ENERGY CONSERVATION IN OECD COUNTRIES

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CONTENTS

1. This note relates to some aspects of energy conservation in OECD countries. First it appraises the recent experience of conservation by way of analysing changes in the ratio of energy consumed to output produced and income generated in these countries. It then details some of the OECD country government policies and other measures encouraging energy conservation and comments on their probable effectiveness. Finally, it provides some indications of the incentives and scope for future conservation.

I. The recent experience

2. The term 'energy conservation' is capable of several interpretations : in its most simple sense it can be construed simply as 'doing with less', e.g. changing 'life-styles' or altering the composition of economies as a result of cyclical or structural factors; it can also be construed as 'doing better' e.g. raising efficiencies in converting, distributing and utilising energy through technological development. In a dynamic world both these constructions are likely to take place simultaneously, but in the advanced industrial countries during recent years cyclical factors seem to have been much more important than improved efficiencies in accounting for the remarkable drop in the ratio of change in energy consumed to that of GDP generated or industrial production.

3. Table 1 shows average annual rates of growth in energy consumption and in GDP for selected OECD countries during the 1970s, the data being split into two periods - 1970-73 when oil was still very cheap and supplies abundant and 1974-78 when it became more expensive and, at times, less abundant. Table 2 shows the same data expressed in ratio form (i.e. percentage change in energy consumption divided by percentage change in GDP) for 1970-73 and 1974-78, together with one earlier and longer period (1960-73) and projections for two later ones (1978-85 and 1985-90). Table 3 shows average annual rates of growth of energy consumed in industry and of industrial production for selected OECD countries on average during 1970-73 and 1974-78.

4. The following are the major features shown by the tables :

i) energy consumption and GDP each increased much less quickly on average during 1974-78 than during 1970-73 ;

ii) but whereas the overall average rate of growth in GDP decelerated by less than half, that in energy consumption slackened by around four-fifths ;

iii) it followed that the energy/GDP ratios were substantially lower on average during 1974-78 than they had been during 1970-73, the overall drop for OECD being from 0.9 to 0.3 ;

iv) such a low energy/GDP ratio is not expected to be maintained however, and for IEA countries(1) in total, the IEA Secretariat

1. The International Energy Agency, established in 1974, consists of 21 of the 24 member countries of OECD (all except Finland, France and Iceland).

has projected coefficients for the 1980s which are substantially above those registered on average during 1974-78, though significantly below those of earlier periods ;

v) several countries' consumption of energy actually declined on average during 1974-78 although their GDP continued to increase (albeit at reduced rates) ;

vi) in CECD as a whole, energy consumed by industry showed no overall change during 1974-78 while growth of industrial production was only two-fifths the rate of 1970-73 ;

vii) although there were marked variations between countries, in none of them did energy consumed by industry rise on average as quickly in the later as in the earlier period whilst in over half of them it actually declined ; and

viii) the average energy/industry ratios during 1974-78 were lower than during 1970-73 for almost all countries.

5. The following reasons can be adduced to explain the above factors :

i) although it is not possible to quantify the effects of energy conservation policies, much, almost certainly most, of the decline in the ratio of growth in energy consumed to that of GDP produced in OECD countries since 1974 can be attributed to economic recession or stagnation causing the composition of these countries' economies to undergo cyclical change ;

ii) these changes meant that comparing the two periods 1970-73 and 1974-77, the contribution to GDP of the industry sector (which accounts for about two-fifths of the final consumption of energy in OECD) decreased from 32% to 30%, whereas that of the services/commercial sector (accounting for only around a tenth of the final consumption of energy) increased from 53% to 55% ;

iii) within the industry sector, the 'heavy', energy-intensive industries were particularly depressed : comparing 1970-73 with 1974-78, production of steel, which accounts for between a fifth and a quarter of the consumption of energy in the industry sector, had risen on average by 5% annually during the earlier period but fell by 2% annually during the later one; growth in the production of chemicals, which accounts for around a sixth of the sector's consumption of energy, dropped from 7% to 3% annually, and that of aluminium from 7% to 2% annually; output of cement, which had grown on average by 7% annually during 1970-73, showed no growth on average during 1974-78. Production in the less energy-intensive industries, such as food, drink and tobacco, was generally less depressed and in certain industries, e.g. electronics, pharmaceuticals and precision instruments, it remained comparatively buoyant ;

iv) the pace of increase of energy consumption in the services/commercial sector also diminished after 1973, mainly as a consequence of the slowing down in economic activity, as it did in the residential sector, chiefly as a result of the more efficient utilisation of energy in the home (e.g. the change to using central

heating boilers rather than open fires). Together the rate of growth of energy consumption in these two sectors, which account for around a third of the total in OECD countries, slackened from 5% on average during 1960-73 to 0.4% during 1974-77 ;

v) growth of energy consumed in the transport sector - accounting for around a quarter of the OECD total - also diminished in pace after 1973, the 1974-77 annual average of 2.1% being much less than the 5% of 1960-73. Most of the deceleration reflected the slower rate of economic growth, although improved technical efficiencies and conservation policies played a part ; and

vi) turning to the future, the projected IEA energy/GDP coefficients of more than 0.8 for the 1980s, compared with 0.3 during 1974-78, are on the basis of a return to high rates of economic growth (1) and a resurgence in industrial production.

II. Government policies and other measures affecting energy conservation

6. Member countries of the IEA have been concerned with energy conservation ever since the Agency was established, and in November 1974 they adopted an International Energy Programme which included the long-term cooperation between members to reduce their excessive dependence on oil. In October 1977 the Agency adopted a Group Objective consisting of a ceiling target of 26 mbd(2) for net imports of oil in 1985 and reinforced measures of energy conservation, on a high priority basis with increased resources, to limit growth in energy demand relative to economic growth, eliminate inefficient use, especially of rapidly depleting fuels, and encourage substitution for fuels in shortest supply. The means by which these objectives would be attained included pricing policies (including fiscal measures), implementation of minimum energy-efficiency standards, and encouragement of increased investment in energy-saving equipment and techniques.

a) Oil import targets

7. The concept of a ceiling target for net oil imports became increasingly important during the course of 1979 as the rapidly changing situation and uncertain prospects in Iran led to growing anxiety among the IEA importers regarding the security of future supplies. In June, leaders of the seven countries at the Tokyo Summit had agreed on a set of goals for the limitation of oil imports, but these had been variously expressed and it was not until the December Ministerial Meeting of the IEA member countries that agreement was reached on country-by-country targets for the limitation of net imports of crude petroleum and petroleum products in 1980 and 1985. These targets, together with net imports during the 1970s, are shown in Table 4. The 1985 aggregate target of 26.2 mbd (including bunkers) is significantly lower than the previously agreed level of 27.6 mbd and well below earlier projections for 1985 of 29.7 mbd (1977 Review) or 28.5 mbd (1978 Review). Most of the decline was for the United States and Japan, the two largest importers.

8. The December meeting also agreed on an oil monitoring process. This would involve quarterly ministerial meetings when all aspects of oil supply and demand would be discussed, each country's results reviewed, and decisions taken whether the specific measures in operation were adequate and

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1. Average annual increases in GDP of 4.2% during 1977-85 and 3.6% during 1985-90 compared with an out-turn of 2.7% during 1974-78.

2. Million barrels per day.

being implemented effectively and whether additional measures were necessary. Ministers also agreed (i) on the importance of keeping domestic oil prices at world market levels or raising them to those levels as soon as possible; (ii) to seek to develop a system of consultation on oil stock policies, both among governments and between them and the oil companies; and (iii) to consider other measures leading to a more coordinated approach to oil spot market activities.

b) Other government policies and measures

i) Overview

9. The Secretariat of the IEA concluded in 1979 that the measures which had contributed most significantly to energy conservation in member countries were public information programmes, pricing policies, incentive schemes, and efficiency standards and regulations. In general the countries which had experienced the largest increases in energy prices and had the strongest conservation programmes had been those in which the energy consumed per unit of GDP had diminished most. Denmark, Netherlands and Sweden were judged by the IEA Secretariat to have strong and quite comprehensive programmes which were being effectively implemented. Canada, Germany, Italy, Japan, New Zealand, Norway, United Kingdom and United States had all implemented programmes but in general these needed reinforcement. Austria, Belgium, Greece, Ireland, Luxembourg, Spain and Switzerland had still not adopted significant measures except for information campaigns.

10. It is very difficult if not impossible to quantify satisfactorily the results of the conservation measures taken in countries. The IEA Secretariat has estimated that the overall efficiency in the use of energy improved by 2.3% in 1974, 4.2% in 1975, 4.5% in 1976 and 6.7% in 1977. But by basing their calculations on the average ratio of growth of energy consumption to that of GDP generated during the period 1960-73, they appeared to have assumed an unchanging composition of GDP, which was far from the case. It may have been the fallacious nature of this assumption which accounted for the apparently rather perverse results of some of their calculations for individual countries. These showed that in ten countries (Belgium, Denmark, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, Norway and United Kingdom), actual consumption of energy during 1974-77 was more than 4.5% lower than hypothetical consumption based on the average 1960-73 ratio of energy to GDP; for five countries (Austria, Canada, Germany, Sweden and United States), it was less than 4.5% lower; while for four countries (New Zealand, Spain, Switzerland and Turkey), actual consumption was equal to or higher than hypothetical consumption. Whilst these results would accord with the relative strength or weakness of conservation policies in some countries (e.g. strength in Denmark, Netherlands and to a lesser extent Sweden; weakness in Spain and Switzerland), they would appear to be very misleading for other countries (e.g. Belgium, Greece, Ireland and Luxembourg). It may be noted that in some of these countries, for example Belgium and Luxembourg, cyclical changes in the composition of GDP have been very marked as a result of the depression in the steel industry. Details of some of the main conservation policy elements in the three major energy consuming sectors are given in the following paragraphs.

ii) Industry sector

11. The composition of industrial energy conservation programmes has varied from one IEA country to another : some have placed the major emphasis on voluntary and incentive measures, whereas others primarily employ regulatory measures. Considerable progress has been made in conserving the use

of energy in industry, but there have been significant constraints of an economic nature (lack of funds and the long pay-back period for many energy-conservation investments), of an informational character (lack of awareness of technological possibilities, particularly in smaller enterprises) and of an institutional type (especially important for the use of waste heat). In consequence the IEA 1978 Review of Energy Policies and Programmes concluded that as this sector is the largest single user of energy in most IEA countries and is expected to show the greatest growth in energy consumption over the next decade or so, efforts to promote the conservation of energy in industry should be expanded and intensified.

12. The most important element in any energy conservation programme for industry was judged to be energy prices and taxes. Energy price increases from 1973 to 1977 were higher for use in industry than in other sectors but they varied considerably from one IEA country to another, depending in part on their mix of fuels in total energy consumed and in part on government fiscal policies. In general, increases were lower for those countries, such as Germany and Belgium, where use of coal was relatively more important than in those, such as Italy and Japan, where oil was comparatively more significant. One exception was the United States, where increases were restrained by domestic price controls and a passive fiscal policy toward fuels. Energy prices paid by industry still vary greatly from one country to another; in real terms they are probably highest in Japan and lowest in North America (particularly for natural gas). The evolution of energy price increases during the 1970s for selected OECD countries' industry sectors is given in Table 5, which also enables the making of inter-country comparisons of fuel prices in 1978.

13. A second major element in such a programme consists of financial and fiscal incentives to encourage investment in energy-saving techniques and equipment (including the greater utilisation of combined heat and power production in combination with district heating and that of waste heat and other waste). In 1978, twelve(1) IEA member countries provided grants or subsidies for this purpose and eight(2) of them provided loans. Eight (3) countries allowed various kinds of tax relief for this purpose.

14. Other elements of energy conservation programmes for industry include : (i) target setting by governments or industry associations for energy-intensive industries (in operation in five IEA countries, usually on a voluntary basis); (ii) schemes under which companies are required to report their energy consumption to governments (operated by five member countries) or are required to collect information on energy flows within industries (operated by nine IEA countries but on a comprehensive basis in only three and used only for advisory purposes); (iii) the provision of information on energy-savings by means of publication programmes (operated by seventeen IEA countries) or programmes of meetings and seminars (operated by twelve member countries); (iv) the provision of advice services for small and medium sized industries (operated by fifteen member countries); and (v) greater emphasis on the importance of appropriate patterns of fuel utilisation, particularly on the substitution of oil and, to a lesser extent, natural gas by other energy sources (part of the policies of thirteen IEA members).

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1. Canada, Denmark, Germany, Ireland, Japan, Netherlands, New Zealand, Norway, Spain, Sweden, United Kingdom and United States.
2. Austria, Denmark, Germany, Japan, Netherlands, New Zealand, Norway and United States.
3. Austria, Canada, Germany, Japan, New Zealand, Norway, United Kingdom and United States.

iii) Residential and services (commercial) sector

15. The greatest potential for energy-saving in the residential and services (commercial) sector lies in retro-fitting existing buildings and adopting codes which stipulate minimum thermal efficiencies for new buildings. In general the incentives available for and existing regulations on energy conservation in this sector appeared inadequate. Among IEA member countries in 1978, fiscal incentives for building insulation were available in only seven(1), grants in ten(2) and loans in eight(3). Building regulations incorporating energy conservation provisions were in operation in thirteen countries in the case of new homes, in eight in the case of existing homes, and in nine in the case of public buildings. Regulations on maximum air temperature existed in five countries and on maximum water temperatures in two. Six countries gave grants or other fiscal/financial incentives for the introduction of domestic solar heat/power systems, but experience in many IEA countries shows that the economics of conventional conservation measures are, for the time being, better than the economics of renewable energies, although this should change in the long-term. Standards programmes on the energy efficiency of domestic appliances were in operation in seven countries and in preparation in an eighth. Labelling of the energy efficiency or energy usage of domestic appliances was undertaken on a voluntary basis infour countries and under preparation in eight others; three countries operated labelling on a mandatory basis.

16. The promotion of energy conservation in the residential sector through the price mechanism appeared in general to have been rather relaxed in IEA countries during 1974-78. Although in most IEA countries prices increased significantly (more than in the transport sector but less than in industry), there were considerable variations between them; in general the increases were less steep in countries with strong currencies, such as Germany, than in those with weak ones, such as Italy. Prices themselves also varied substantially between countries : lack of data make comparisons difficult, but it appears that in 'real terms' they were particularly low for natural gas and heating oil in North America. The evolution of prices for certain fuels in the residential sector of the major OECD countries and inter-country comparisons of prices in 1978 are shown in Table 6.

iv) Transport sector

17. The IEA Secretariat has stated that it is more difficult to implement energy conservation programmes in the transport sector than in all others; consequently there has been little progress in improving the sector's energy performance. One reason for this has been the lack of price incentives : gasoline prices decreased in real terms from 1975 to 1978 (inclusive) in most IEA countries and by 1978 were higher than during 1973-74 in only four of them (Canada, Ireland, Italy and Spain). The evolution of gasoline and diesel prices during the 1970s is shown in Table 7, which also enables inter-country comparisons to be made of prices in 1978; the latter shows the very low level of prices of gasoline and diesel in North America (mainly due to the small tax element) and of diesel in Italy, where gasoline prices were the highest in the IEA. However, prices increased sharply during 1979 : in the EEC those of gasoline rose on average by over two-thirds and of diesel by around three-quarters; in the United States prices of gasoline and diesel each rose by more than two-fifths and, even more important, there were severe shortages during part of the year which led to rationing of gasoline in some states and to a fall in consumption of around 5%.

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1. Canada, Denmark, Germany, Greece, Spain, Sweden and United States.
2. Austria, Belgium, Canada, Denmark, Germany, Ireland, Netherlands, Sweden, United Kingdom and United States.
3. Canada, Germany, Japan, Netherlands, New Zealand, Norway, Sweden and United States.

18. The most important regulatory measures to conserve energy in the transport sector are the mandatory fuel economy standards adopted by the United States and Canada. In the United States minimum fuel economy standards have been set for automobiles manufactured after 1977. The standard is becoming progressively more stringent and is to reach 27.5 miles per gallon by 1985. In Canada similar standards have been announced to take effect in 1980 and 1985. Elsewhere, manufacturers in Germany have agreed to increase fuel economy by not less than 10% by 1985 and in Japan some 1978 models showed more than a 20% improvement in fuel economy over 1975 models. Fuel consumption labelling is already mandatory in Sweden, the United States and the United Kingdom, and some producers are applying voluntary schemes in Canada and Japan; the EEC Commission is considering the adoption of a scheme for the Community (the 'Europa Test'). Other government measures to conserve energy in the road transport sector include initiatives to promote car pooling schemes (in operation in four IEA countries and under consideration in seven others) and the implementation of speed limits (in operation in all member countries but at generally higher levels than during the 1974 energy crisis). One measure which would save energy, but which is so unpopular as not to have been taken on any significant scale, would be to ban private cars from city centres and thus to increase the use of the more energy-effective forms of public transport.

III. The incentives and scope for future energy conservation

19. The chief incentive for expanding and deepening the effort to conserve the use of energy is that of possible future shortage. In the short- or medium-term, such a shortage is likely only as a result of political instability in the Middle East or a marked change in OPEC oil production policies. Both are insufficiently improbable for the comfort of oil-importing countries. Many commentators now suggest it likely that OPEC's maximum oil production in the 1980s will remain at or around 31-32 mbd, compared with its present maximum technical capacity of some 39-40 mbd, and that output will be reduced if necessary to maintain real prices. In the longer-term a shortage could be caused by a lack of investment in conventional energy production facilities and/or a lack of energy resources.

20. The recent steep increases in OPEC prices, from some $13.50 per barrel at the end of 1978 to an average of around $27.00 per barrel at the end of January 1980, should have given a sharp fillip to planned conservation in the use of oil. Although the depreciation of the US dollar has mitigated the effects of recent price rises for many IEA countries, while the continuing inflation has softened the consequences for nearly all of them, pronouncements by OPEC make it unlikely that the 1980s will see any significant periods of declining oil prices in real terms. In February 1980, for example, an OPEC Committee, meeting in London, is understood to have agreed on an automatic system to raise oil prices in real terms. It was reported that the system would lead to prices being adjusted on a quarterly basis by first taking account of inflation and of currency movements in OECD countries and then raising the resultant prices by the percentage increases of OECD countries' GDP in real terms; oil production would be adjusted to demand in order to maintain such prices. The proposed system is to be considered by a full meeting of OPEC later in the year.

21. If such a scheme were adopted and implemented effectively, the price of oil in real terms could rise by, say, 2% to 4% or 5% annually, depending on the growth of OECD countries' economies (whether it would be allowed to fall if OECD growth became negative is another issue). This would provide a significant incentive to further efforts to conserve the use of oil, both because of the current rise in its 'real' price and because of the certainty that such rises would continue. Assuming the price of OPEC oil

sets a long-term ceiling to that of other sources of oil and of other forms of energy (taking into account their differing calorific values and other relevant factors, such as ease of use, certainty of supply, etc.), action by OPEC should also stimulate efforts to conserve the use of other forms of energy, particularly other depletable fossil fuels.

22. The scope for such further conservation is very substantial, though subject to varying estimates. One recent study(1) has estimated that in the EEC over a quarter of the primary energy input is lost at the processing and distribution stage and a further two-fifths in its conversion into useful energy; in other words only one-third of primary energy is transformed into useful energy. Data are given in Table 8.

23. Over two-thirds of the losses at the energy processing and distribution stage in the EEC have occurred in the conversion of primary energy into thermal electricity. The average net thermal efficiency of electricity generating stations is currently around 32%, although the newest plants achieve some 35% and in a few nuclear plants the rate is nearer 40%. As the maximum thermal efficiency likely to be achieved in conventional stations is only around 43% there is clearly need for the early and widespread adoption of other methods of cutting losses of energy in the generation of electricity; the most obvious means would be the greater use of combined heat and power (CHP) systems which give a total thermal efficiency at least 1.5 times higher than that obtained when heat and electric power are generated separately. The second largest losses at this stage have taken place in oil refining. There are technical difficulties in achieving further economies in this process owing to the need for product flexibility, but it has been held that in the medium-term (say by 1990) a net saving in crude oil input per unit of oil product output of 10%-15% can be achieved, and in the longer-term (say by 2025) one of 25% may be possible.

24. At the stage when delivered energy is converted into useful energy the greatest proportionate losses in the EEC have occurred in the transport sector where, it has been estimated, they reached some 80%. It has been suggested that between 1975 and 1985 the fuel efficiency of this sector could be improved by 16% in the EEC, by 18% in Japan, and by 35%-45% in North America; between 1975 and 2000 savings would be considerably greater, possibly of up to 35%-40% in the EEC. In all cases the bulk of the improvement would come from improved vehicle engine efficiency, although other factors such as lighter construction materials would also play their part.

25. In the residential and services (commercial and public administration) sector, it has been estimated that in the EEC over half of the delivered energy is lost in the conversion into useful energy. Much of this could have been saved with adequate insulation and it has been suggested that between 1975 and 1985 25% of energy used in this sector in the EEC could be saved and 45% by 2000.

26. In the industry sector, calculations suggest that almost half of the delivered energy is lost in the conversion to useful energy. Among the energy-intensive industries, fuel savings of at least 20%-25% per unit of finished steel have been suggested as achievable in the ECE region by the end of the century; these figures are probably conservative and significantly

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1. Fred Roberts : 'The scope for energy conservation in the EEC', 'Energy Policy' (IPC Business Press), June 1979.

higher ones have been quoted for individual countries (e.g. 30% in UK). In the chemical industry it has been estimated that savings of 15% in fuel input per unit of output could be achieved between 1975 and 1985 and of 20% by around 1995. In aluminium it has been calculated that raising the proportion of scrap recycled from, say, 20% to 40% would save around 12% of the energy consumed by the industry, while using the new Alcoa process for primary smelting would raise its energy efficiency from around 30% to 40%. In the cement industry the use of the dry process (as against the wet one) would lead to energy savings per unit of output of around 35%. In the case of other industries - some of which, like glass and brick-making, are energy-intensive - it has been estimated that the amount of energy consumed per unit of output could be reduced overall by around 15% between 1975 and 1985 and by some 25%-30% between 1975 and 2000.

27. The effects on total energy consumption per unit of GDP generated, of these technical possibilities for conserving the use of energy in particular purposes would depend on the future relative importance of the sectors in which the energy is used. The IEA Secretariat, in its 1978 Review, forecast that final consumption of energy in member countries from 1977 to 1990 would grow at below-average rates in the residential, services (commercial) and transport sectors, but at above-average rates in the industry sector; the last mentioned would therefore rise in relative importance while the others declined. Total final consumption of energy, it was forecast, would rise at about $2\frac{1}{2}$% annually whereas that of the primary energy input would increase at a higher rate during 1977-1985 (3.5% annually) than during 1985-1990 (2.9% annually)(1). Details are given in Table 9. Such a forecast would imply a considerably greater improvement in the efficiency of processing primary energy and of distributing marketable energy during 1985-1990 than during 1977-1985.

28. Taking all these factors into account, the IEA has concluded that member countries could save 10%-15% of their total energy consumption by 1985 if they follow a vigorous and systematic energy conservation policy. On assumed high rates of growth of GDP it forecast a decline in the ratio of primary energy consumed to GDP generated from 0.84 (1977-1985) to 0.81 (1985-1990). Another study(2) has suggested that by the end of the century around a third of the energy losses in the EEC could be saved and that the average energy/GDP coefficient may have fallen to 0.5 on assumed high rates of economic growth. A third study(3) has demonstrated in great detail how the United Kingdom GDP could increase on average by $1\frac{1}{2}$% or $2\frac{1}{4}$% annually between 1976 and 2025 (so that its GDP in 2025 was two or three times respectively more than that in 1976) and at the same time consume 22% or 8% respectively less primary energy in 2025 than it had in 1976. This would imply a negative energy/GDP coefficient (not unknown in the UK). A fourth study(4) has concluded that "with sufficiently high energy prices over the next few decades, the United States could double the efficiency with which it uses energy without significant adverse effect on economic growth". Whatever variations exist in the estimates, all agree that the scope for further conservation in the use of energy is very considerable in the long-term.

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1. These projections were based on expected annual GDP rates for the IEA group of 4.2% and 3.6% respectively.
2. Fred Roberts : 'The scope for energy conservation in the EEC', 'Energy Policy' (IPC Business Press), June 1979.
3. Gerald Leach et al : 'A low energy strategy for the United Kingdom' (IIED, Science Reviews 1979).
4. US National Academy of Sciences : 'Energy in transition, 1985-2010' (US Department of Energy, January 1980).

Table 1

Growth in energy consumption and in GDP for selected OECD countries, 1970-78*

(percentages, annual average)

	1970-1973		1974-1978	
	Energy	GDP	Energy	GDP
Canada	5.10	5.84	1.90	3.31
United States	3.54	3.65	0.65	2.68
Australia	5.04	4.85	4.07	2.53
Japan	8.19	9.00	0.82	3.95
Belgium	5.52	5.55	-0.69	2.27
Denmark	1.61	3.89	1.59	2.11
France	5.93	5.61	0.45	2.86
Germany	4.48	4.24	0.58	2.13
Ireland	3.37	4.49	2.05	3.43
Italy	5.60	3.77	1.67	1.97
Netherlands	10.10	4.78	-0.94	2.59
United Kingdom	1.95	3.60	-0.74	1.25
Austria	6.64	6.23	0.18	2.49
Greece	16.07	7.86	4.03	4.12
Norway	2.94	4.15	2.89	4.63
Spain	10.47	6.86	4.90	2.44
Sweden	0.97	2.14	1.19	0.88
Switzerland	6.25	4.06	-0.23	-1.32
Total[a]	4.4	4.7	0.9	2.7

*Average annual percentage growth rates calculated as exponential curves fitted to the data by least squares.

a Includes other OECD countries.

Sources: Commonwealth Secretariat calculations based on data from UN 'World Energy Supplies' (various issues) and OECD 'Economic Outlook', December 1979.

Table 2

Energy/GDP ratios for selected OECD countries, 1960-90*

	1960-1973	1970-1973	1974-1978	1977-1985	1985-1990
Canada	0.98	0.87	0.58	0.83	0.69
United States	1.05	0.97	0.24	0.76	0.90
Australia	..	1.04	1.61	..	..
Japan	1.00	0.91	0.21	1.05	0.76
Belgium	0.95	0.99	-0.30	0.76	0.58
Denmark	1.38	0.41	0.75	0.05	0.72
France	..	1.06	0.16	..	..
Germany	1.04	1.01	0.27	0.82	0.54
Ireland	1.08	0.75	0.60	1.36	0.89
Italy	1.51	1.48	0.85	1.05	0.90
Netherlands	1.61	2.11	-0.36	1.29	0.60
United Kingdom	0.71	0.54	-0.59	0.49	0.62
Austria	1.02	1.07	0.07	1.26	0.85
Greece	1.57	2.05	0.98	2.04	1.20
Norway	1.26	0.71	0.62	1.09	0.81
Spain	1.13	1.53	2.01	1.06	0.99
Sweden	1.08	0.45	1.36	0.52	0.59
Switzerland	1.28	1.54	0.17	0.60	0.88
Total a	1.0b	0.94	0.34	0.84b	0.81b

* Average annual percentage growth rates in energy consumption divided by average annual percentage growth rates in GDP during different periods. Note overlap in time-series between different columns. The average percentage growth rates for 1970-73 and 1974-78 have been calculated as exponential curves fitted to the data by least squares.

a Includes other OECD countries.

b Excludes France.

Sources: 1960-1973, 1977-1985 and 1985-1990: 'Energy policies and programmes of IEA countries, 1978 Review' (OECD, 1979); 1970-1973 and 1974-1978: Commonwealth Secretariat calculations based on data of energy consumption given in UN 'World Energy Supplies' (various issues) and of GDP given in OECD 'Economic Outlook', December 1979.

Table 3

Growth in energy consumed by industry and in industrial production for selected countries*

(percentages, annual averages)

	1970-1973		1974-1978	
	Energy consumed by industry	Industrial production	Energy consumed by industry	Industrial production
Canada	7.6	5.8	1.2	2.1
United States	2.4	3.4	0.5	2.3
Australia	4.3	4.3	3.7	0.8[b]
Japan	6.4	8.6	1.4	1.6
Belgium	3.6	4.6	-2.7	0.7
Denmark	3.6	..	-0.5	..
France	0.5	5.9	-0.7	1.7
Germany	3.5	4.3	-3.4	1.3
Ireland	3.6	5.1	2.1	4.3[c]
Italy	4.1	4.3	-1.7	1.4
Netherlands	7.3	6.4	1.3	1.2
United Kingdom	0.9	4.2	-0.0	0.7
Austria	6.1	6.9	-3.9	1.8
Greece	11.3	12.7	4.3	4.7
Norway	1.3	4.6	-0.2	4.7
Spain	9.6	10.4	2.7	4.3
Sweden	2.1	3.8	-3.1	-1.3[c]
Total [a]	3.5	4.6	0.1	1.8

* Average annual percentage growth rates calculated as exponential curves fitted to the data by least squares.
[a] Includes other OECD countries.
[b] Excludes ISIC class 2.
[c] Excludes ISIC class 4.

Sources: Commonwealth Secretariat calculations based on data in OECD 'Energy Balances of OECD Countries' (various issues) and OECD 'Indicators of Industrial Activity' and 'Industrial Production' supplement to 'Main Economic Indicators' (various issues).

Table 4

IEA countries : net imports of crude petroleum and petroleum products

(million tonnes, crude petroleum or equivalent)

	1970-73 Average	1974-78 Average	1974	1975	1976	1977	1978	1979 estimated	1980 target	1985 target
Canada d	-6.0	6.0	-4.9	1.4	8.9	13.4	11.2	7.9	7.4	29.4
United States	223.6	367.4	296.5	312.0	371.8	442.1	414.5	414.1	437.2	436.0
Japan	235.5	261.1	267.1	253.0	258.2	266.9	260.1	265.5	265.3	308.7
Australia	10.6	9.1	10.5	8.3	8.8	8.9	8.9	10.3	13.5	17.0
New Zealand	4.0	4.2	4.9	4.2	4.0	4.1	3.8	5.0	4.2	4.4
Belgium	28.8	26.6	28.8	25.6	26.1	26.6	26.1	28.0	30.0	31.0
Denmark	19.0	16.9	17.8	16.6	16.3	17.0	16.9	16.2	16.5	11.0
France a	111.6		127.1	103.2	120.4	112.6		n.a	117.3	111.0
Germany	133.6	135.6	133.6	124.0	141.0	138.5	141.1	149.1	143.0	141.0
Ireland	5.1	5.6	5.5	5.2	5.2	5.7	6.2	6.5	6.5	8.0
Italy	96.1	95.8	102.0	89.8	97.4	95.6	94.4	98.7	103.5	124.0
Luxembourg	1.5	1.4	1.6	1.3	1.4	1.4	1.5	1.4	1.5	2.0
Netherlands	37.4	36.3	35.9	31.5	37.6	35.6	35.6	40.9	42.0	49.0
United Kingdom d	110.8	76.4	113.2	90.5	82.8	54.1	41.5	19.6	12.0	-5.0
Austria	8.2	9.4	8.7	8.4	9.8	9.6	10.3	11.2	11.5	13.5
Greece	8.7	10.6	10.8	7.9	11.7	10.5	12.0	13.3	14.8	16.5
Norway d	7.5	-2.6	6.5	-1.6	-5.2	-4.0	-8.7	-10.2	-15.5	-18.3
Spain	34.1	45.0	42.4	40.8	47.2	46.8	47.6	49.7	51.0	52.9
Sweden	29.4	28.4	28.0	29.3	28.9	29.2	26.5	29.8	29.9	29.0
Switzerland	14.1	13.8	14.1	12.9	13.6	14.0	14.3	14.0	14.0	14.5
Turkey	6.6	12.2	9.7	10.0	12.8	14.8	13.6	16.6	17.0	25.0
Total b	1,008.6	1,159.2	841.1	1,071.1	1,233.5	1,230.0	1,177.4	1,187.6	1,205.3	1,289.6
Bunkers	c	c	c	c	c	c	72.3	71.6	70.0	80.0
Total less bunkers	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1,105.1	1,116.0	1,135.3	1,209.6
Total (mbd)	(20.5)	(23.6)	(17.1)	(21.8)	(25.1)	(25.0)	(23.9)	(24.1)	(24.5)	(26.2)
Total less bunkers (mbd)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	(22.5)	(22.7)	(23.1)	(24.6)

Note: Country figures for 1970-1977 include bunkers and for 1978-1985 exclude bunkers.

a Not a member of IEA Agreement.
b Excludes France.
c Included in country figures.
d Negative sign indicates net exports.

Sources: 1970-1977: OECD 'Energy Balance of OECD Countries, 1975-1977' (Paris 1979);
1978-1985: IEA Press Release (11 December 1979) and OECD Economic Observer, January, 1980.

Table 5

Average prices of major fuels consumed in industry sector

1968 = 100 a

	Average 1970-1973	1974	1975	1976	1977	1978	Price b
Electricity c							
United States	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Japan	107.4	107.4	191.1	191.7	233.8	236.5	554.6
Germany	96.9	112.2	132.5	141.7	143.6	150.9	540.7
United Kingdom	112.0	133.8	198.9	247.9	286.6	320.6	409.3
France	108.4	119.2	163.0	222.2	230.0	244.7	404.6
Italy	99.4	96.7	164.1	222.1	294.9	340.6	435.1
Canada	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Natural gas d							
United States	237.3	256.6	337.0	378.3	468.0	520.3	71.8
Japan	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Germany	n.a	n.a	n.a	n.a	n.a	n.a	n.a
United Kingdom	112.2	183.3	250.0	325.5	345.6	443.4	115.0
France	120.1	150.8	277.4	276.6	312.0	380.4	107.5
Italy	123.9	128.8	336.8	391.4	515.8	601.9	82.1
Canada	113.2	131.1	177.5	262.3	347.7	393.4	54.3
Coal e							
United States	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Japan	121.0	135.5	187.1	245.1	267.0	306.7	94.3
Germany	129.5	161.3	210.9	233.0	234.0	234.0	125.9
United Kingdom	135.2	145.3	291.9	390.7	442.0	512.8	84.0
France	139.5	168.0	216.5	234.9	286.6	303.6	77.7
Italy	117.9	227.1	235.0	249.3	283.3	301.6	63.5
Canada	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Heavy fuel oil f							
United States	138.6	333.3	487.2	500.0	586.7	563.0	109.8
Japan	100.5	177.7	310.5	358.9	379.6	354.3	106.3
Germany	120.7	208.4	298.2	267.8	273.0	267.8	96.5
United Kingdom	131.0	183.3	404.2	443.7	609.4	573.0	104.8
France	107.9	218.6	290.0	266.9	311.8	343.0	88.6
Italy	117.9	177.8	373.3	570.8	643.0	673.0	89.6
Canada	n.a	n.a	n.a	n.a	n.a	n.a	n.a

a Indices based on average prices in terms of national currencies.
b Average price in 1978, in terms of US dollars per unit of energy equivalent to 10^7 Kcal (i.e. one tonne of oil).
c Annual consumption of 15 GWh.
d Annual consumption of 5,000 x 10^6 Kcal
e Steam coal, washed, 0-10 mm.
f Annual consumption of 5,000 tonnes.

Source: OECD Energy Statistics, 1975-77 (Paris, 1979).

Table 6

Average prices of major fuels consumed in residential sector

1968=100 a

	Average 1970-73	1974	1975	1976	1977	1978	Price b
Electricity c							
United States	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Japan	106.6	106.6	127.7	127.8	153.9	153.9	972.3
Germany	120.6	148.0	164.7	175.3	179.2	181.1	1,001.6
United Kingdom	112.1	132.0	171.5	231.0	274.1	305.6	616.2
France	114.0	131.1	166.6	166.5	197.5	211.7	823.2
Italy	83.6	81.5	142.3	183.5	231.8	266.9	836.0
Canada	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Natural gas d							
United States	113.7	137.4	163.8	189.7	n.a	n.a	n.a
Japan	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Germany	108.1	111.5	131.9	156.6	181.7	182.1	450.0
United Kingdom	116.8	137.6	159.3	183.3	195.9	219.7	185.0
France	128.4	148.7	204.3	204.3	221.3	235.6	350.0
Italy	112.8	125.7	125.7	239.2	347.5	378.9	152.2
Canada	91.6	92.4	108.1	136.0	179.5	200.9	77.5
Coal e							
United States	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Japan	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Germany	121.9	163.0	216.8	250.1	207.2	229.6	211.4
United Kingdom	117.2	125.5	155.7	199.6	251.5	296.6	132.8
France	124.1	156.9	205.5	244.5	239.0	247.6	139.9
Italy	115.0	145.0	224.7	275.4	312.9	333.2	145.8
Canada	115.8	144.3	188.9	203.3	288.0	380.0	191.5
Heating oil f							
United States	104.4	256.7	310.5	333.8	368.6	400.0	149.0
Japan	116.1	176.0	256.8	259.7	262.3	264.9	232.8
Germany	n.a	n.a	n.a	n.a	n.a	n.a	n.a
United Kingdom	70.1	160.0	285.8	311.6	384.0	418.6	179.6
France	120.3	251.4	286.7	314.6	348.3	385.4	193.6
Italy	94.1	182.5	234.9	377.3	439.6	474.9	180.9
Canada	126.2	168.7	179.4	210.0	257.2	286.8	127.4

a Indices based on average prices in terms of national currencies.
b Average price in 1978, in terms of US dollars per unit of energy equivalent to 10^7 Kcal (i.e. one tonne of oil).
c Annual consumption of 3,600 kwh.
d Annual consumption of 5.0×10^6 Kcal.
e Anthracite of 5-10 mm in 500 kg lots.
f Gas/diesel oil in 5,000 litre lots.

Source: OECD Energy Statistics, 1975-77 (Paris, 1979)

Table 7

Average prices of major fuels consumed in transport sector

1968 = 100 a

	Average 1970-73	1974	1975	1976	1977	1978	Price b
Gasoline c							
United States d	109.5	135.5	153.3	168.9	175.5	181.1	16.3
Japan	96.0	149.0	202.4	209.2	210.1	205.2	50.8
Germany	99.1	126.8	136.0	138.3	139.0	140.2	43.7
United Kingdom	127.4	153.0	268.5	271.0	286.6	280.0	32.0
France	112.0	166.0	173.3	180.1	213.7	224.8	50.1
Italy	120.3	153.8	230.8	307.7	384.6	384.6	57.4
Canada	111.9	129.4	137.6	175.2	185.3	199.0	19.8
Diesel oil e							
United States f	n.a	169.7	284.8	430.3	433.3	506.0	15.2
Japan	88.1	124.4	179.9	184.6	184.5	176.7	26.5
Germany	100.6	129.2	144.3	148.7	147.6	149.7	42.4
United Kingdom	149.0	183.6	245.0	272.0	344.0	374.6	35.7
France	112.7	156.9	175.1	188.4	202.6	216.9	30.2
Italy	108.9	161.4	192.9	240.0	214.3	214.3	17.2
Canada	n.a	n.a	n.a	n.a	n.a	n.a	n.a

a Indices based on average prices in terms of national currencies.
b Average price in 1978, in terms of US dollars per 100 litres.
c Premium gasoline (octane rating 95 or over).
d Regular gasoline (octane rating 94 or below).
e Retail prices.
f 1971 = 100.

Source: OECD Energy Statistics, 1975-77 (Paris, 1979).

Table 8

EEC consumption of energy in 1975 (million tonnes, coal equivalent)

Sector	Domestic, commercial, public administration, agricultural	Industry	Transport	Total
Primary energy input	455	620	225	1300
Non-energy use		-70		-70
Processing and distribution losses[a]	-136	-161	-40	-337
Delivered energy[a]	319	389	185	893
Conversion losses[a]	-175	-175	-148	-498
Useful energy available[a]	144	214	37	395

a Estimated.

Source: based on data in Roberts, op.cit.

Table 9

IEA countries : final consumption of energy by sector

Sector	Consumption (m.t.o.e*) 1977	1985	1990	Growth (% per annum) 1977-1985	1985-1990
Residential and commercial					
total	821	956	1043	1.9	1.8
(of which oil)	(337)	(372)	(388)		
share of sector in total (%)	34	31	30		
Transport					
total	685	773	858	1.5	2.1
(of which oil)	(680)	(766)	(849)		
share of sector in total (%)	28	25	25		
Industry **					
total	826	1166	1394	4.4	3.7
(of which oil)	(310)	(437)	(514)		
share of sector in total (%)	34	38	40		
Non-energy uses					
total	102	156	173	n.a.	n.a
(of which oil)	(96)	(142)	(159)		
share of sector in total (%)	4	5	5		
Total					
final consumption	2434	3051	3468	2.6	2.5
(primary energy input)	(3335)	(4397)	(5080)	(3.5)	(2.9)

* m.t.o.e. = million tonnes of oil equivalent.

** Energy uses only.

Source : International Energy Agency 'Energy Policies and Programmes of IEA Countries, 1978 Review' (OECD, 1979).