by decreases in comfort (e.g. some diminished performance with a 5 liter car) and choices (e.g. resulting from demand management) are also not included.
105. On the other hand, these compliance costs may be overestimated since the cost estimates assume implementation of the measures only in the EU. Joint implementation of emissions reductions would be able to substantially reduce costs (by 10% to 50%). Costs may also be overestimated since they do not incorporate positive secondary effects resulting from the more rapid cost saving technological progress that might occur if energy efficiency and renewables options are implemented on a larger scale. Finally, the estimates may also tend to be too high since they ignore the use of horizontal market based instruments such as removal of subsidies and/or energy taxation which are likely to reduce emissions while at the same time improving overall economic efficiency.
106. **As an overall conclusion, annual compliance costs of meeting the EU emission reduction objective are estimated to be between 15 and 35 bn Ecu. These costs might be lowered by lowering transaction costs, pursuing joint implementation, removing existing inefficiencies and reducing especially those greenhouse gases which can be reduced at low costs.**

12.3. Macro-economic impacts

²⁸ There are only small (around 0.1 bn Ecu) additional costs of reducing methane beyond current policy (0.16 m Ecu) since a 13 % to 15% reduction compared to 1990 is expected with current policies. A 15% reduction in nitrous oxides is expected to cost less than 0.1 bn ECU.

107. Evidence on the so called welfare costs, related to altered consumption patterns, is usually restricted to estimates on the impacts on macro-economic performance. EU wide studies suggest that significant reductions in CO₂ emissions could result in a variety of GDP effects ranging from small positive impacts of up to 1% of GDP to negative impacts on GDP of up to 1.5%. The above impacts are likely to be overestimated since the studies do not fully account for joint implementation, all technical options and technical progress. The macro-economics impacts on both GDP and employment can thus be positive or negative depending on the initial economic situation and on how tax revenues are used. The effects are always small in relation to the expected growth in GDP of 50% from 1990 to 2010 and should be viewed as redirecting economic development and growth towards sustainability.
108. Positive impacts mainly occur if the revenues of carbon/energy taxation (or the proceeds of auctioned tradable permits) are used to cut the indirect labor costs paid by employers. In case of high levels of unemployment positive impacts on GDP and employment can be expected. If tax revenues are not used to lower labour costs the economic impacts generally tend to be negative. Such model simulations do not usually consider the positive impact of budget consolidation on economic growth for cases where unsustainable trends in public finance prevail.

12.4. Distribution of costs

109. Although EU-wide compliance and welfare costs might be limited, the distribution of the costs across Member States and sectors is nevertheless an area of concern. Burden sharing schemes might imply an uneven distribution of compliance and welfare costs across Member States. Clearly, this will tend to affect the implementation and political feasibility of the proposed reductions.
110. The same applies to the sectoral distribution of costs. Even with cost-effective policies some economic sectors might still face losses which might not be fully compensated. For these sectors the situation can only be improved if other industrialized countries agree to make substantial efforts as well. If this is not the case pragmatic measures such as export subsidies may have to be taken to compensate for the loss of international competitiveness and the shift of relative prices.
111. Without comparable efforts in other developed countries the CO₂ reduction achieved in the EU might also be partially undone because production and carbon emissions could be shifted outside the EU (carbon leakage). For this reason, and because the EU contribution to the global problem is limited, coordinated action at a global level is essential to achieve the proposed reductions.

12.5. Environmental benefits

112. The costs estimates mentioned above neglect the positive economic impact from reduced damage due to air pollution. Preliminary values on the benefits due to CO₂ reductions range from 2 to 590 US \$/ton C. The estimate depends on the assumptions made on discount rates, climate sensitivity, the reference point for the emissions and the weight attached to damage in developing countries. Accounting for all these factors suggests that the global benefits of a 15% reduction in CO₂ emissions in the EU would be between 0.3bn and 101 bn Ecu /yr. Such benefits include many factors such as ecosystem preservation whose value is still underestimated and difficult to assess²⁹. These benefits depend very much on the value attached (the discount rate) to future damage.

²⁹ R. Constanza et al "The value of the World's Ecosystems services and natural Capital. Nature Vol 387, 15 May

113. This estimate does not yet reflect the avoided damage costs (secondary benefits) due to the reduction in other pollutants. The strategy would reduce sulphur dioxide, nitrogen oxides sulphur and particulate emissions compared to current legislation by at least 15% to 25%. The associated benefits (mainly mortality and morbidity) can be estimated at 11bn to 32 bn Ecu (see Annex for details). In addition, the reduction in CO₂ emissions would also cut the annual compliance costs from the Commission's proposed acidification strategy by at least 4 bn Ecu each year.
114. **The total benefits related to the reduction in greenhouse gases are difficult to express and quantify in monetary terms. Available estimates suggest that these benefits might range from 15 bn to 137 bn Ecu per year. This estimate taken together with the direct compliance costs would imply that the proposed emission reduction could on balance bring net benefits.**

13. CONCLUSIONS

115. The feasibility of achieving the EU 15% reduction objective depends on the technical reduction potential, on whether this reduction potential can be secured without damaging effects on the economy and finally on the readiness of all the actors concerned in society, in particular governments, to take the relevant decisions to realise this potential. This Commission Staff Working Paper has shown that there is sufficient low cost reduction potential to enable the EU to achieve its 15% reduction objective for 2010 without major economic disruption. The analysis has identified in a number of sectors that there is more than enough reduction potential for CO₂ alone - around 800 Mtonnes- and this could be even more if the full reduction possibilities of other gases in the basket, such as methane, and the use of JI are taken into account.
116. The sectoral analysis has shown that in general the proposed 15% emission reduction can be achieved through low cost and in some cases negative cost policies and measures. The model analysis shows that annual compliance costs could lie between 15 bn and 35 bn Ecu which corresponds to around 0.2 and 0.4% in 2010 of GDP. This reduction cost can be put into perspective if one compares this range to the cost of subsidies given to the fossil fuel sector which averaged 10 bn Ecu in the period 1990-1995. If all environmental benefits are taken into account such as reduced damage from air pollution the 15% reduction objective of the EU could provide a positive benefit. The differences between the two cost assessments stems from the analytical framework used in each case. However, both approaches show that the proposed 15% emission reduction objective for 2010 can be achieved with manageable impact on the EU economy and could be positive when externalities are taken into account. Such a challenge is a no regret policy for sustainable development, already identified within the 5th Environment Programme and the 5th RTD Framework Programme.
117. This Paper has also set out a number of proposals for policies and measures that can be used to realise this emission reduction potential. Many of these policies and measures at Community level are fully developed proposals and are on the Council's table or in the pipeline. Others still need to be further refined. The actual combination of policies and measures and their implementation at national and Community's level will of course, have an important bearing on the overall cost.

118. In conclusion, the Commission believe that there is a sufficient emission reduction possibilities available to meet the EU proposed 15% emission reduction for 2010 compared to 1990. The analysis has also shown that with sensible policies and measures and international co-operation, emissions can be reduced with manageable impact or even with benefit to the economy. However, such policies only make a significant contribution to the worldwide climate challenge if efforts are made jointly with other countries

9/25/97

Several analyses indicate that Western Europe will bear higher costs for reducing carbon emissions than will the United States. Western Europe already has high energy taxes relative to the U.S., and has already "backed out" a lot of the fossil fuels in their energy supplies. This implies that a lot of the cheap measures for reducing carbon reductions have already occurred in Europe. The U.S. has more opportunities to inexpensively cut carbon emissions. For example, 20% of all energy in France, and a majority of its electricity production, is nuclear, while only 7% is coal. Since nuclear is a non-carbon base energy source, there are no opportunities to reduce carbon emissions with this fuel, and few opportunities with the small percentage of coal. In the U.S., nuclear power comprises only 9% of total energy production, while coal comprises 23%. There are many more opportunities to reduce carbon emissions at low cost in the U.S. given the greater reliance on fossil fuels.

File: EI15117

Variable: Gross Domestic Product (Current PPP)

Units: Current Million International \$ (Purchasing Power Parity Method)

Source: Penn World Tables

Date: 4/15/96

Years: 1950-92

Range: B12..AT214

Format: 00.00

44		
Code	Country	1992
✓040	Austria ✓	132.67
✓056	Belgium ✓	181.19
~~203~~	~~Czech Rep~~	~~X~~
~~208~~	~~Denmark ✓~~	~~96.58~~
~~246~~	~~Finland ✓~~	~~78.63~~
~~251~~	~~France ✓~~	~~1043.23~~
~~276~~	~~Germany ✓~~	~~1315.23~~
~~300~~	~~Greece ✓~~	~~X~~
~~348~~	~~Hungary~~	~~59.33~~
~~352~~	~~Iceland ✓~~	~~4.25~~
~~372~~	~~Ireland ✓~~	~~43.19~~
~~382~~	~~Italy ✓~~	~~954.75~~
~~442~~	~~Luxembourg ✓~~	~~8.26~~
~~528~~	~~Netherlands ✓~~	~~263.55~~
~~579~~	~~Norway ✓~~	~~73.15~~
~~616~~	~~Poland, Rep~~	~~187.58~~
~~620~~	~~Portugal ✓~~	~~X~~
~~724~~	~~Spain ✓~~	~~511.79~~
~~752~~	~~Sweden ✓~~	~~158.99~~
~~757~~	~~Switzerland ✓~~	~~150.96~~
~~792~~	~~Turkey ✓~~	~~285.59~~
~~826~~	~~United Kingdom ✓~~	~~941.41~~
840	United States	5925.08

→ Western
Europe
in IEO 97

	United States	OECD Europe
	(1992)	(1992)
CO2/PPP	823.85	645.77
PPP	13.55	10.8
CO2/POP	19.13	8.93
E/POP	0.31	0.15

Note1: data for OECD Europe are averages

Note2: OECD Europe, does not include Czech Rep, Greece, Portugal

United States OECD Europe

(1992) (1992)

CO2/GDP	984.22	1173.38
/GDP	16.19	17.17
CO2/POP	19.13	8.93
E/POP	0.31	0.15

Note: data for OECD Europe are averages

EU and US Energy Comparison

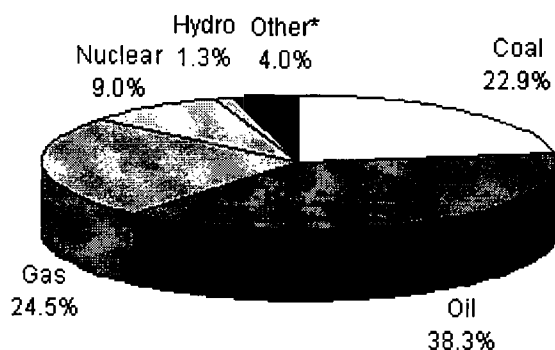
	European Union	United States	US-EU Difference
Annualized GDP Growth (1990-1996)	1.85%	2.15%	0.30%
1994 Coal-Fired ^{Electricity} Energy Capacity/ 1994 Total ~~Energy~~ Capacity	28.24%	42.16%	13.92%
1995 Total Primary ^{Electricity} Energy Supply/ 1995 GDP	22.84%	32.93%	10.09%

United States

1995 Key Energy Indicators

Population (million)	263.06	GDP (billion 1990 US dollars):	6149.52
Total Primary Energy Supply in Mtoe:	2078.27	Electricity Consumption in TWh:	3366.34
TPES/population (toe per capita):	7.90	TPES/GDP (toe per 000 US dollars):	0.34
Electricity Cons./pop (kWh per capita):	12797	Electricity Cons./GDP (kWh per US dollar):	0.55

Energy Share in 1995 TPES



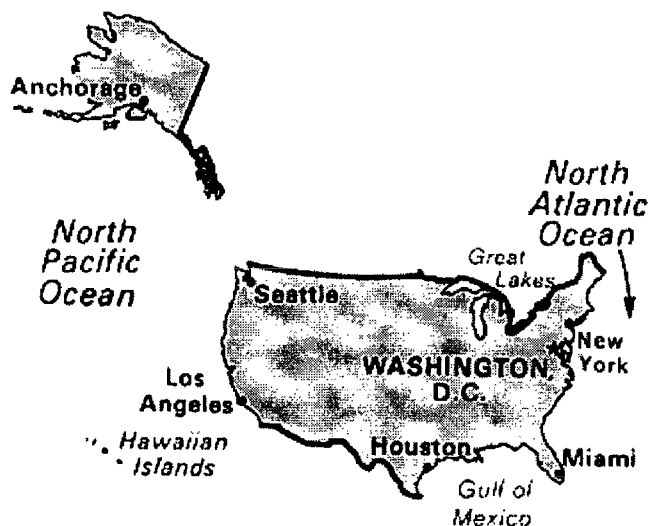
* Includes geothermal, solar, wind, combustible renewables & waste, etc.

Note: Excludes electricity trade.



You can obtain more detailed information from *Energy Statistics of OECD Countries* and *Energy Balances of OECD Countries* as well as in *Energy Policies of IEA Countries - 1996 Review*.

2000 km



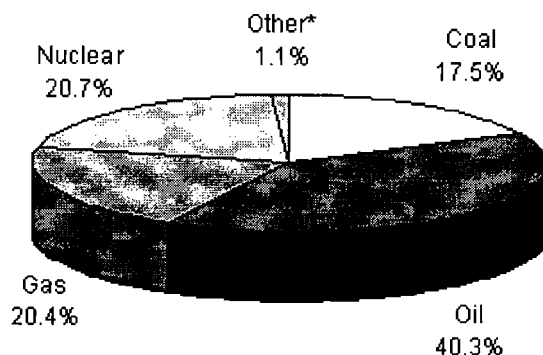
Belgium



1995 Key Energy Indicators

Population (million)	10.14	GDP (billion 1990 US dollars):	205.94
Total Primary Energy Supply in Mtoe:	52.38	Electricity Consumption in TWh:	74.85
TPES/population (toe per capita):	5.17	TPES/GDP (toe per 000 US dollars):	0.25
Electricity Cons./pop (kWh per capita):	7383	Electricity Cons./GDP (kWh per US dollar):	0.36

Energy Share in 1995 TPES

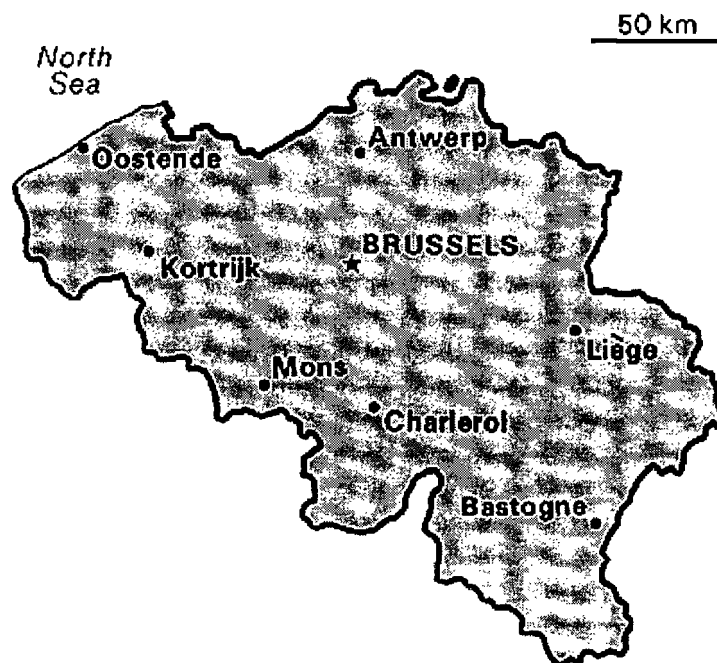


* Includes geothermal, solar, wind, combustible renewables & waste, etc.

Note: Excludes electricity trade.



You can obtain more detailed information from *Energy Statistics of OECD Countries* and *Energy Balances of OECD Countries* as well as in *Energy Policies of IEA Countries - 1996 Review*.



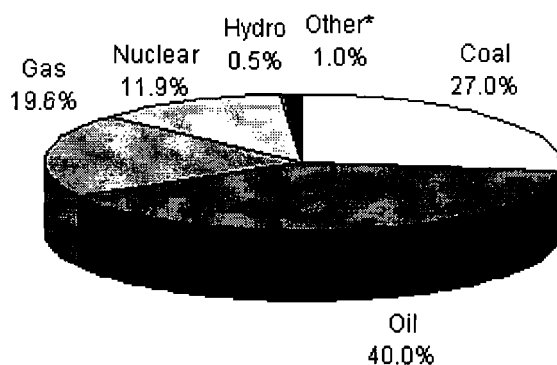
Germany



1995 Key Energy Indicators

Population (million)	81.66	GDP (billion 1990 US dollars):	1787.01
Total Primary Energy Supply in Mtoe:	339.29	Electricity Consumption in TWh:	516.89
TPES/population (toe per capita):	4.15	TPES/GDP (toe per 000 US dollars):	0.19
Electricity Cons./pop (kWh per capita):	6330	Electricity Cons./GDP (kWh per US dollar):	0.29

Energy Share in 1995 TPES

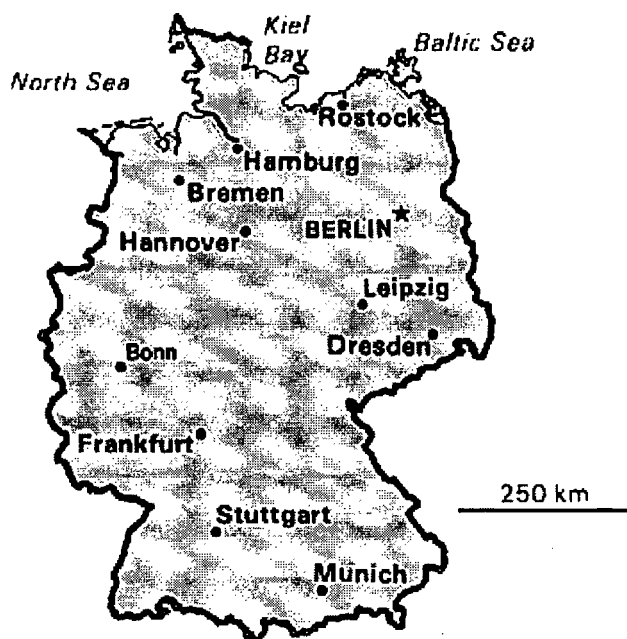


* Includes geothermal, solar, wind, combustible renewables & waste, etc.

Note: Excludes electricity trade.



You can obtain more detailed information from *Energy Statistics of OECD Countries* and *Energy Balances of OECD Countries* as well as in *Energy Policies of IEA Countries - 1996 Review*.

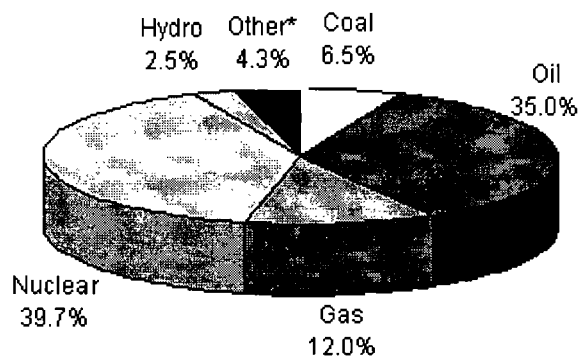


France

1995 Key Energy Indicators

Population (million)	58.14	GDP (billion 1990 US dollars):	1260.12
Total Primary Energy Supply in Mtoe:	241.32	Electricity Consumption in TWh:	394.02
TPES/population (toe per capita):	4.15	TPES/GDP (toe per 000 US dollars):	0.19
Electricity Cons./pop (kWh per capita):	6777	Electricity Cons./GDP (kWh per US dollar):	0.31

Energy Share in 1995 TPES

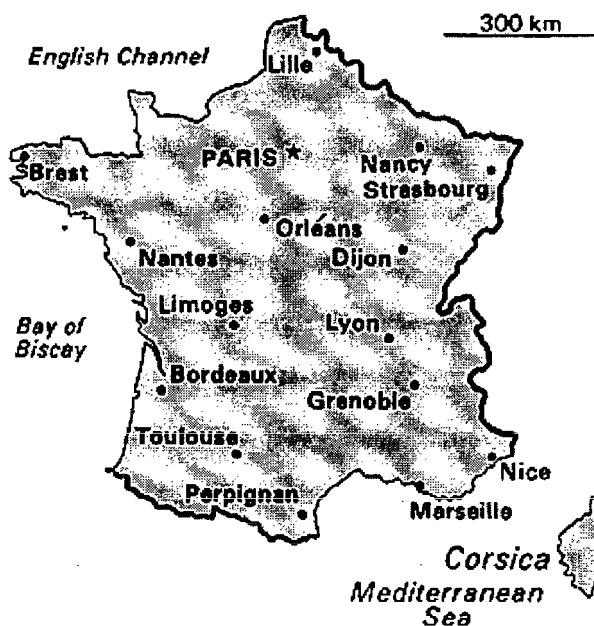


* Includes geothermal, solar, wind, combustible renewables & waste, etc.

Note: Excludes electricity trade.



You can obtain more detailed information from *Energy Statistics of OECD Countries* and *Energy Balances of OECD Countries* as well as in *Energy Policies of IEA Countries - France - 1996 Review* and *Energy Policies of IEA Countries - 1996 Review*.

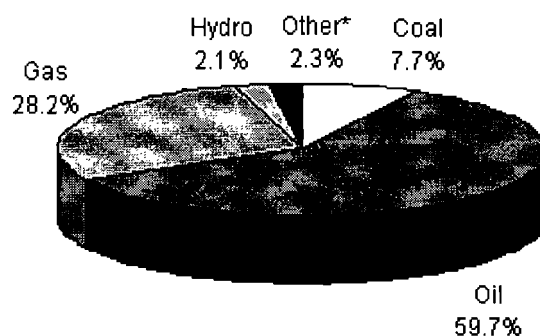


Italy

1995 Key Energy Indicators

Population (million)	57.27	GDP (billion 1990 US dollars):	1156.51
Total Primary Energy Supply in Mtoe:	161.36	Electricity Consumption in TWh:	261.31
TPES/population (toe per capita):	2.82	TPES/GDP (toe per 000 US dollars):	0.14
Electricity Cons./pop (kWh per capita):	4563	Electricity Cons./GDP (kWh per US dollar):	0.23

Energy Share in 1995 TPES



* Includes geothermal, solar, wind, combustible renewables & waste, etc.

Note: Excludes electricity trade.



You can obtain more detailed information from *Energy Statistics of OECD Countries* and *Energy Balances of OECD Countries* as well as in *Energy Policies of IEA Countries - 1996 Review*.

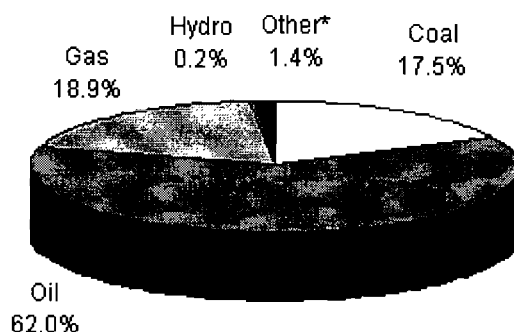


Luxembourg

1995 Key Energy Indicators

Population (million)	0.41	GDP (billion 1990 US dollars):	13.49
Total Primary Energy Supply in Mtoe:	3.38	Electricity Consumption in TWh:	6.10
TPES/population (toe per capita):	8.24	TPES/GDP (toe per 000 US dollars):	0.25
Electricity Cons./pop (kWh per capita):	14873	Electricity Cons./GDP (kWh per US dollar):	0.45

Energy Share in 1995 TPES

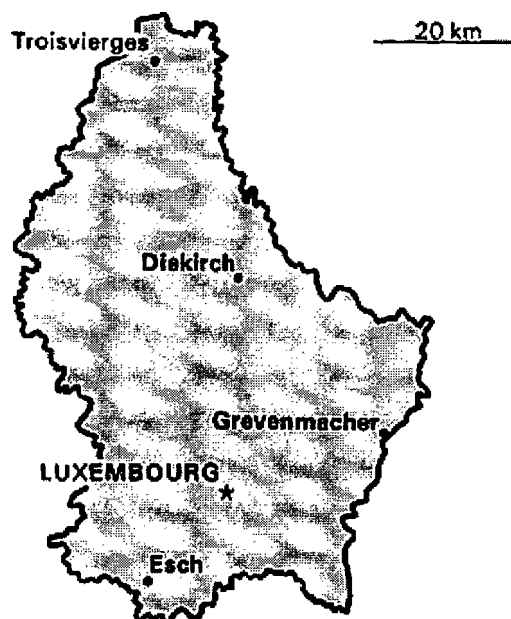


* Includes geothermal, solar, wind, combustible renewables & waste, etc.

Note: Excludes electricity trade.



You can obtain more detailed information from *Energy Statistics of OECD Countries* and *Energy Balances of OECD Countries* as well as in *Energy Policies of IEA Countries - 1996 Review*.

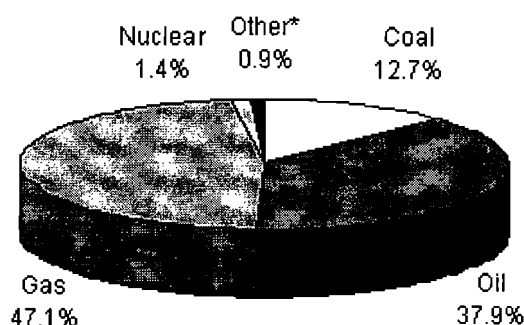


The Netherlands

1995 Key Energy Indicators

Population (million)	15.45	GDP (billion 1990 US dollars):	314.96
Total Primary Energy Supply in Mtoe:	73.29	Electricity Consumption in TWh:	88.99
TPES/population (toe per capita):	4.74	TPES/GDP (toe per 000 US dollars):	0.23
Electricity Cons./pop (kWh per capita):	5760	Electricity Cons./GDP (kWh per US dollar):	0.28

Energy Share in 1995 TPES



* Includes geothermal, solar, wind, combustible renewables & waste, etc.

Note: Excludes electricity trade.



You can obtain more detailed information from *Energy Statistics of OECD Countries* and *Energy Balances of OECD Countries* as well as in *Energy Policies of IEA Countries - the Netherlands - 1996 Review* and *Energy Policies of IEA Countries - 1996 Review*.

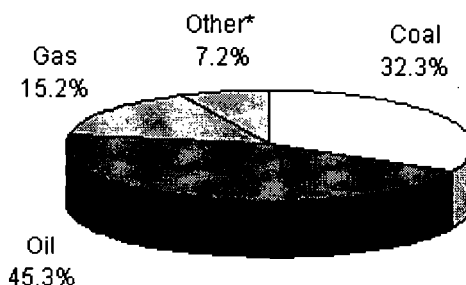


Denmark

1995 Key Energy Indicators

Population (million)	5.23	GDP (billion 1990 US dollars):	142.81
Total Primary Energy Supply in Mtoe:	20.48	Electricity Consumption in TWh:	33.80
TPES/population (toe per capita):	3.92	TPES/GDP (toe per 000 US dollars):	0.14
Electricity Cons./pop (kWh per capita):	6466	Electricity Cons./GDP (kWh per US dollar):	0.24

Energy Share in 1995 TPES



* Includes geothermal, solar, wind, combustible renewables & waste, etc.

Note: Excludes electricity trade.



You can obtain more detailed information from *Energy Statistics of OECD Countries* and *Energy Balances of OECD Countries* as well as in *Energy Policies of IEA Countries - 1996 Review*.

Skagerrak

100 km



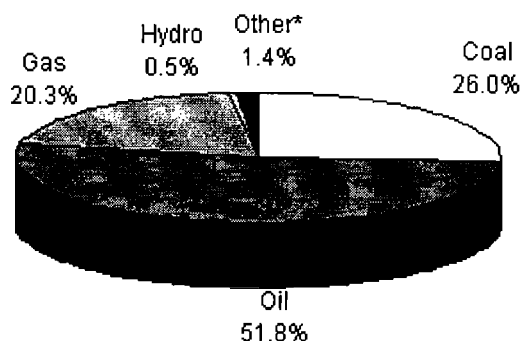
Ireland



1995 Key Energy Indicators

Population (million)	3.58	GDP (billion 1990 US dollars):	60.28
Total Primary Energy Supply in Mtoe:	11.46	Electricity Consumption in TWh:	16.34
TPES/population (toe per capita):	3.20	TPES/GDP (toe per 000 US dollars):	0.19
Electricity Cons./pop (kWh per capita):	4561	Electricity Cons./GDP (kWh per US dollar):	0.27

Energy Share in 1995 TPES



* Includes geothermal, solar, wind, combustible renewables & waste, etc.

Note: Excludes electricity trade.



You can obtain more detailed information from *Energy Statistics of OECD Countries* and *Energy Balances of OECD Countries* as well as in *Energy Policies of IEA Countries - 1996 Review*.

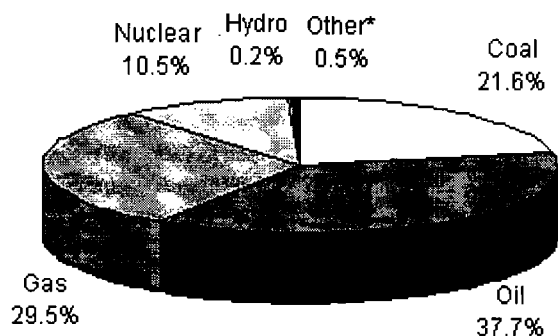


United Kingdom

1995 Key Energy Indicators

Population (million)	58.61	GDP (billion 1990 US dollars):	1033.88
Total Primary Energy Supply in Mtoe:	221.91	Electricity Consumption in TWh:	325.85
TPES/population (toe per capita):	3.79	TPES/GDP (toe per 000 US dollars):	0.21
Electricity Cons./pop (kWh per capita):	5559	Electricity Cons./GDP (kWh per US dollar):	0.32

Energy Share in 1995 TPES



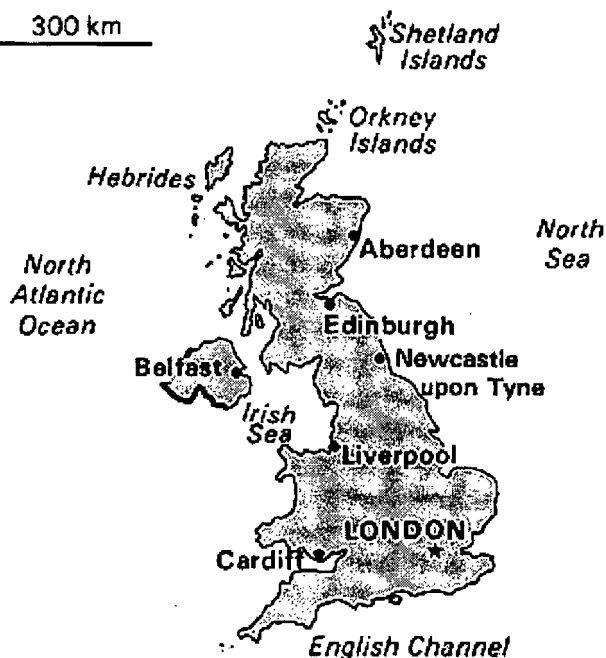
* Includes geothermal, solar, wind, combustible renewables & waste, etc.

Note: Excludes electricity trade.



You can obtain more detailed information from *Energy Statistics of OECD Countries* and *Energy Balances of OECD Countries* as well as in *Energy Policies of IEA Countries - 1996 Review*.

300 km



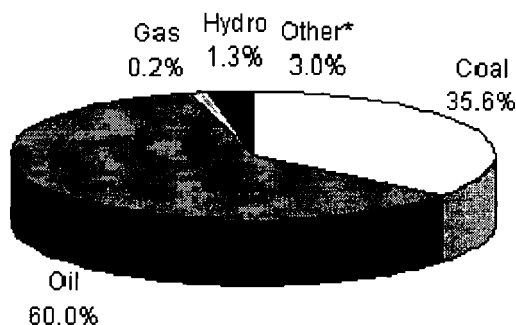
Greece



1995 Key Energy Indicators

Population (million)	10.45	GDP (billion 1990 US dollars):	89.73
Total Primary Energy Supply in Mtoe:	23.70	Electricity Consumption in TWh:	39.17
TPES/population (toe per capita):	2.27	TPES/GDP (toe per 000 US dollars):	0.26
Electricity Cons./pop (kWh per capita):	3747	Electricity Cons./GDP (kWh per US dollar):	0.44

Energy Share in 1995 TPES



* Includes geothermal, solar, wind, combustible renewables & waste, etc.

Note: Excludes electricity trade.



You can obtain more detailed information from *Energy Statistics of OECD Countries* and *Energy Balances of OECD Countries* as well as in *Energy Policies of IEA Countries - 1996 Review*.



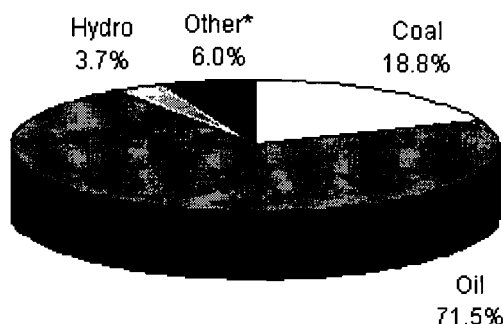
Portugal



1995 Key Energy Indicators

Population (million)	9.92	GDP (billion 1990 US dollars):	72.36
Total Primary Energy Supply in Mtoe:	19.24	Electricity Consumption in TWh:	30.41
TPES/population (toe per capita):	1.94	TPES/GDP (toe per 000 US dollars):	0.27
Electricity Cons./pop (kWh per capita):	3067	Electricity Cons./GDP (kWh per US dollar):	0.42

Energy Share in 1995 TPES

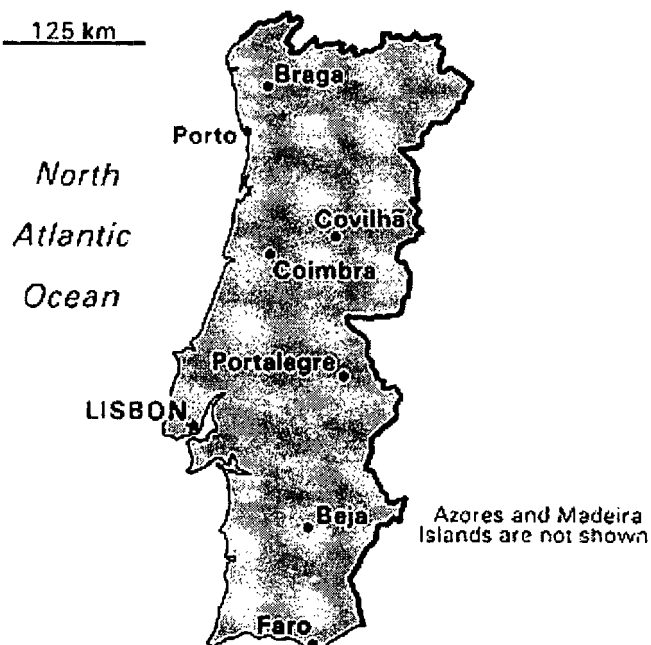


* Includes geothermal, solar, wind, combustible renewables & waste, etc.

Note: Excludes electricity trade.



You can obtain more detailed information from *Energy Statistics of OECD Countries* and *Energy Balances of OECD Countries* as well as in *Energy Policies of IEA Countries - Portugal - 1996 Review* and *Energy Policies of IEA Countries - 1996 Review*.



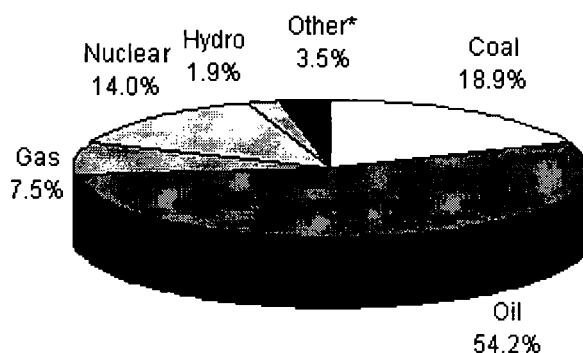
Spain



1995 Key Energy Indicators

Population (million)	39.21	GDP (billion 1990 US dollars):	525.30
Total Primary Energy Supply in Mtoe:	103.49	Electricity Consumption in TWh:	155.61
TPES/population (toe per capita):	2.64	TPES/GDP (toe per 000 US dollars):	0.20
Electricity Cons./pop (kWh per capita):	3969	Electricity Cons./GDP (kWh per US dollar):	0.30

Energy Share in 1995 TPES

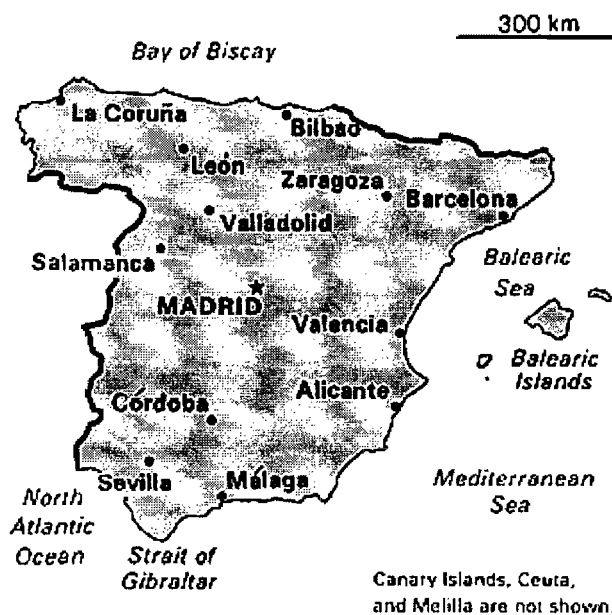


* Includes geothermal, solar, wind, combustible renewables & waste, etc.

Note: Excludes electricity trade.



You can obtain more detailed information from *Energy Statistics of OECD Countries* and *Energy Balances of OECD Countries* as well as in *Energy Policies of IEA Countries - Spain - 1996 Review* and *Energy Policies of IEA Countries - 1996 Review*.



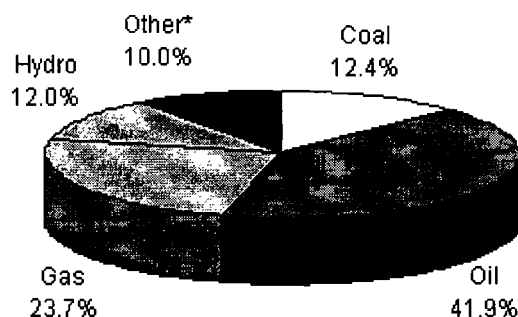
Austria



1995 Key Energy Indicators

Population (million)	8.05	GDP (billion 1990 US dollars):	175.08
Total Primary Energy Supply in Mtoe:	26.38	Electricity Consumption in TWh:	50.73
TPES/population (toe per capita):	3.28	TPES/GDP (toe per 000 US dollars):	0.15
Electricity Cons./pop (kWh per capita):	6305	Electricity Cons./GDP (kWh per US dollar):	0.29

Energy Share in 1995 TPES



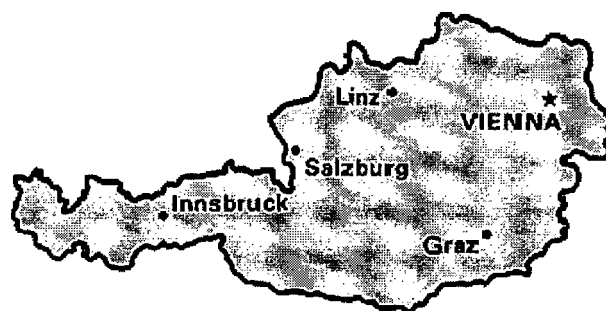
* Includes geothermal, solar, wind, combustible renewables & waste, etc.

Note: Excludes electricity trade.



You can obtain more detailed information from *Energy Statistics of OECD Countries* and *Energy Balances of OECD Countries* as well as in *Energy Policies of IEA Countries - 1996 Review*.

150 km

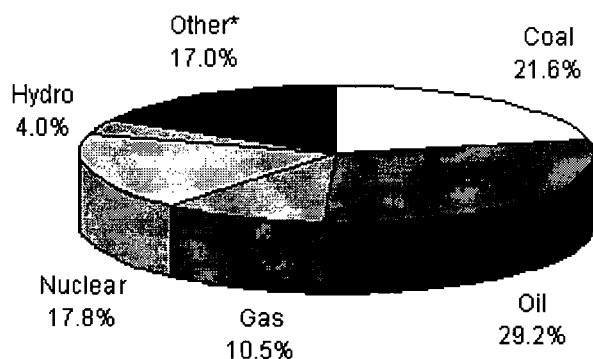


Finland

1995 Key Energy Indicators

Population (million)	5.11	GDP (billion 1990 US dollars):	129.96
Total Primary Energy Supply in Mtoe:	28.67	Electricity Consumption in TWh:	69.29
TPES/population (toe per capita):	5.61	TPES/GDP (toe per 000 US dollars):	0.22
Electricity Cons./pop (kWh per capita):	13565	Electricity Cons./GDP (kWh per US dollar):	0.53

Energy Share in 1995 TPES

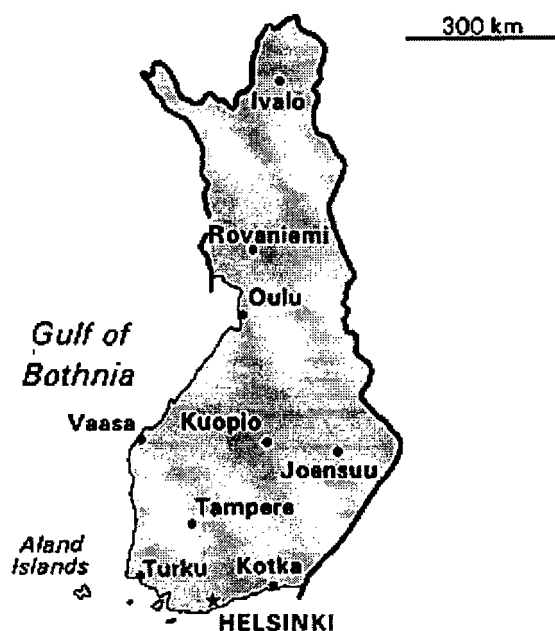


* Includes geothermal, solar, wind, combustible renewables & waste, etc.

Note: Excludes electricity trade.



You can obtain more detailed information from *Energy Statistics of OECD Countries* and *Energy Balances of OECD Countries* as well as in *Energy Policies of IEA Countries - 1996 Review*.

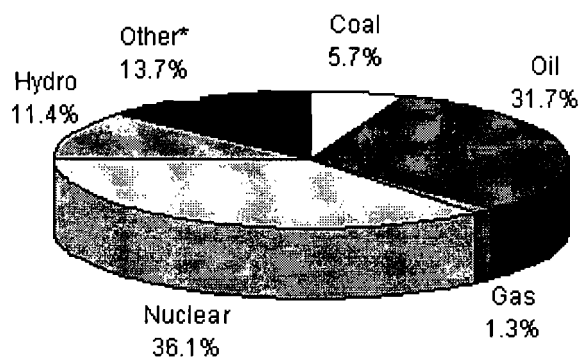


Sweden

1995 Key Energy Indicators

Population (million)	8.84	GDP (billion 1990 US dollars):	234.38
Total Primary Energy Supply in Mtoe:	50.66	Electricity Consumption in TWh:	136.37
TPES/population (toe per capita):	5.73	TPES/GDP (toe per 000 US dollars):	0.22
Electricity Cons./pop (kWh per capita):	15432	Electricity Cons./GDP (kWh per US dollar):	0.58

Energy Share in 1995 TPES



* Includes geothermal, solar, wind, combustible renewables & waste, etc.

Note: Excludes electricity trade.



You can obtain more detailed information from *Energy Statistics of OECD Countries* and *Energy Balances of OECD Countries* as well as in *Energy Policies of IEA Countries - Sweden - 1996 Review* and *Energy Policies of IEA Countries - 1996 Review*.

400 km



Case	Paper Tons/ Corresponding Reductions	GDP2010 b.i	Foregone GDP	Permit Price 2010	Permit Price 2050	Intl Trades 2010	Value of Trades	Intl Trades 2050	Value of Trades
BAU	x/a US	9185							
1990-10% <i>BAU</i>	~~2~~ EN	6942							
1990-10%	PT Europe								
1990	<del>W lamp ~~PT~~ ~~US~~</del>	6874	2281	158	318				
1990	PT ~~US~~	~~9185~~	20	~~10810~~	582	AN/A			
WRE550		9165							
WGI550	20 An I E	6918	24	42	149	-150	6.86	-115	17.16
WRE450	70 " US	9172	13	42	149	-202	8.55	-364	~~735~~
WGI450									84.2

-10% Eur 6791 151 354 924
 notr US 9149 36 175 843
 Eur 6890 52 91 238
 tr US 9155 30

-150 -166 -166 15.15 -120 28.68
 +332 -180 16.46 -332 79.05

Emissions
 US 835
 90 1350
 2010 1729

107490-10 ~ 1.x15
 Case 10 ~ 1.x15 - 9/10/97
 9/24/97

2010 GDP
 9915
 9164

2050 GDP
 21304
 16005
 1990
 BAU: 6139
 An I: 6178

Cons losses
No trade
 90
 Eur 25% more

-10%
 Eur 561% more
Trade
 90
 Eur 321% more
 -10%
 Eur 121% more

95
 BAU: 6739
 notr: 6858



United States Department of State

Bureau of Oceans and International
Environmental and Scientific Affairs

Washington, D.C. 20520

9/29

TELEFAX TRANSMISSION

TO:

NAME:

Joe Aldy
CEA

TEL:

FAX:

395-6809

NUMBER OF PAGES, INCLUDING THIS PAGE: 9

FROM:

NAME:

Susan Wickert

TEL:

(202) 647-4069

OFFICE OF GLOBAL CHANGE

FAX:

(202) 647-0191

OES/EGC - RM. 4330

MESSAGE:

Per our conversation.

ANNEX

Council conclusions on climate change

CONSIDERATIONS

1. The Council recalls the Community proposal for a draft protocol made in AGEU, as amended in the submission of 15 January 1997, and in particular the following elements of that proposal:
 - a combined approach of including in a protocol both commitments on policies and measures (Annexes A, B and C), including legally binding policies and measures as well as on quantified legally binding objectives for emission limitations and significant overall reductions within specified time-frames;
 - coverage in the protocol of industrialised countries including all OECD members and countries with economies in transition (Annex X list);
 - Annex E, covering the strengthening by all Parties of the implementation of existing Convention commitments, which contains inter alia provisions to enhance the development, application and diffusion, including transfer of technology;
 - provisions for the review of all commitments in Article 4;
 - provision in Article 2(d) that Annex X Parties may implement policies and measures and attain QELROs jointly with other Annex-X Parties;
 - Annex Y, which is still to be developed, meant to specify the QELRO provisions in Article 2(c) for Annex X Parties;
 - the resolution of questions regarding implementation and compliance in Article 10.

17 15 FROM STANBROOK AND COOPER
03/25 97 MON 57EPA 12/2 2338028 FAX CAB PRESS ID: 22385713

2. The Council notes that:

- AGBM-6 (March 3-7, 1997) is the last AGBM before a draft negotiating text has to be circulated (deadline is June 1, 1997);
- the Council has reiterated the need for the Community to play a leading role.

3. The Council recalls its conclusion that the equitable sharing of the objective within the Community should be discussed and agreed in parallel with the decision on proposals by the Community for quantified reduction objectives and policies and measures for inclusion in the protocol (Council conclusions December 1995).

4. The Council recalls that:

- existing commitments of the Community are to stabilise CO₂ emissions at 1990 level by 2000, which means that this level cannot be exceeded after the year 2000 (Council conclusions June 1995 and December 1995);
- It has concluded that commitments for significant overall reductions of greenhouse gas emissions after the year 2000 below 1990 level should be included in a protocol (Council conclusions June 1996);
- It has concluded that global average temperatures should not exceed 2 degrees Celsius above pre-industrial level and that therefore concentration levels lower than 550 ppm CO₂ should guide global limitation and reduction efforts (Council conclusions June 1996), which calls for early action on emission reduction and indicates the need for significant reductions from industrialised countries in the 2000-2020 time-frame;
- national commitments by a number of Member States for the period after the year 2000 are an important contribution towards reductions of greenhouse gas emissions below 1990 level for the Community as a whole.

QUANTIFIED EMISSION REDUCTION OBJECTIVES

5. The Council stresses that these conclusions establish a Community negotiating position for the ongoing negotiations on the Berlin Mandate, not a unilateral commitment; that the Community commitment in the Protocol will be subject to acceptance of comparable commitments by other Annex X Parties; that the outcome of COP-3 in Kyoto will determine both the actual Community target and the final package of policies and measures which must be taken to help meet that target.
 6. The Council agrees on the following negotiating position on quantified reduction objectives, for inclusion in the Community protocol proposal, Annex Y.
 7. The reduction objectives cover the following greenhouse gases: CO₂, CH₄ and N₂O (weighted total, using GWP with 100 year time-horizon). HFC, PFC and SF₆ will be added no later than 2000 to the basket of gases, but policies and measures to reduce emissions of these gases will have to be included in the Protocol.
 8. Article 2(d) of the Community protocol proposal provides for the possibility for Annex X Parties to implement policies and measures and attain limitations and/or reduction objectives jointly with other Annex X Parties and Parties that have made a notification of intention to be bound by commitments on emission limitation and reduction objectives set in Annex Y. The Council recognizes that rules governing joint implementation with these Parties should be part of a Protocol.
- Regarding joint implementation with other Parties, the Conference of the Parties shall take decisions regarding criteria for joint implementation as soon as Parties to the Convention have taken a decision on the pilot phase of AIJ.
9. The proposed reduction objectives for the Protocol are subject to agreement by COP-3 on inclusion in the protocol of legally binding and other policies and measures.

10. The Council regrets the lack of firm commitments so far from other Annex X Parties. It agrees that the Community should propose that Annex X Parties, individually or jointly, in accordance with the Berlin Mandate, shall reduce emission levels for CO₂, CH₄, and N₂O together (weighted total, using GWP with a 100 year time-horizon) by 15% by 2010 (reference year 1990).

It also agrees that an interim target should be set for 2005.

In the longer term, more sophisticated methods to allocate reduction targets shall be implemented, in accordance with the Berlin Mandate, eventually leading to convergence of emission levels based on appropriate indicators.

INTERNAL COMMUNITY BURDEN-SHARING

11. The Council reaffirms its position expressed in the Council conclusions of December 1995 that commitments to limit and reduce greenhouse gas emissions under the future Protocol will be fulfilled by the Community as a whole through action by the Community and its Member States within their respective competences.
12. It also recalls its conclusions that the equitable burden sharing among Member States with regard to the overall emission reduction objective by the Community as a whole will be discussed and agreed having regard to cost-effectiveness and the aspects included in the Berlin Mandate such as differences in starting points, approaches, economic structures and resource bases, the need to maintain strong and sustainable economic growth, available technologies and other individual circumstances, recognising that each Member State must contribute substantially to the fulfilment of the obligations in the protocol (Council conclusions December 1995).

Member States which start from relatively low levels of energy consumption and therefore low emissions measured on a per capita or other appropriate basis, are entitled to have CO₂ targets and/or strategies corresponding to their economic and social development, while improving the energy efficiency of their economic activities.

The decisions on the equitable sharing of the burden will take account of national circumstances and capabilities in sectors such as, inter alia, electric power generation, internationally oriented energy intensive industry, transportation, light industry, agriculture, households and services and of the potential for energy efficiency improvement as affected by measures already taken, the reduction of the carbon intensity of the fuel mix and considerations of convergence between Member States.

13. Reductions required on the basis of the outcome of the protocol negotiations will have to be achieved with a combination of national and Community policies and measures. This might require an assessment of existing Community legislation that might impede Member States' implementation of national mitigation measures. Further elaboration of common and coordinated policies and measures needs to be pursued by Member States and the Commission through the Ad Hoc Group and in the context of the elaboration by the Council dealing with relevant Community policies and measures regarding economic instruments and taxation as well as regarding energy on the demand and supply side, industry, transport and agriculture. In this connection the Council reaffirms the need for coordination and integration of work in these key areas.
14. The Council notes the work done by the Ad Hoc Group on the assessment of the potential of common and coordinated policies and measures as an approach to the equitable sharing of the burden and underlines that Community and coordinated policies and measures will be essential instruments for Member States to implement their contributions to the fulfilment of the reductions emerging from the protocol negotiations.

The Council stresses that the commitment by Member States is needed to develop and implement common and coordinated policies and measures by the Community, which are a necessary contribution to meeting the reduction objectives agreed at Kyoto, in line with the conclusions regarding the coordination and integration of Community work in the key areas

Common and coordinated policies and measures in the following areas have a high potential for contributing to meeting the reduction objectives to be agreed at Kyoto:

- Renewable energy programmes
- Programmes regarding Combined Heat and Power, energy efficiency improvements in the transformation sector and fuel switching to less GHG emitting sources
- Energy efficiency standards and/or improvements for household appliances, home entertaining equipment, office equipment, lighting products, space heating equipment and air compressors
- Energy efficiency in buildings
- Fuel efficiency improvement and CO₂ emission reduction from passenger and freight vehicles
- Energy efficiency improvements and GHG emission reductions in heavy industry (iron/steel, chemicals, non-ferrous metals, non-metallic minerals, pulp and paper) and large combustion plants
- Limitation of emissions of HFC's, PFC's and SF₆
- Reduction of CH₄ emissions
- N₂O reductions in the chemical industry
- Progressive reduction/removal of fossil fuel and other subsidies, tax schemes and regulations which counteract an efficient use of energy
- Increase of minimum tax levels as a way to reduce GHG emissions and improve energy efficiency
- Modal switch in transportation

The Ad Hoc Group is requested to present to the next Council an overview of the progress concerning these common and coordinated policies and measures and their likely contribution to greenhouse gas reductions for the Community as a whole and the individual Member States. On this basis the Council may wish to review the Community negotiating position.

16. In the light of national emission targets Member States have set, analyses made by Member States on the limitation and reductions they can achieve in the 2000-2020 time-frame, information provided by the Commission through its Energy 2020 study, the work of the Ad Hoc Group on the potential of Community policies and measures and other relevant information, the Council decides that an emission index for each Member State in the year 2010 shall guide the determination of the contribution of each Member State towards the reduction the Community as a whole will have to realise in 2010 on the basis of the outcome of the protocol negotiations. The attached table 1 represents the current commitments of Member States, adding up already to a 10% reduction. Member States also agree to identify additional national and common and coordinated Community policies and measures such as those indicated in paragraph 15, to meet the proposed Annex X targets. Similar arrangements will need to be developed for the target the Community as a whole will have to realise in 2005.

17. The initial distribution between Member States will be reviewed by the Council, if necessary prior to and in any case after completion of protocol negotiations, on the basis of an assessment of actual developments, taking account of the principles and approaches referred to in paragraphs 11, 12, 13 and 14.

APPENDIX I

TABLE 1

MEMBER STATES	EMISSION REDUCTIONS IN 2010 FOR CO ₂ , CH ₄ , AND N ₂ O TOGETHER (GWP100 WEIGHTED), COMPARED TO 1990
BELGIUM	-10%
DENMARK	-25%
GERMANY	-25%
GREECE	+30%
SPAIN	+17%
FRANCE	0%
IRELAND	+15%
ITALY	-7%
LUXEMBOURG	-30%
NETHERLANDS	-10%
AUSTRIA	-25%
PORTUGAL	+40%
FINLAND	0%
SWEDEN	+5%
UNITED KINGDOM	-10%

Michèle Jolif
from ^{rm 320} Bill Antholis
cc: JF
AM
RL
JA

European Union Policies and Measures to Achieve the -15% Kyoto Negotiation Position

by Kornelis Blok and Dian Phylipsen¹

1. Introduction

On 2 March 1997 the Environment Council of the European Union has decided upon a negotiation position for the third Conference-of-the-Parties to the UN Framework Convention on Climate Change, to be held in December 1997 in Kyoto. The fifteen ministers responsible for environment there decided that [1]:

... the Community should propose that Annex X parties, individually or jointly, in accordance with the Berlin Mandate, shall reduce emission levels for CO₂, CH₄ and N₂O together (...) by 15% by 2010 (reference year 1990).

Part of the agreement within the European Union (EU) is an agreement on the internal burden sharing. Another important aspect is the agreement on so-called common and coordinated policies and measures (CCPM's). In the March council decision twelve areas, both for CO₂ and non-CO₂ greenhouse gases are mentioned for which such common policies should be adopted.

In this paper the question will be discussed whether these policies and measures are sufficient to attain the 15% reduction as proposed by the Environment Council.

First of all, some remarks will be made on the present level of greenhouse gas emissions and the projected business-as-usual development in the European Union. Subsequently, the status and potential effects of common and coordinated measures will be discussed. Finally, an overview will be presented, including the effect on 2010 EU greenhouse gas emissions.

¹ Dr. K. Blok is assistant professor at Utrecht University and director of Ecofys Energy and Environment. Drs. G.J.M. Phylipsen is a researcher at Utrecht University. They both served as consultants to the Netherlands' government during it's presidency of the European Union. Address: Dept. of Science, Technology and Society, Padualaan 14, NL-3584 CH Utrecht, fax +31-30-2537601.

The negotiating body within the European Union is the so-called EU Ad Hoc Group on Climate. In September 1996 this Ad Hoc Group established an Expert Group to provide technical analysis to support the Ad Hoc Group's work. The results presented here are in general based on the work of the Expert Group. An extended compilation of the work is available from the authors [2]. The conclusions in this paper are for the full responsibility of the authors.

2. Business-as-usual development

The emissions of CO₂ in the European Union in the year 1990 amounted to 3328 Mtonnes (908 MtC) [3]. In the year 1995 emissions are, after a dip in the early nineties, more or less at the same level. Main causes for the stabilization of emissions are: the limited rate of economic growth in the early nineties, the reduction of activities in former East-Germany (effect on emissions approx. 4%) and the shift from coal to natural gas (notably in the UK).

For the year 2000 there are several projections, ranging from stabilization to a slight increase, up to 5% [4]. A commonly used business-as-usual scenario is the so-called Conventional Wisdom scenario developed on behalf of the Directorate-General for Energy of the European Commission. In this scenario GDP growth until the year 2010 is somewhat over 2% per year. CO₂ emissions in 2010 are expected to grow by 9% compared to 1990 [5].

In 1990 emissions of methane were 24.7 Mtonnes (519 Mtonnes CO₂-equivalent) and of nitrous oxides 0.92 Mtonnes (286 Mtonnes CO₂-equivalent) [3]. From these figures we see that the two gases contribute about 20% to total EU greenhouse gas emissions. The emission of other greenhouse gases like HFC's and PFC's in 1990 is estimated to have been not more than 50 Mtonnes CO₂-equivalent (except gases that are subject to the Montreal Protocol).

Projections of non-CO₂ greenhouse gas emissions are not readily available for the EU as a whole. However, from national projections available for most countries, one can derive that in the year 2000 emissions of CH₄ will probably have declined by about 10% compared to 1990 and those of N₂O by 25% [6]. This decline is mainly due to a decrease of CH₄ emissions from landfills and N₂O emissions from adipic acid production.

3. Policies and measures to reduce CO₂ emissions

Nine policy areas have been distinguished: six in the energy policy area, two economic instruments and one in transportation. Here, the

potential effect of these measures on CO₂ emissions, the possible policy incentives and the actual status of policy formulation will be discussed.

Renewable energy programmes

In 1996, the European Commission published a green paper on renewable energy [7]. The target set out is to double the contribution of renewable energy from 6% in the early nineties to 12% in the year 2010 (15% in terms of avoided primary energy). Compared to a moderate development in a business-as-usual scenario, such doubling saves 200 Mtonnes of CO₂ emissions.

Important instruments may be those directed at supporting renewable energy in the liberalising EU energy markets (including so-called Non-Fossil Fuel Obligations). Other instruments are already in place, like extended R&D programmes. As biomass should have an important contribution to the growth of the share of renewables, also adaptations in agricultural policies are important.

Cogeneration programmes

Combined generation of heat and power (cogeneration or CHP) may have a substantial share in EU power generation. The ultimate cogeneration potential is estimated to be 50% of total EU power production. On the medium term the growth is restricted by the slow turnover rate of capital stock in electricity production. For the year 2010 the contribution of enhancing the implementation rate of CHP is estimated to be 110 - 220 Mtonnes.

Although some individual countries already have considerable shares of cogeneration, for the EU as a whole, policy development in this field is still in an early stage. It is expected that liberalisation of EU energy markets will boost at least some applications of CHP. Other possibilities can be found in the new draft of the Large Combustion Plant Directive that states that operators of power plant should justify why they do not apply cogeneration.

Energy efficiency improvements of appliances

It is estimated that adequate policies on household and office appliances may save 150 million kWh of electricity consumption [8]. This is equivalent to 55 - 90 Mtonnes of CO₂ emissions, depending on the type of fuel saved.

Several policies are already in place, including R&D programmes, mandatory—energy consumption labelling and minimum energy efficiency standards for refrigerators and freezers (EC-directive, in place up from 1999). Furthermore, negotiations on voluntary energy efficiency standards are in progress between the European Commission and the manufacturers of washing machines, TV's and VCR equipment (standby-mode). This set of instruments is by far not

yet implemented to its full strength, but can be expanded by additional policy instruments like golden-carrot programmes and technology procurement to speed up technological innovation.

Energy efficiency in buildings

Substantial emission reductions can still be achieved by improving the thermal integrity of homes and office buildings, and the efficiency of heat production. No estimates are available yet on the CO₂ emission reduction potential of these measures.

Also thinking on common and coordinated EU policies has not yet very well developed. It should be noted that differences in climate, construction technology and ways of living trouble the formulation of such common policies.

Fuel economy improvement of passenger cars

In June 1996 the Council of Ministers of the EU adopted the principle that in the year 2005 new passenger cars should have a specific fuel consumption of 4.5 and 5.0 liter per 100 km for diesel and gasoline cars respectively (53 - 47 mpg) [9]. At present specific fuel consumption is between 7 and 8 liters per 100 km (about 30 mpg). The target year may be postponed to the year 2010. Depending on the target year, the effect of realization of this development will be a CO₂ emission reduction of 80 - 120 Mtonnes.

At present negotiations are underway with the car manufacturers in the European Union to come to an agreement on these targets. Furthermore, fiscal instruments are considered to support the sales of energy efficient cars.

Energy efficiency improvement in heavy industry

Branches like the iron and steel industry, refineries, basic chemical producers and the pulp and paper industry are energy-intensive and are often referred to as heavy industry. Despite substantial past achievements, there is still room for further energy efficiency improvements, of e.g. 1.5 - 2.0% per year (incl. cogeneration). Such improvements will lead to a CO₂ emission reduction of 70 - 110 Mtonnes compared to a business-as-usual development in which the improvement will be only 0.5 - 1.0% per year.

A policy instrument that draws much attention is the voluntary agreement. Experience with this instrument has been obtained in, among others, Denmark, Germany and the Netherlands. On a recent workshop the EU wide application of this instrument was discussed. The best solution seems to have EU wide guidelines for agreements closed nationally. The European Commission is presently preparing a communication in this field.

Alternatives for voluntary agreements are EU guidelines or directives,

e.g. in the form of best-available-technology performance descriptions. Implementation of such guidelines, however, will be more time-consuming than closing voluntary agreements.

Progressive removal of fossil fuel subsidies

Fossil fuel subsidies in the European Union are especially important with respect to the coal industry, e.g. in France, Germany, Spain and the UK. There is a tendency - in line with the common policy agreed upon in 1993 which sets conditions for subsidies to be allowed - to reduce or cease such subsidies.

The effect on CO₂ emissions for the year 2010 are estimated to be at least 15 Mtonnes.

Increase of minimum tax levels

The discussion on taxation of energy products or CO₂ emissions in the EU is ongoing from the early nineties. Recently, the European Commission has drafted a new proposal for a directive on 'minimum excise duties' for energy products. It is proposed to gradually increase the minimum duties on non-automotive energy carriers to 0.7 ECU/GJ (equivalent to \$30 - 50 per tonne of carbon) [10]. The expected effect on CO₂ emissions is moderate: approx. 40 Mtonnes.

It is still highly uncertain whether the Commission's proposal will be accepted by the member states.

Modal switch in transportation

Based on limited data it is estimated that changes in modal split may lead to a CO₂ emission reduction on the order of 30 Mtonnes.

Some policy development is underway, especially with respect to freight transport (switch from road to rail).

4. Policies to reduce other greenhouse gas emissions

Not for all sectors where greenhouse gases, other than CO₂, are emitted, emission reduction options are available. Nevertheless, for a number of areas policy formulation is under way.

Reduction of CH₄ emissions from landfills and other sources

Methane emissions from landfills in the EU are declining. Extra reduction of landfilling organic waste, methane collection from landfills and biological methane oxidation can reduce emissions further by 30 - 60 Mtonnes of CO₂ equivalent in the year 2010 (compared to the declining baseline) depending on the extent to which these measures are combined.

The European Commission has proposed a directive aiming at waste

prevention and ensuring high standards for the disposal of waste, including methane recovery.

Furthermore, the European Commission has issued a Strategy Paper on methane [11]. Here, policies and measures in various other areas (coal mining, natural gas production and distribution, enteric fermentation) are discussed, but no concrete proposals are put forward.

N₂O emission reduction in the chemical industry

Technical measures are available or under development that can reduce N₂O emissions from chemical industry by over 90%.

Most far ahead are the adipic acid manufacturers (70% of N₂O emissions in EU chemical industries) of which the big five have agreed to cut emissions before the year 2000. For emission reduction from nitric acid plants technology development is required, but also for these plants substantial reductions are expected to be feasible before 2010. No policies have been implemented yet.

Reduction of fluorocarbon emissions

In 1990 emissions of fluorocarbons and SF₆ were fairly small. However, due to the partial replacement of Montreal Protocol substances like CFC's and HCFC's by HFC's the business-as-usual emissions are expected to rise.

Emissions may increase to 150 Mtonnes CO₂-equivalent in 2005 - 2010. However, due to the uncertainty in replacement rates, this figure is highly uncertain. It is estimated that at least two-thirds of these emissions can be avoided by applying leak-free systems or non-fluorinated compounds.

Fluorocarbons are not part of the Council proposal. Policy development is still in an embryonic stage.

5. Overview and discussion

An overview of the reduction potential of the measures is given in Table 1. The total effect of the measures for CO₂ emission reduction may have a combined effect of 430 - 760 Mtonnes (avoiding double counting, e.g. on CHP and minimum energy taxation) compared to the baseline. If all these measures are successful emissions will not increase by 9% as in the business-as-usual scenario, but decline by 5 - 15%. Whether the upper end of this range will be attained depends on the degree of ambitiousness of the policies implemented. A first conclusion may be that the -15% target in principle is achievable for the EU with concrete policies and measures.

Note that in some areas additional emission reductions are possible, e.g. energy efficiency improvement in buildings, light industry, air traffic and freight traffic and material efficiency improvement. An earlier study for the year 2005 explored the potential effect of policies and measures in these areas as well and showed that there is indeed additional potential [12].

Table 1. Overview of common and coordinated policies and measures and the expected emission reduction potential (in Mtonnes of CO₂ equivalent).

Renewable energy	up to 200
Cogeneration	110 - 220
Energy efficiency electric appliances	55 - 90
Energy in buildings	?
Energy efficiency passenger cars	80 - 120
Energy efficiency heavy industry	70 - 130
Removal of subsidies	15 or more
Energy taxation	40
Modal switch	up to 30
HFC's	~ 100
Methane from landfills	30 - 60
N ₂ O chemical industry	70 - 95

For methane stronger emission reductions are feasible. The Strategy Paper from the European Commission estimates the potential to be 40% in 2010 compared to 1990. This is not unimportant: if this full potential were to be realised the required emission reduction for the other two gases would only be 11 - 12% in order to reach the average target of 15%.

For nitrous oxides the emission reduction potential is uncertain, especially due to the fact that it is uncertain to what extent individual countries have already included emission reduction measures in their baseline estimates.

6. Conclusions

In this paper an overview was given of the policies and measures available for greenhouse gas emission reduction in the European Union. Common and coordinated policies and measures can lead to a reduction of CO₂ emissions by 15% in the year 2010 compared to 1990. However, this requires an ambitious policy. For most of the relevant areas such policies are in place or under development. The situation can be alleviated by developing national and coordinated policies in some other areas, including methane emission reduction.

References

1. Council conclusions on climate change, Meeting document CONS/ENV/97/1 REV 1, General Secretariat of the Council, European Commission, Brussels, 1997.
2. G.J.M. Phylipsen, K. Blok, H. Merkus: The Expert's Group work on EU Common and Coordinated Policies and Measures, Dept. of Science, Technology and Society, Utrecht University, 1997.
3. Communication of the European Commission to the UN-FCCC, COM(96) 217 final, Brussels, 1996.
4. Report on the in-depth review of the national communication of the European Community, FCCC/IDR.1/EUR, UN-FCCC secretariat, Bonn, 1997.
5. European Energy to 2020 - A Scenario Approach, European Commission, Luxembourg, 1996.
6. Based on individual country submissions to the secretariat of the UN-FCCC.
7. Energy for the Future: renewable sources of energy. Green Paper for a Community Strategy, Communication from the Commission COM(96)576, Brussels, 1996.
8. P. Bertoldi: European Union Efforts to Promote More Efficient Use of Electricity: the PACE Programme, European Commission, Brussels, 1996.
9. A Community strategy to reduce CO₂ emissions from passenger cars and improve the fuel economy, Council Conclusions, European Union - The Council, 8748-96, Brussels, 1996.

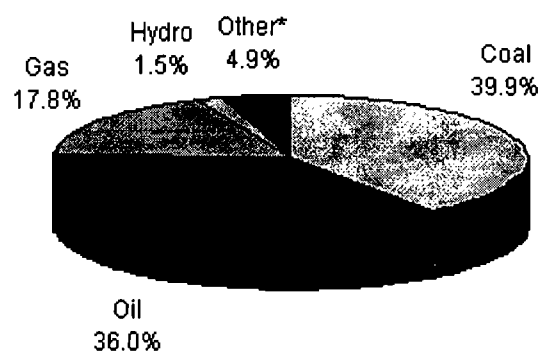
10. Proposal for a Council Directive restructuring the Community framework for the taxation of energy products, European Commission, Brussels, 1997.
11. Strategy Paper for reducing methane emissions, European Commission, COM(96)557, Brussels, 1996.
12. K. Blok, D. van Vuuren, A.J.M. van Wijk, L.G. Hein: Policies and measures to reduce CO₂ emissions by efficiency and renewables, WWF Netherlands, Zeist, 1996.

Australia

1995 Key Energy Indicators

Population (million)	18.05	GDP (billion 1990 US dollars):	335.94
Total Primary Energy Supply in Mtoe:	94.20	Electricity Consumption in TWh:	162.10
TPES/population (toe per capita):	5.22	TPES/GDP (toe per 000 US dollars):	0.28
Electricity Cons./pop (kWh per capita):	8979	Electricity Cons./GDP (kWh per US dollar):	0.48

Energy Share in 1995 Total Primary Energy Supply

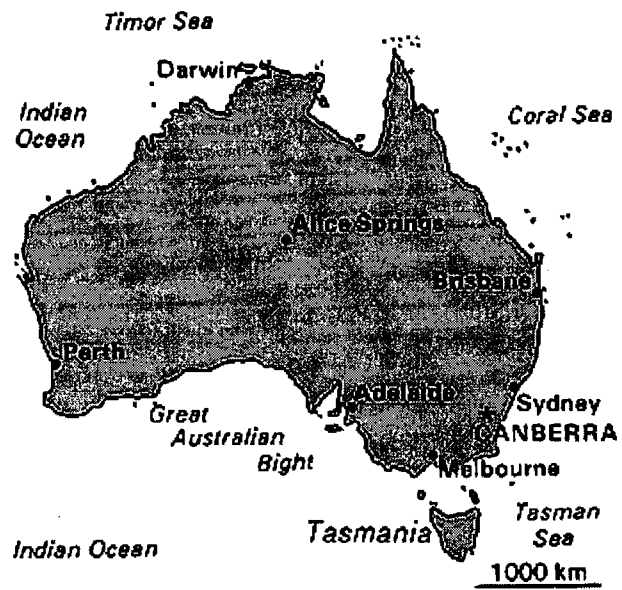


* Includes geothermal, solar, wind, combustible renewables & waste, etc.

Note: Excludes electricity trade.



You can obtain more detailed information from *Energy Statistics of OECD Countries* and *Energy Balances of OECD Countries* as well as in *Energy Policies of IEA Countries - 1996 Review*

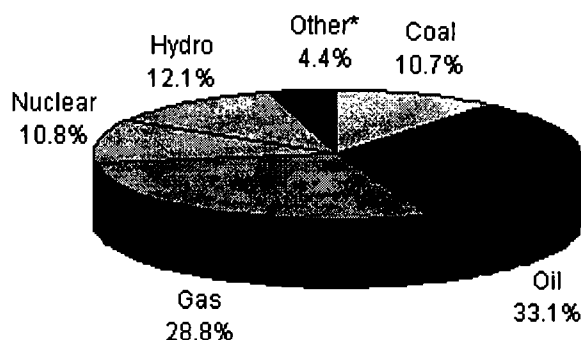


Canada

1995 Key Energy Indicators

Population (million)	29.61	GDP (billion 1990 US dollars):	612.23
Total Primary Energy Supply in Mtoe:	233.33	Electricity Consumption in TWh:	490.01
TPES/population (toe per capita):	7.88	TPES/GDP (toe per 000 US dollars):	0.38
Electricity Cons./pop (kWh per capita):	16551	Electricity Cons./GDP (kWh per US dollar):	0.80

Energy Share in 1995 TPES



* Includes geothermal, solar, wind, combustible renewables & waste, etc.

Note: Excludes electricity trade.

You can obtain more detailed information from *Energy Statistics of OECD Countries* and *Energy Balances of OECD Countries* as well as in *Energy Policies of Canada - 1996 Survey* and *Energy Policies of IEA Countries - 1996 Review*.



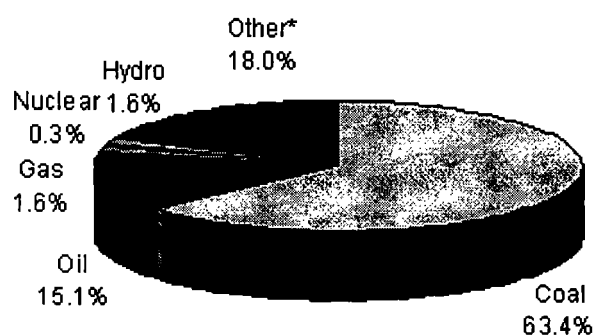
China



Key Energy Indicators in 1995

Population (million)	1200	GDP (billion 1990 US dollars):	634
Total Primary Energy Supply in Mtoe (does not include combustible renewables):	851	Electricity Consumption in TWh:	928
TPES/population (toe per capita):	0.71	TPES/GDP (toe per 000 US dollars):	1.34
Electricity Cons./pop (kWh per capita):	773	Electricity Cons./GDP (kWh per US dollar):	1.46

Energy Share of TPES in 1995

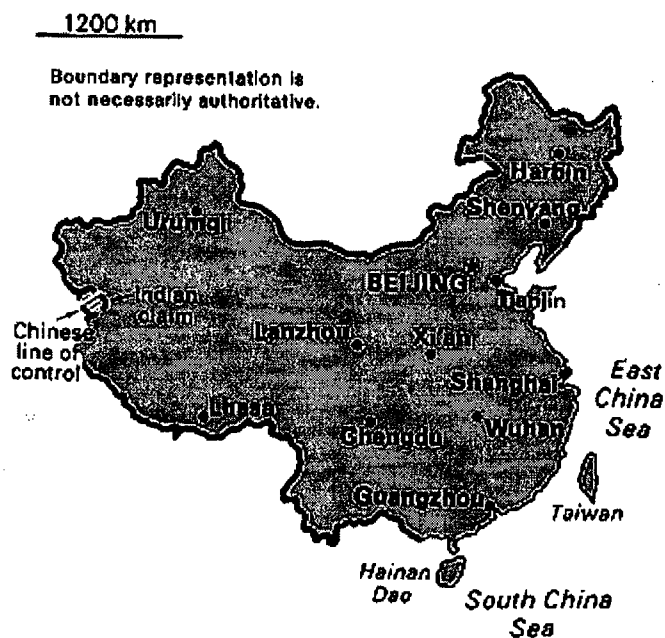


* Includes geothermal, solar, wind, combustible renewables & waste, etc.

Note: Excludes electricity trade.



You can obtain more detailed information from *Energy Statistics and Balances of non-OECD Countries*

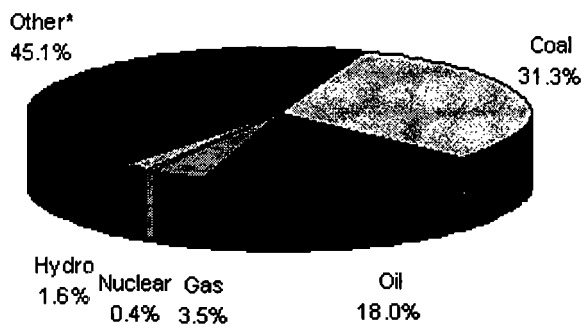




Key Energy Indicators in 1995

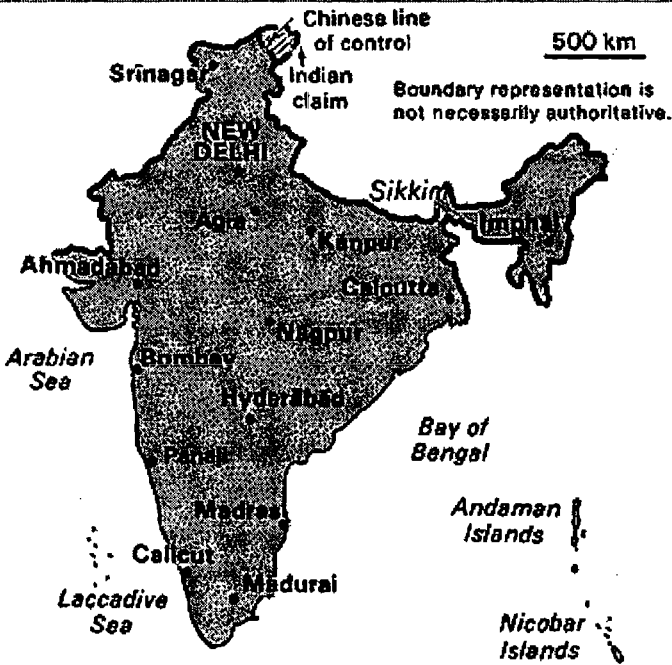
Population (million)	929.4	GDP (billion 1990 US dollars):	370.2
Total Primary Energy Supply in Mtoe:	241.29	Electricity Consumption in TWh:	341.51
TPES/population (toe per capita):	0.26	TPES/GDP (toe per 000 US dollars):	0.65
Electricity Cons./pop (kWh per capita):	367	Electricity Cons./GDP (kWh per US dollar):	0.92

Energy Share of TPES in 1995



* Includes geothermal, solar, wind, combustible renewables & waste, etc.
Note: Excludes electricity trade.

You can obtain more detailed information from *Energy Statistics and Balances of non-OECD Countries*

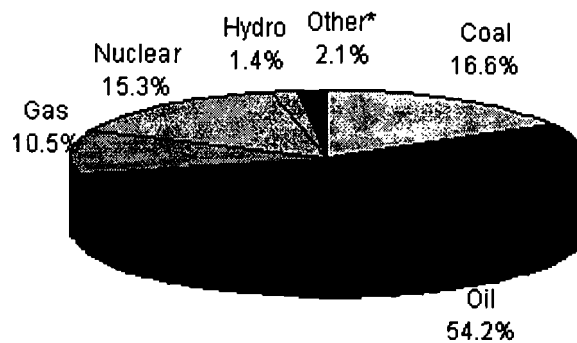


Japan

1995 Key Energy Indicators

Population (million)	125.57	GDP (billion 1990 US dollars):	3168.55
Total Primary Energy Supply in Mtoe:	497.23	Electricity Consumption in TWh:	952.69
TPES/population (toe per capita):	3.96	TPES/GDP (toe per 000 US dollars):	0.16
Electricity Cons./pop (kWh per capita):	7587	Electricity Cons./GDP (kWh per US dollar):	0.30

Energy Share in 1995 TPES



* Includes geothermal, solar, wind, combustible renewables & waste, etc.

Note: Excludes electricity trade.

You can obtain more detailed information from *Energy Statistics of OECD Countries* and *Energy Balances of OECD Countries* as well as in *Energy Policies of IEA Countries - 1996 Review*



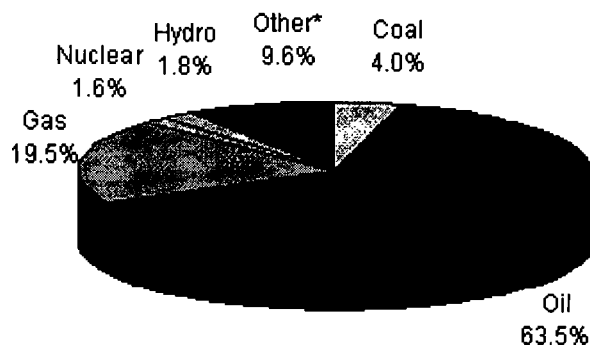
Mexico



1995 Key Energy Indicators

Population (million)	94.78	GDP (billion 1990 US dollars):	283.42
Total Primary Energy Supply in Mtoe:	133.37	Electricity Consumption in TWh:	130.00
TPES/population (toe per capita):	1.41	TPES/GDP (toe per 000 US dollars):	0.47
Electricity Cons./pop (kWh per capita):	1372	Electricity Cons./GDP (kWh per US dollar):	0.46

Energy Share in 1995 TPES



* Includes geothermal, solar, wind, combustible renewables & waste, etc.

Note: Excludes electricity trade.



You can obtain more detailed information from *Energy Statistics of OECD Countries* and *Energy Balances of OECD Countries* as well as in *Energy Policies of IEA Countries - 1996 Review*



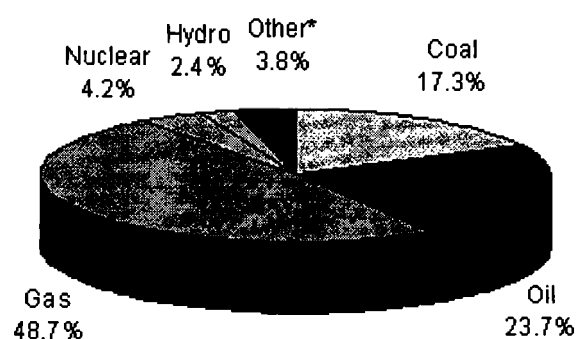
Russia



Key Energy Indicators in 1995

Population (million)	148.2	GDP (billion 1990 US dollars):	360.3
Total Primary Energy Supply in Mtoe (does not include combustible renewables):	604.46	Electricity Consumption in TWh:	756.95
TPES/population (toe per capita):	4.08	TPES/GDP (toe per 000 US dollars):	1.68
Electricity Cons./pop (kWh per capita):	5108	Electricity Cons./GDP (kWh per US dollar):	2.10

Energy Share of TPES in 1995

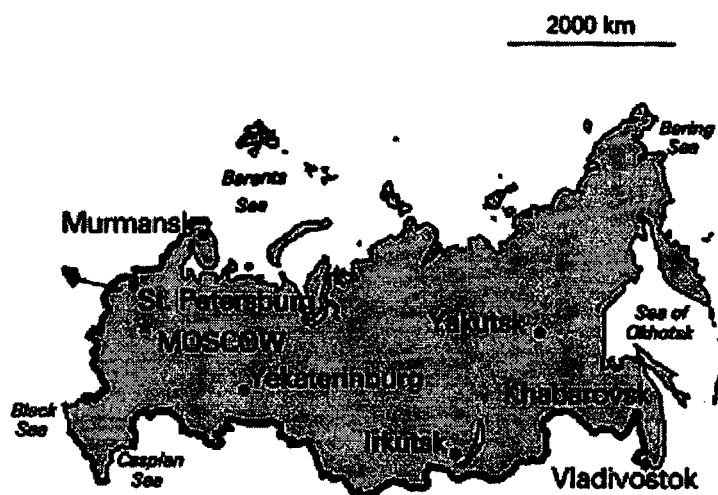


* Includes geothermal, solar, wind, combustible renewables & waste, etc.

Note: Excludes electricity trade.



You can obtain more detailed information from *Energy Statistics and Balances of non-OECD Countries* as well as in *Energy Policies of the Russian Federation*.



Boundary representation is
not necessarily authoritative.