Working Paper Series No. 84

THE GLOBAL ENERGY CRISIS AND INTERNATIONAL DEVELOPMENT

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July 1990

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INTRODUCTION

Three events in the early 1970s fundamentally changed the framework within which problems of international development are discussed. They marked a watershed in conceptualizing development thinking, development models and practices, and changed the character of international economic relations. The discussion shifted from an ideological East-West confrontation of capitalism vs socialism, to a North-South confrontation. Increasingly, the policy debate began to focus on the division of, and rights to, limited natural resources in a global context, as distinct from nation-centered development strategies in a multi-nation state context. Higher level planning than national planning seems to be required.

Firstly, the activities of the Club of Rome called attention to the implications of geometrically increasing use of resources by mankind living in a finite world. Secondly, the Stockholm Conference of 1972, which spearheaded the creation of the United Nations Environment Programme, generalized international concerns about the by-products of economic growth, in the form of emissions and residuals, for the natural environment, especially air, water and land-based natural resources, in the development process. Thirdly, the actions of OPEC brought awareness of global dependency on non-renewable fossil fuel resources, which were geographically distributed unequally. Those owning or controlling such strategic resources could and did wield immense power. It began to be realized that decisions to disrupt supplies, in general or to specific countries, could have major consequences for global development efforts, international security and thus for world peace.

Up to the late 1960s, international development efforts were envisaged such as to be conducted in a basically harmonious fashion. Conscious, and deliberately stimulated economic growth strategies were seen as enabling the poorer countries to, over time, join the table of the rich countries and to enjoy the fruits of development. The newly industrializing countries (NICs) were held up as proof that countries could develop very rapidly indeed. In the process, the rich countries were not expected to have to sacrifice much of what they had grown to accept as their entitlement to the globe's natural resources.

The realization took root, however, that in a world with finite, though not precisely defined and known natural resources, developing countries could not join the tables of the rich by emulating their patterns of resource use. The development of the people in the developing countries, if it was to be successful, would seem impossible unless the rich countries substantially reduced their disproportionately high level of natural resource use. Only if one believed that abundant, new, and exploitable, natural resources would be discovered, and that rates of technological change would be very high, and of resource saving quality, could one continue to believe that the globe would have sufficient natural resources for the growing population in all parts of the world.

Almost inevitably, therefore, international economic relations came to be seen in more antagonistic terms. As a scramble of countries and nations competing, possibly ever more fiercely, over scarce natural resources.

The three issues which proved most divisive in the clamor for a New International Economic Order, for instance during the 6th Special Session of the United Nations in 1974, were:

(a) the right to form cartels and producer organizations such as OPEC, which model was quickly followed by a host of other producer organizations, though with much less success;
(b) permanent sovereignty over natural resources, which would not obligate developing countries to continue to meet current international demands for resources under developing country jurisdiction; and
(c) the treatment of transnational corporations, where the issue was whether they should be governed by national legislation in the countries where they operate, instead of by international arbitration in cases of conflict.

In retrospect, it can hardly be surprising that the post World War II-process of growing international cooperation suffered a major set back at that time, of which it has not yet recovered at present.

Whether the 1990s will witness a resumption of effective international North-South cooperation remains to be seen. The developmental, environmental and socio-political crisis in Sub-saharan Africa is said to be 'widening and deepening' (World Bank, 1989b). This may inhibit effective intergovernmental cooperation as the legitimacy of many regimes is at issue. The crumbling of what used to be the socialist block in Eastern Europe, will absorb all their energy to attempt the political and economic restructuring which is needed and now demanded. Western Europe will also have to devote much institutional energy in redefining its own role and in forging new forms of intra-European cooperation. There are few signs that the United States changes its now already prolonged disinterest in the development problems of the South, and thus of most of the developing countries. Finally, diverging development trends among different categories of developing countries in the former South, will make it increasingly difficult to maintain solidarity and common positions in discussions and/or negotiations with the North, where also major conflicts have emerged between the United States, Europe and Japan as evidenced in the current Uruguay Round of international trade negotiations under the auspices of GATT.

Interdependencies on a global scale increase, in terms of trade, capital flows, human migration and transborder environmental problems. Yet, global management on multiple and interdependent issues where most parties have different priorities and interests, seems to be elusive at the present juncture.

This paper does not provide an overview of the events and of the nature and substance of the international debates indicated above. Instead, it selects one topic for discussion: the energy base of international development. It brings together factual information about patterns of energy use and development in a broader time perspective. It sketches some of the factors behind these energy trends and differentiates the responses to the 'energy crisis' between the developed and the developing countries. The paper thus hopes to provide a frame work for a discussion about energy and development in a global perspective.

The paper does not pretend to be complete in coverage even on the more limited subject of energy, nor does it pretend to add anything new to the ongoing discussions. Rather, it provides the uninitiated reader, who has no easy access to a fairly scattered range of relevant key source materials, with a quick, but hopefully useful, general introduction to problems and issues in the energy field in relation to international development.

Section 1 presents some data on patterns of energy production and consumption in the last 20 years, including data on the distribution of fossil fuel energy resources at the time when the energy crisis manifested itself.

Section 2 discusses the main responses to the energy crisis in the developed countries, and tries to look into the future. It suggests that, again, high growth rates of energy supplies are being planned, as if the 'crisis' of the early 1970s has been merely a temporary interruption in the historical growth patterns of energy demand and supply, and little needed to have been learned since.

In Section 3 we take up the nature of, and the conditions for the much more limited response to the energy crisis in developing countries, and it briefly discusses energy development policies being shaped for the rural areas in the early 1970s. These expectations turned out not to be feasible, and will have to be largely abandoned.

In Section 4, we discuss some issues in the planning of energy requirements, and some of the reasons why it is so difficult to bring about a required and necessary turning point in the energy intensity of production and in the direction of energy consumption patterns.

PATTERNS OF ENERGY PRODUCTION AND CONSUMPTION

Indicators of energy production, consumption and imports between 1965 and 1987 for different groupings of countries, are summarized in Table 1 on the next page.

Table 1. : Energy indicators for developing countries.

	Average annual energy growth rate (percent) Energy production. 1965-80	1980-87	Energy consumption. 1965-80	1980-87	Energy consumption, per capita (kg oil equivalent) 1965	1980	Energy imports as percentage of merchandise export 1965	1980
Low- and Middle income	5.5	3.7	7.2	3.5	253	503	7	11
Sub-Sahara Africa	15.3	-1.3	5.6	2.3	71	82	7	10
East Asia	9.8	5.5	9.4	4.4	168	477	6	9
South Asia	5.8	5.7	5.7	5.2	99	183	7	20
EMENA	4.4	2.8	6.2	2.7	746	1204	9	19
LA & Caribbean	1.9	2.5	6.9	1.9	515	1071	8	9
17 highly indebted	3.6	1.7	6.9	2.1	420	776	6	10
High-Income Economies	3.1	-0.1	3.1	0.6	3707	4953	11	11
OECD Members	2.1	1.8	3.0	0.5	3748	6573	11	12
Other	7.7	-9.8	5.7	2.8	1943	3030	7	7
Total reporting countries	4.0	1.3	4.0	1.4	1007	1253	10	11
Oil Exporters	5.8	-2.2	4.7	3.0	325	766	5	4

Source: World Development Report 1989, World Bank

Three points stand out. Compared to the period 1965-80 the growth of energy demand in the 1980s has been substantially reduced. This reduction of energy demand growth, by over 50 percent for the developing countries and 65 per cent for all reporting countries, could be due to a reduction in economic growth rates in the 1980s as a result of the world-wide slow down in the pattern of economic growth, and it could reflect a rapid increase in the energy efficiency of output.

Indicators of GDP growth and the resulting energy output elasticities are given in Table 2.

Table 2. GDP Growth Rates and Energy/GDP Elasticities.

	Ave.Annual Growth of GDP		Energy/GDP Elasticity	
	1965-80	1980-87.	1965-80	1980-87
Low & Middle Income Countries	5.9	4.0	0.93	0.93
Sub-Sahara Africa	5.1	0.4	3.00	-3.25
East Asia	7.2	8.0	1.36	0.69
South Asia	3.8	4.8	1.53	1.19
Europe,Mid East,North Africa	6.2	..	0.71	..
Latin America & Caribbean	6.0	1.4	0.32	1.79
17 Highly Indebted Countries	6.1	1.1	0.59	1.55
High Income Countries	3.7	2.6	0.84	-0.04
OECD	3.6	2.7	0.58	0.67
Other	8.1	-2.6	0.95	-3.77
Total Reporting Countries	4.1	2.9	0.97	0.45
Oil exporters	6.5	0.7	0.89	-3.14

Source: World Development Report 1989, World Bank

These figures show the wide variations in growth experience in different geographical groupings of countries. Latin America and Sub-Saharan Africa have been badly hit in the 1980s, with declines in average per capita incomes. Sub-Saharan Africa is also the only continent which experiences a long term trend of accelerating population growth outstripping food production, resulting in a rapid increase in food imports. Food imports, energy imports and debt servicing virtually preempt total foreign exchange availability in many poor Sub-Saharan African countries (World Bank, 1989b).

Similarly, the Table shows a wide variation in the Energy/GDP elasticities, as calculated from the data provided in the World Development Report.

The data base is insufficient to discuss the reasons underlying these figures in detail. At the most aggregate level, the figures indicate a constant energy production elasticity of GDP for all Low and Middle Income Countries, at near to one: 0.93. The OECD countries show elasticities which are much lower than in the developing countries, but rising over time from 0.58 to 0.67. This would seem to indicate that the changing patterns of GDP growth in the rich countries tend to become more energy intensive, rather than less energy intensive.

The diversity in energy elasticities from Table 2, may be contrasted with earlier World Bank calculations and opinions. In the 1981 World Development Report, the Bank argued (p.37) that "typical" income and long-term price elasticities for energy were as follows:

Table 3. Typical income and long-term price elasticities for energy.

	Income elasticity	Price elasticity
Industrial market economies	1.0	0.4 (0.2-0.6)
Developing Countries	1.3	0.3 (0.1-0.5)

Source: World Bank, World Development Report 1981.

At that time the Bank argued that "income elasticities tend to be higher in developing countries than in industrial ones, reflecting the rapid increases in industrialization and urbanization that accompany the early stages of growth". In light of the material in Table 2 above, there do not seem to be 'typical' developing countries and 'typical' industrial countries. The relative differences seem to be more or less confirmed, though the absolute levels of the coefficients seem to be much lower than was assumed in 1980.

This is not the point to discuss these figures, in the absence of further details. The point to make is, however, that apparently little information was available in energy planning circles about variations in energy use patterns and in seeing differences in energy intensities as possible objectives of policy action. A point to which we shall return later on in this paper.

The second point to note in Table 1 is the enormous discrepancy in energy use per capita between the rich and the poor countries. In terms of per capita averages, energy consumption in the developed countries are large multiples of levels in developing countries. Even the increase in per capita energy consumption in the rich OECD countries is about two and one-half times the average energy consumption per capita in Europe, the Middle East & North Africa (EMENA) and Latin America, more than fifteen times the average consumption in South Asia and thirty times that in Sub-Saharan Africa.

The third point to note is that for most of the developing countries, energy imports have become a major drain on the balance of payments. Future energy use patterns seem to have become inexorably tied up with export earnings.

For the developed countries, the relative weight of the energy import bill on the balance of payments has remained constant. The development of domestic energy sources and higher export earnings off-setting the increase in the import energy bill following OPEC price actions.

Oil dependency.

The discovery of large amounts of oil reserves in the Middle East, and their exploitation at low cost, and under the effective control of the large multinational petroleum companies, has induced a long-term trend towards the substitution of oil for other sources of primary energy, notably coal, in the industrialized countries since the 1950s. It also stimulated a substitution of cheap import oil for relatively more costly and more heavily regulated petroleum resources in the USA.

Most developing countries, with China and India as the major exceptions, did not have extensive coal resources to build their modernization on and, from the beginning, their modernization and industrialization have been based on the preferred fuel base: imported petroleum.

The extent to which global energy supplies had become dependent on Middle Eastern oil production and reserves by the early 1970s, is illustrated in Table 4.

Table 4. WORLD OIL RESOURCES, 1973

Shares	Proven oil Reserves.	Production	Consumption	Refining Capacity.
North America	8	22	33	25
Latin America	5	10	6	11
Middle East	55	37	2	4
Africa	11	10	2	2
Western Europe	3	1	27	29
Eastern Europe	13	15	14	15
Far East	6	5	16	15
TOTAL	100	100	100	100

Source: SIPRI, 1974.

The nationalizations of multinational petroleum corporations in Iran under Mossadeq in 1953, has perhaps been the decisive factor in corporate decision making to build new oil refineries not near the producing centers, but near the major consumption areas. This relegated the Middle East oil economies to exporters of crude oil, with most of the value added accruing down-stream and in the developed countries.

Differences in the degree of dependence of various categories of countries upon Middle Eastern oil is given in Table 5, which shows major petroleum flows (leaving out minor flows and balancing items) in international trade in 1973.

Table 5. MAIN WORLD OIL MOVEMENTS in 1973.
(Crude Oil and Products, million tons)

Importers.	Exporters				
	Caribbean.	Middle East.	N.Africa.	W.Africa.	Total
USA	131	41	18	25	313
W.Hemisphere		47		20	97
W.Europe	18	513	121	50	756
S.E.Asia		65			68
Japan		216			284
TOTAL	187	989	163	106	1695

Source: SIPRI, 1974.

This global dependency on Middle East oil gave enormous strategic power to OPEC countries in the early 1970s, once they had learned to "handle" the international petroleum corporations. Much uncertainty and new elements entered in discussions about energy futures. Under the old regime of the international oil companies, large amounts of oil were supplied to the industrialized countries at low and declining real prices. New OPEC power introduced the potential for novel exploitation strategies, which these countries, as an effective producers cartel, could successfully pursue.

The following four strategies suggest themselves. Oil exporters could change from volume maximization to revenue maximizing strategies. Volume restrictions would lead to sharply increasing prices, and monopoly practices could be applied.

A second strategy would be to aim for a target income, compatible with the expected rate of absorption of oil revenues in development programmes within OPEC countries.

A third strategy could be to agree to continue to meet global demand volumes, though at much higher absolute and possibly inflation-linked prices. If this would generate revenues in excess of absorptive capacity in OPEC countries themselves, surplus funds could be held in reserve, or lead to portfolio investments outside the OPEC countries, mostly in the industriali countries but also perhaps in some developing countries. However, the initial placement of 'surplus' revenues with the international banking system might not be seen to be attractive. Being centered in the major Western countries, such deposits might be a focal point in possible retaliation strategies being planned to break the OPEC stranglehold on energy markets.

A fourth strategy could be to manipulate markets deliberately in an unpredictable manner. The danger to OPEC power and inherent in the third strategy, of consumers diversifying sources of energy supply, could be countered by a variable volume and price policy strategy. The uncertainties which would then be deliberately introduced in international energy markets would act as impediments to governments and the major international oil companies to make and sustain the long-term commitments to diversify sources of supply or to implement conscious strategies aiming at energy saving and energy switching investments.

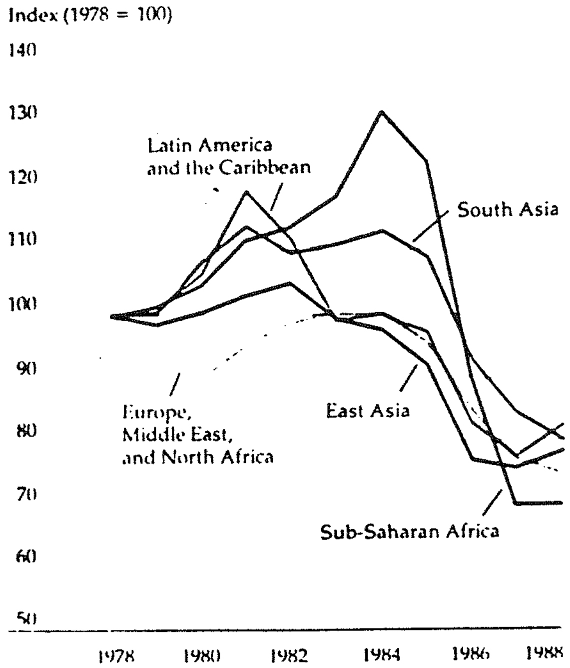
No wonder that many policy makers in the mid-1970s thought and feared that the world would never be the same again. Clearly, even the mere thinking about such scenarios caused much anxiety in policy circles in the industrialized countries, and in oil importing developing countries.

RESPONSES IN DEVELOPED COUNTRIES.

Short term

Early short term responses to the oil crisis of 1973/4 cushioned energy consumers, as governments reduced taxes on petroleum products. This delayed consumer price response to economize on energy use, or to implement energy substitutions where such choices were present.

Figure 1 Real effective exchange rates in developing countries by region, 1978 to 1988



Note: The real effective exchange rate is the trade-weighted exchange rate adjusted for relative inflation. An increase in the index indicates an appreciation of the currency. The regional index values, which are based on a total sample of eighty-three developing countries, are annual averages weighted by the dollar value of exports.
Source: IMF and World Bank data.

Macro-economic policies were geared to <u>accommodate</u> the rising flow of petro dollars. The main oil exporters initiated a buying spree in the industrialized countries and placed their temporary liquid funds with the large commercial banks, --which on-lent these funds to middle-income oil importing countries, mostly in Latin America. In actual fact, a major stimulus was given to the developed market economies. GDP growth rebounded within the year from the massive initial shift of real resources implied by the rise in oil prices. In combination with an inflationary explosion the initial price shock was absorbed and a gradual erosion of the purchasing power of the newly earned petro dollars set in.

The macro economic response to the second oil price hike of 1979/80 --in the wake of the ouster of the Shah of Iran-- was one of <u>retrenchment</u>.

Deflationary policies and tight money in both the USA and in the UK, to adjust to the new shift in real resources, spread to other developed countries. Recycling petro-dollars to the middle income oil-importing economies was no longer an option, as most of these countries by now were loaned-up close to assumed or suspected limits in their credit worthiness and export prospects.

These expectations became self-fulfilling prophesies, leading to a global recession in the early 1980s. The combined effects of deflation in most high and middle income countries quickly weakened oil prices, until they sharply fell in 1985/86 (see Figure 1).

Long-term adjustment policies aiming at energy alternatives and energy savings technologies and initiated in the mid-1970s, received a new impetus in 1979/80. This impulse, however, was of short duration. The doom of crisis quickly lifted in the early 1980s, and many of the new energy development ventures under consideration made no longer economic sense in the face of weakening international oil prices.

In retrospect, the events of the 1970s and 1980s thus seem to fit the stop-go strategy, the fourth strategy option indicated above. This was not so much a policy grand design but, rather, the outcome of market forces in conjunction with internal OPEC policy conflicts.

This historical record, however, has left international and national energy policy planning with widespread and profound uncertainties, and a loss of a sense of direction. As will be shown later on in this paper, old planning models are seen to be obsolete, but commitments to a new energy future remain hesitant. There is a real possibility that efforts to change energy futures will not be sustained in development policy and practice.

Long term

From the perspective of the early 1970s, the energy future in the industrialized countries was seen to require a correction, in that a more balanced proportion for the supply of the three major sources of primary energy was to be brought about. These primary energy sources are oil, coal and nuclear power. The potential for energy savings, or conscious energy demand management strategies only gradually came to be realized.

(a) Oil

Structural policies to combat the oil price shocks centered on a world wide search for additional sources of petroleum. Geological formations with a promising potential for yielding oil and gas have been found in the continental shelves off Eastern Africa, Southern Africa, Northwest Africa, and various shelf areas off South America, India and Antarctica. (World Bank, 1980). It has been suggested that the deep sea bed could harbor major hydrocarbon reserves, while also land-based reserves have been diagnosed in various parts of Africa and Asia. In all, the relevant geological formations appear to be more equally spread over the globe than had been previously assumed.

Technological development has made it possible to drill in deeper waters and to work at greater distances from the shore. Offshore exploration only began in the 1950s. Between 1970 and 1980 the number of exploratory wells had increased from 1000 to 5500. Drilling in waters deeper than 300 meters did not start until 1972. By 1980 drilling in depths over 1300 meter was undertaken in a number of different locations (Dolman, 1985).

However, though potential global oil reserves may be much larger than assumed and/or known in the mid-1970s, the road towards the identification and delineation of exploitable reserves and de facto exploitation is long and costly. This implies that only the major industrialized countries and the largest international petroleum corporations have the financial and human resources to lead this effort. Whether this road will be travelled depends on the continuous assessment of the political climate in the current, low-cost, major producing areas.

Political tempers have considerably cooled since the clashes of the mid-1970s, and major OPEC producers currently have a much greater interest to export their petroleum to maintain the momentum of their own development process. Only the prospect of sustained high international oil prices, and the depletion of low-cost oil reserves would provide the impetus towards the exploitation of higher cost oil and gas resources. Such pressures do not seem to be very strong at the present time.

In actual fact, the major significant oil resources entering supplies in the 1970s and 1980s were from Alaska, the oil and gas resources of the North Sea, and from already developed petroleum reserves. Changes in policies, which had hampered the exploitation of domestic oil resources in the USA, added significantly to internal supply, thus relieving pressures on international oil trade flows. Oil imports into Europe saw a steady decline.

These new resources were located closer to and, more importantly, under the jurisdiction of the developed countries. This contributed to a steady shrinkage, from two-third to nearly one-third, of the OPEC market share and thus the power of the cartel to control the markets was gradually undermined.

(b) Coal

The industrial development of the Western world had been based on coal. Despite the competition of oil, sizable coal supplies were still part of the energy scene. Moreover, financial resources technologies and staff resources for exploitation were available, and prior exploration had revealed that proven coal and lignite reserves were much larger than prospects for oil. Moreover, most of the world's coal resources were geographically more widespread in Europe, the USA and in China and India, thus lessening dependency upon a single major source of Middle East oil, which was seen to have become politically and strategically unreliable.

The Report of the World Coal Study (WOCOL, 1980) documented that in the period 1960-77 67 percent of the total increase in OECD energy use was met by oil, as against 2 percent for coal. A trend reversal, in favor of coal, was seen to be needed.

For the period 1978-2000, major changes were foreseen. The expected contribution of oil to the increase in energy needs, in the base scenario, was put at only 10 percent. The contribution of nuclear power was to rise from 5 percent to 32 percent, and coal was expected to contribute most of the remainder, at 37 percent. The share of gas, hydro, solar and other sources of energy was expected to decline from 26 per cent to 21 percent, largely on account of a sharp reduction in the contribution of gas, from 21 to 8 percent, in line with the declining contribution of oil.

Under alternative scenarios, --with additional limitations on oil, and with delays in nuclear power-- the share of coal to the increased energy needs could rise to 67 percent, a complete reversal of the relative roles of oil and coal, compared to the period 1960-77 (WOCOL, 1980, 16-17).

Coal was seen, not unexpectedly from the world's coal industry in a concerted study effort, as 'the bridge to the future', in an energy transition towards the assumed era of plentiful cheap energy resources from nuclear power, in which coal could also play its role through the 21st Century.

The _environmental_ effects of coal were recognized, but were down played. It was assumed that technological advances in combustion, gasification and liquefaction would greatly widen the scope for environmentally acceptable use of coal in the 1990s and beyond.

(c) _Nuclear power_

The nuclear power industry, another major contender for a more diversified energy future for the developed countries, has experienced major set backs over time. Problems with the technologies themselves are part of the explanations. Sharply escalating financial costs are another, and growing public resistance against the use of nuclear power, in view of unresolved issues in respect of safe disposal of radioactive nuclear waste materials, are a third. Uncertainties about future energy demands and price levels have added to the technological supply problems of the industry.

Public opinion against nuclear power in the USA was galvanized by the disaster near Harrisburg in Pennsylvania (Three Mile Island) in 1979. The Chernobyl disaster, in 1986, performed a similar function in Eastern Europe and also in Western Europe. _Glasnost_ and _peristroika_, and especially the events of 1989 took the lid off to expose the manner in which the environment had been brutalized in the socialist development strategies of the last 40 years, not only by nuclear power but also by coal mining and industrialization policies generally pursued without much regard for harmful emissions and residuals on the natural environment.

Public opinion in Eastern Europe is now beginning to play a role, in demanding attention for these effects of past policies. Hopefully, these concerns will not again be suppressed as before. To strengthen such new forces it is perhaps a positive and hopeful sign that the recently approved European Bank for Reconstruction and Development has been suggested to play a major role in investment in the natural environment. In addition to assisting in the modernization of the production structure in Eastern Europe, such a strategy would also significantly contribute to the reduction of transborder environmental emissions which affects the natural milieu in Western Europe especially. Western Europe would thus benefit double: from supplying needed capital goods and in a lesser need to incur environmental damage abatement costs.

In other countries governments have so far managed to downplay damaging data which is becoming available and public outcry has remained too limited, such as in the United Kingdom in respect of Sellafield.

To illustrate the turnabout in the fate of the nuclear energy sector in the USA the following data are presented.

Table 6. Coal and Nuclear Plant Orders and Cancellations in the USA, 1970-1984, (in MegaWatts).

Period	Orders		Cancellations	
	Coal	Nuclear	Coal	Nuclear
1970-74	89,733	154,435	0	14,028
1975-79	52,292	15,250	13,687	47,290
1980-84	11,995	0	19,465	57,733

Source: Flavin, 1984.

The large volume of plant orders, which were subsequently cancelled, imply major losses in 'sunk cost'. These are to be charged to consumers directly, by way of rate increases, or indirectly, by way of the government bailing out electric power corporations which are finding themselves near bankruptcy.

In Western Europe, France has been the major proponent of a nuclear power based energy strategy. Its installed capacity in 1984 was equivalent to that of the Federal Republic of Germany, the U.K. Belgium and Spain combined (WRI 1986, 109). France's nuclear construction programme has far outstripped growth in power use, and a dozen relatively new coal-fired plants have been decommissioned (Flavin, 1984, 24). Currently, the share of nuclear power in France has increased to about 70 per cent. Japan, too, continues full speed on the nuclear route, in view of its almost total dependency upon imported oil and in the absence of energy alternatives at home.

Energy savings

It came to be realized that energy savings could also provide an important contribution to the scenario for the future. It is useful, in this context, to distinguish the following concepts: energy intensity is the consumption of energy per unit of product output, or GDP; energy savings represent a reduction in this intensity. Energy rationalization is a combination of energy savings and switching from higher cost to lower-cost fuels, in response to changes in relative fuel prices.

A key aspect then of energy rationalization policies is that the historically close relationship between GDP growth and energy demand is deliberately broken, and trends begin to diverge.

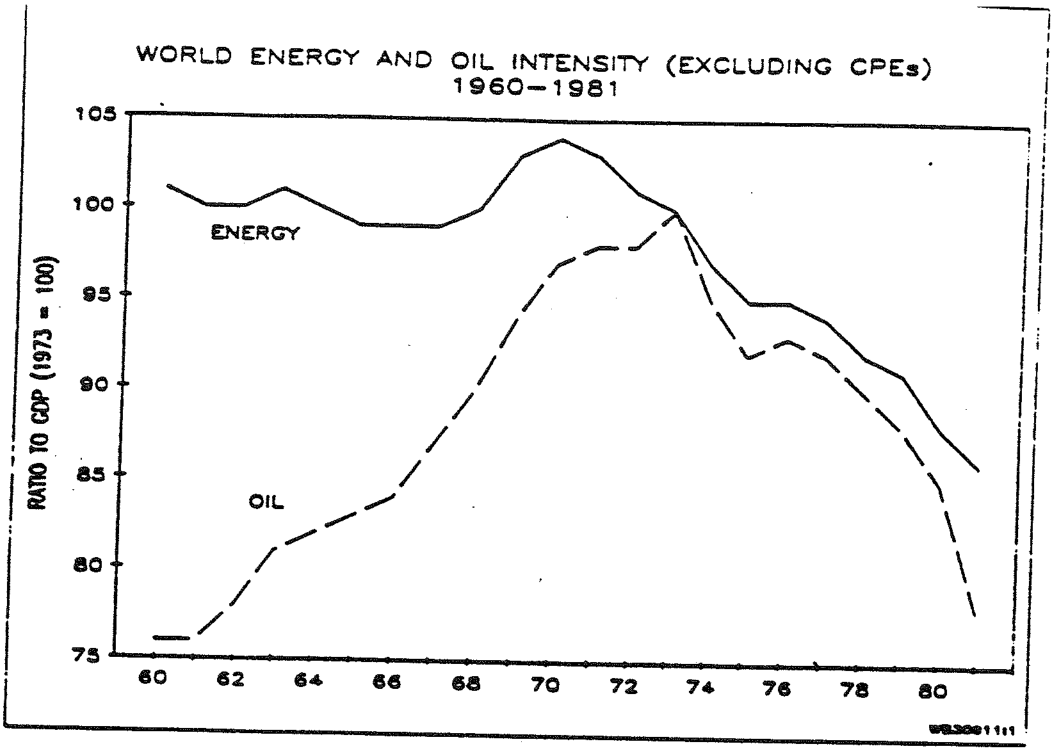
The figures 2abc on the next page, comparing energy inputs to GDP, are somewhat crude, as they include changes in the composition of output as well as lowered energy intensity within sectors. Yet, they show that of the developed countries, Japan made the most concerted effort to promote energy saving practices. The United States and Canada, both much more favorably endowed in the energy field, and thus facing less external pressures to adjust, made only limited progress. The European countries occupy the middle ground; they have energy resources of their own and were only moderately import dependent.

For the world as a whole the ratio energy to GDP remained roughly constant through the 1960s, but sharply declined in the 1970s. The rise and fall of the oil intensity of GDP is also clearly illustrated.

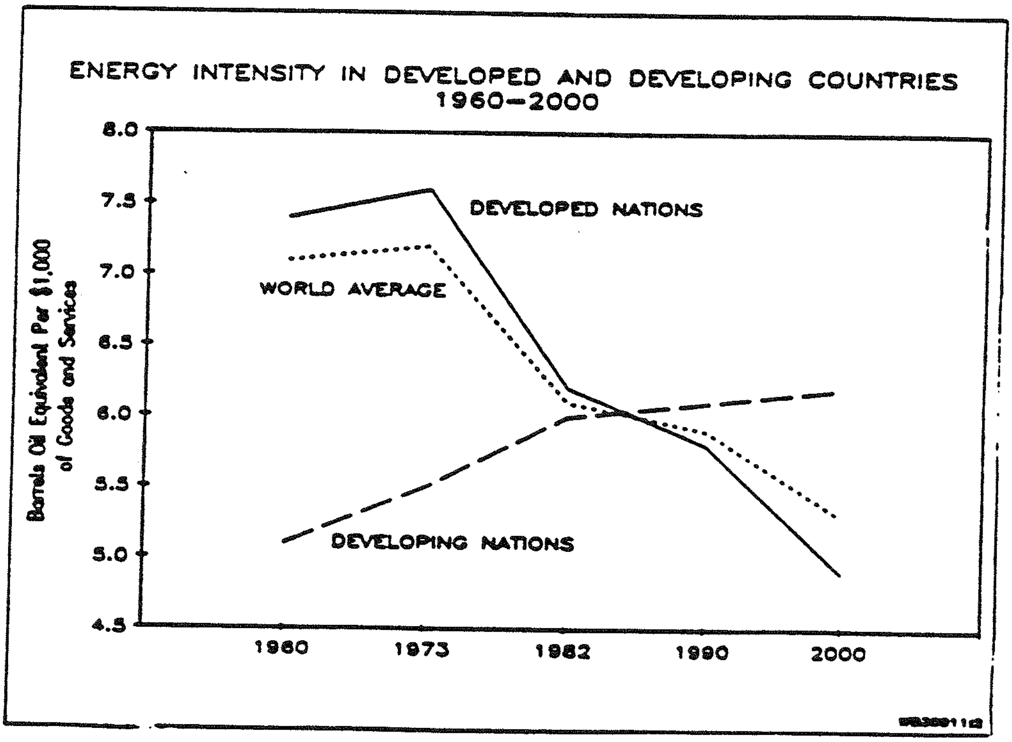
Of special interest are the diverging energy intensity trends in the developed compared to the developing countries. An expected continuing decline in the developed countries is compensated by a rising trend in energy intensity of production in developing countries.

In the early stages of thinking about the role of energy savings in adjustments to the oil price shocks, no drastic changes in styles of living were foreseen to be necessary. On the whole, technological optimism about the possibilities to reduce the energy intensity of industrial processes, continued to underlie energy scenarios. A number of one-off changes suggested themselves in many cases and these have by now been implemented for the most part. Once these changes are made, energy growth may well resume old trends. Alternatively, strategies and policies to widen and deepen the search for more energy saving products might begin to affect customary lifestyles of consumers. These two options are at the core of the discussions about energy futures at the present time.

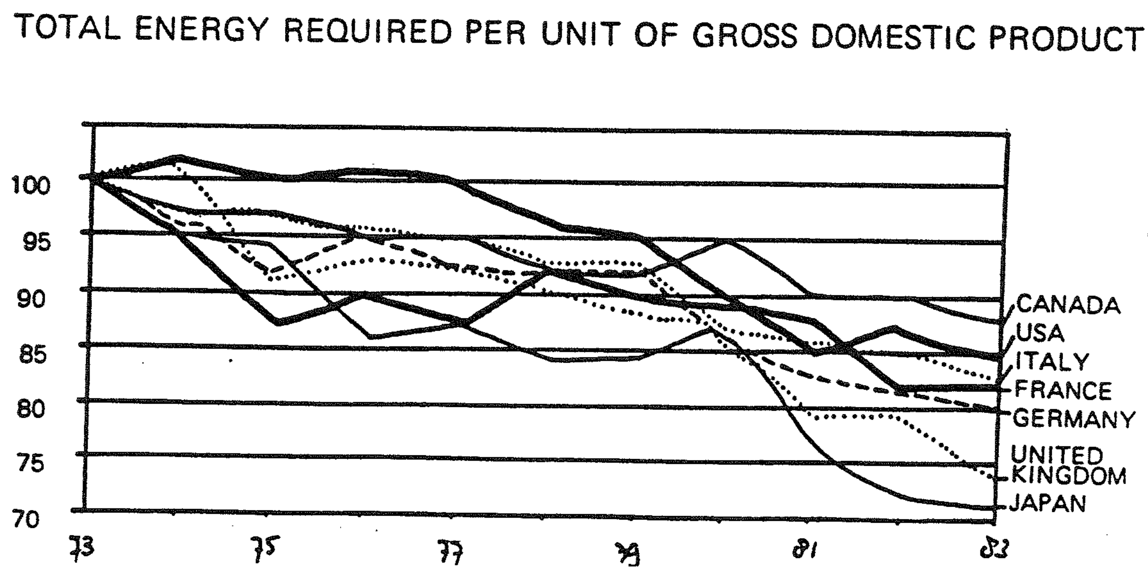
Figure 2


WORLD ENERGY AND OIL INTENSITY (EXCLUDING CPEs)
1960-1981
RATIO TO GDP (1973 = 100)
105
100
95
90
85
80
75
ENERGY
OIL
60
62
64
66
68
70
72
74
76
78
80

(a)


ENERGY INTENSITY IN DEVELOPED AND DEVELOPING COUNTRIES
1960-2000
Barrels Oil Equivalent Per $1,000 of Goods and Services
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
DEVELOPED NATIONS
WORLD AVERAGE
DEVELOPING NATIONS
1960
1973
1982
1990
2000

(b)


TOTAL ENERGY REQUIRED PER UNIT OF GROSS DOMESTIC PRODUCT
100
95
90
85
80
75
70
CANADA
USA
ITALY
FRANCE
GERMANY
UNITED KINGDOM
JAPAN
73
75
77
79
81
83

(c)

Renewable energy

In the 1970s much attention was given to the search for renewable forms of energy. Overall, they provide about 21 per cent of the energy consumed world wide, of which 15 per cent is biomass (mostly in developing countries) and 6 per cent hydro power (Brundtland, 1987, 192).

Fuel wood can no longer be considered a 'renewable' source of energy in many parts of the world because consumption rates have overtaken sustainable yields, sometimes by wide margins. The potential for hydropower is huge, though not without major environmental problems. Solar energy use is small globally, but it is beginning to assume an important place in the energy consumption pattern of some countries. Wind power has been used for centuries, and its application is being revitalized in some countries. It may become competitive.

The fuel alcohol programme in Brazil produced about 10 billion liters of ethanol from sugar cane in 1984 and replaced about 60 per cent of the gasoline that would have been required. Ethanol as a gasoline blend or substitute, can be produced from biomass raw materials: sugar cane, molasses, starches and celluloses. For a description of production processes and cost structures, see World Bank, 1980.

The World Bank (1988b) has studied the impact of the reduced oil prices on the economic viability of selected technologies which utilize solar, wind and biomass energy sources. The technologies include dendrothermal power plants (wood burning, supplied by short rotation tree-species), bagasse, fuel alcohol, wind electric, biomass gasifiers, solar water heaters, biogas, photovoltaic pumps and wind pumps. Specific projects in each of these categories were reviewed under the reduced oil prices of the mid-1980s.

The findings indicate that the economic sensitivity of renewable energy technologies to changing oil prices is mainly a function of scale and location of the projects concerned. Renewable energy technologies that compete directly in the modern sector as large scale petroleum substitutes, such as dendrothermal power plants and fuel alcohol projects, are the most adversely affected by falling oil prices. One of the most successful fuel alcohol programmes, that of Brazil, has become uneconomical.

But remote and rural applications are less affected because of their generally smaller sizes and, therefore, much lower proportion of fuel cost to total cost in the equivalent sized conventional alternative; the reduced availability and higher cost of petroleum fuels as compared to urban areas; and the lower cost of biomass fuels (e.g. wood for gasifiers) in rural areas. When account is also taken of the risks of interruptions in conventional fuel supply, the renewable application may still be the appropriate one to use despite lower economic rates of return, according to the World Bank study findings.

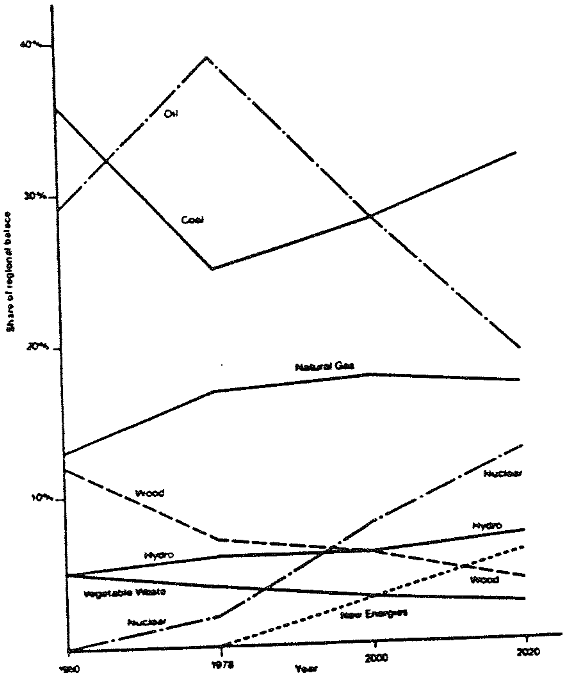
Energy futures

Numerous studies of energy futures have been prepared since the early 1970s. These shall not here be reviewed, in part because it would serve little purpose, and in part because not many studies are fully documented. Instead, we shall focus on the authoritative work done for the World Energy Conference.

The World Energy Conference, in its Report of 1983, projected the following configuration of energy supplies in the world and in the industrialized countries (see Figures 3-4). It was estimated that total world consumption of energy could double or more between 1978 and 2020, even though a slowing down in the rate of demand growth was foreseen (WEC, 1983).

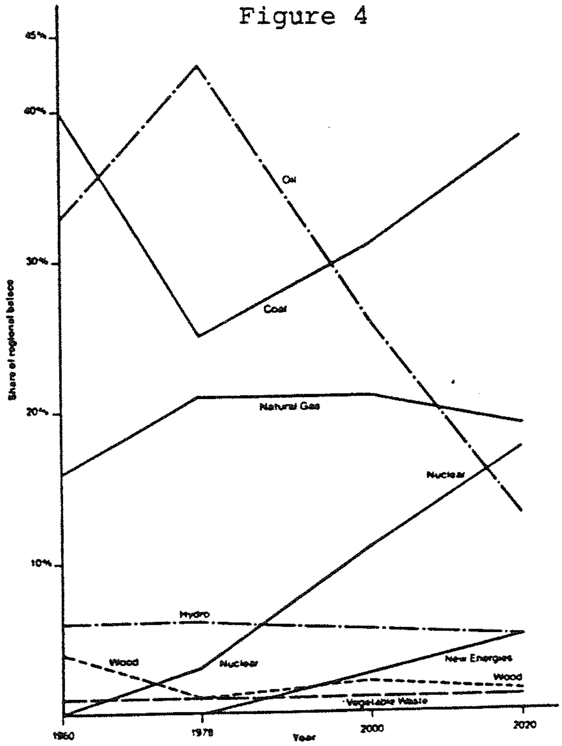
Its policy assumptions include no provision for a major effort towards energy saving measures. In fact, therefore, it represents mostly trend extrapolations, including trend reversals in energy mixes which by that time had already been set in motion. It thus represents a typical conventional exercise in forecasting.

Figure 3



World energy consumption: evolution of supplies

Figure 4



Energy consumption in industrialised countries: evolution of supplies

Source: WEC, 1983

But the energy scenario's of the early 1980s continue to be in need of readjustment as oil prices have again fallen dramatically. Energy futures remain uncertain. Questions that need to be answered with increasing urgency include the following. Are there foreseeable limits to aggregate energy savings per unit of output as a strategy for the long run, without the need for drastic changes in lifestyles? What is the future in terms of the energy mix: with opposition against nuclear power increasing and massive nuclear power cancellations, the shares to be filled by coal or by oil should again be reevaluated. These choices, in turn, will have differential effects on the balance of payments of the countries concerned, raising the specter again of strategic dependence and consequent vulnerability of the economy, especially for many of the smaller, and economically weaker developing countries.

The price fall in international oil prices in 1985/6, weakened the incentives to conserve energy, and more expensive sources of energy are closed down. For instance, in the case of oil and for the USA, it implied a re-substitution of import oil for domestic oil. By 1989 the USA had again reached relative import dependency ratio's above those of the early 1970s, importing 46 percent of its oil needs (de Volkskrant, January 19, 1990). Strategic considerations may also have played a role in the decisions to save domestic oil reserves, and to rely again on imported oil as the political threat of international supply disruptions was seen to be receding.

At the crossroads.

There is evidence that major energy consuming countries have tended to treat the upheavals in the energy markets of the 1970s merely as short lived disturbances. These should not distract, so many energy professionals argue, from well established long-term energy planning practices.

For instance, long term projections by the Department of Energy, made in 1983, of future energy demands for the USA, indicate another phase of rapid growth. An international survey of 328 organizations that have published energy demand projections was undertaken for the International Energy Workshop. This survey of alternative projections produced a 'median' forecast for the year 2000 at 485 exajoules, as against 300 exajoules in 1984 (Chandler, 1985, 40, 51). Not since the early 1970s had energy analysts so complacently projected a high energy demand for the future.

This convergence of the numerous energy forecasts is attributed by Alan Manne, of Stanford University, to the 'herd instincts' in the profession. It suggests a collective wisdom which would be very difficult to attack from outside the profession. With most expertise embodied within the profession of energy forecasters, often linked to the major interest groups in energy planning and production, this combined power can be awesome indeed.

The long lead-times needed for the construction of new power plants, between 6 to 15 years, imply that optimistic estimates of future energy demands may lead to large and costly, almost irreversible investments in capacity creating facilities. Once such new capacities have been created, strong pressures build up to utilize such capacities and to promote energy use, if actual demands would fall below forecasts. Such a process would again stimulate wasteful patterns of energy use into the far future.

Increasingly, however, the discussion of energy futures does not center on supply prospects and constraints and on price levels, but on the environmental consequences of such energy projections, not only on a national scale but also on a global scale.

The optimism in future trends of economic growth, as also reflected in the high growth energy scenarios referred to above, may be contrasted with the major findings of the influential Global 2000 Report to the President of the USA (1981) prepared by the Council on Environmental Quality and the Department of State. The energy projections of the Global 2000 Report are similar to those of the Department of Energy presented above, but the Report draws much attention to the environmental consequences of such optimistic demand scenarios.

If present trends were to continue, the Report found, the world in 2000 will be more crowded, more polluted, less stable ecologically, and more vulnerable to disruption than the world we live in now. Serious stresses involving population, resources, and environment are clearly visible ahead. Despite greater material output, the world's people will be poorer in many ways than they are today.

These environmental consequences relate to rates of energy resources use in excess of new energy resources discovered, to the effects of pollution on air quality, such as the threat of acid rains to global forest resources, and to the effects of Green-House gasses on the ozone layer and global warming affecting climate changes.

For instance, many sources predict temperature increases between 1.5 and 4.5 degrees centigrade (Celsius) by the year 2035. This may not seem much until one realizes that the present average surface temperature of the planet is only 15 degrees. Moreover, the average temperature during the Ice Age that ended 10,000 years ago was only 5 degrees less than today's; if the Green House effect produces a global increase of 3 degrees the world will be warmer than it has been at any time during the past two or three million years (Verwey, 1989, 33 ff).

Such changes, which will affect parts of the world differently, might mean that agricultural production in the corn belt of the American Mid-West, which currently also provides much of the supply in international trade, may sharply reduce; on the other hand, grain production in the USSR may receive a major boost under the impact of climatic change in the expected direction. Droughts may intensify in such countries as India. It could be envisaged that the geopolitical implications of such major shifts in production potential could be far reaching, even though the time frame of this process is such as to possibly permit adaptations in time.

The environmental effects of especially coal, are seen to be far more serious and intractable than was admitted in the WOCOL study referred to above, and apparently also in the long range projections by the Department of Energy a few years later.

The so-called Brundtland report on 'Our Common Future' by the World Commission on Environment and Development (1987), is even more outspoken, when it says:

> The ultimate limits to global development are perhaps determined by the availability of energy resources and by the biosphere's capacity to absorb the by-products of energy use. These energy limits may be approached far sooner than the limits imposed by other material resources. First, there are supply problems: the depletion of oil reserves, the high cost and environmental impact of coal mining, and the hazards of nuclear technology. Second, there are emission problems, most notably acid pollution and carbon-dioxide build-up leading to global warming. Some of these problems can be met by increased use of renewable energy sources. But the exploitation of renewable sources such as fuel wood and hydro power also entails ecological problems. Hence <u>sustainability requires a clear focus on conserving and efficiently using energy</u> (58-9).

RESPONSES IN DEVELOPING COUNTRIES

Responses in the developing countries to the upheavals in commercial markets in the 1970s were in many respects more difficult and problematic than in the developed countries. Conditions differed and the capacity to respond was fundamentally different from the situation in developed countries. Adjustments to the new realities came about much more slowly.

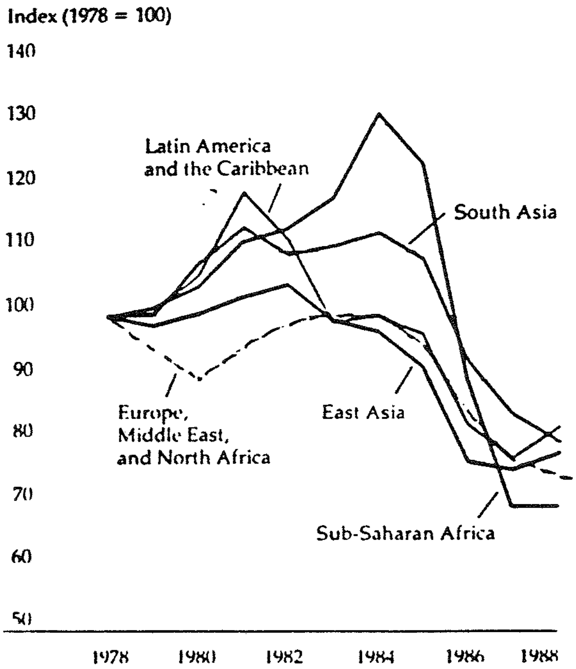
The information base for energy availability, use and planning was weak. A first convenient and comprehensive overview of the energy situation in the developing countries is given in the World Bank Report: Energy in the Developing Countries, (Washington, 1980 and published in 1983). It took the Bank some years to put together a comprehensive picture not least because it did not have the staff capability to analyze and assess the petroleum sector adequately. The bank had until then never been involved in that sector. Its charter prohibits the Bank to compete with the private sector, and it was generally felt that the petroleum multinationals were adequately catering to global petroleum production, refining and distribution activities.

<u>Short term</u>

Short term policy responses were analogous to those in the developed countries: initially, consumers were protected from the effects of the higher oil prices. The reduction in the tax on energy also implied a relatively major reduction in government revenue, especially in the smaller and poorer countries. Various forms of implicit and explicit energy subsidization tended to accumulate visually in the financial accounts of a number of parastatal institutions, the main source of public sector deficits in developing countries. The size and growth of these financial deficits subsequently led to IMF and World Bank-led attacks on parastatal institutions and the allegedly overextended state, within the frame work of conditionality discussions linked to structural adjustment financing.

Delays in passing on the high cost of imported energy were compounded by the fact that many countries maintained overvalued exchange rates through the mid-1980s (see Figure 5).

Figure 5 Real effective exchange rates in developing countries by region, 1978 to 1988



Note: The real effective exchange rate is the trade-weighted exchange rate adjusted for relative inflation. An increase in the index indicates an appreciation of the currency. The regional index values, which are based on a total sample of eighty-three developing countries, are annual averages weighted by the dollar value of exports.
Source: IMF and World Bank data.

Such a policy kept imported energy cheap relative to domestic sources of energy. The oil price increase could be expected to change the competitiveness of thermal power relative to hydro power, because of their differently proportioned cost structures: capital cost and running costs. But the rate of substitution between these two sources of energy supply was retarded by the energy pricing policies pursued.

Unlike the developed countries, most developing countries also had little to offer to the newly rich OPEC countries to satisfy their buying spree. Thus, the impact of the oil prices on the balance of payments remained uncompensated. Compensatory OPEC aid flows to developing countries were small and concentrated on mostly the poorer Arab and Moslem countries.

Long term

To develop structural policies to cope with the oil price increases proved a formidable challenge for a variety of reasons. Most developing countries started their modernization and industrialization drive after World War II. They chose petroleum as the preferred source of commercial energy.

Coal production in developing countries is limited. Major producers are China and India, with Yugoslavia, Korea and Turkey as important minor producers. Hence, little industrial development based on coal existed. Alternative modes of transport, such as railways were limited or non existent. Switching energy sources in transportation was thus not a policy option that could be pursued by most developing countries.

Though many countries, especially in Africa, possess considerable potential for the development of hydro-power their development cost are quite substantial and long distance transmission systems to consumption areas would be necessary as well. The necessary infrastructure investments to accompany such a shift were lacking.

The nuclear power option, obviously, can only be seriously considered by a few of the most developed middle-income countries. Few countries have the resources to develop nuclear capability, and the existing nuclear powers have a long standing policy against nuclear proliferation for reasons of maintaining arms superiority and maintaining global security through the Cold War era. The improvements in East-West international political relations need not imply that the non-proliferation policy will be relaxed for developing countries.

Other forms of energy are insignificant to have a major impact, though some, such as ethanol in Brazil, are noteworthy. But, as noted above, this programme was judged to have become uneconomical since the mid-1980s.

For the middle-income, semi-industrialized countries the transition from traditional (fuel wood, crop residues and dung) fuels to commercial sources of energy had already taken place, major pockets of the poor and underdeveloped regions excepted. Such pockets may still involve millions of people at present. With highly skewed income growth and rapid population growth their numbers may very rapidly increase over time.

Low-income countries still relied mostly on traditional energy, which covered half or more of their total energy requirements, but oil was relied upon in their modern sector development. It has been estimated that 76 per cent of Africa's total energy was supplied by fuel wood in 1980, against 42 per cent for Asia and 30 per cent for Latin America (Dunkerley, 1983).

For most developing countries, therefore, balance of payments pressures were considerable to intensify the utilization of domestic wood resources for fuel. The issue of large scale and accelerating deforestation began to attract global attention in public policy discussions. The increased use of dung for fuel also implied competition with the traditional use of dung as natural fertilizer for agricultural lands. Thus deforestation and land degradation in the crop lands were recognized to be interlinked phenomena.

Many countries were also poorly researched for the existence of natural resources. Of resources which were known to exist, it was often unclear whether they could be exploited technically and efficiently. The human, technological and financial resources to develop their natural resources were weak, and, in many cases the institutional and legal framework governing the exploration and exploitation of natural resources was poorly developed as well.

Even where such frameworks existed, foreign prospectors were reluctant to enter, because of uncertainties about such regulations in an international climate which stressed a major shift in power relations in pursuit of a New International Economic Order.

The large multinational energy corporations, which proved the home base for many of the necessary resources, obviously were choosy in deciding where they went. Their primary interest was in supplying markets in the industrialized countries with energy from sources which could be quickly and cheaply brought into production. Countries and locations which required long term and more uncertain trajectories were preferably avoided. This created additional problems for the developing countries concerned.

Foreign skills and resources for energy development, on which many developing countries had to rely, could not always be obtained. If obtainable in the open market, they could not be paid for due to shortages of foreign exchange.

The major international effort to assist developing countries in energy assessments and in the development of energy planning frameworks was not launched until 1980. In November 1980 the Energy Sector Assessment Programme (ESAP) was launched as a joint effort of the United Nations Development Programme and the World Bank. ESAP's general objective has been to help developing countries establish a realistic strategy for energy sector development and management, and to assist these countries, donor agencies and private investors in implementing the priority activities included in such strategies. Some 70 countries requested assistance under this programme, and most assessments were carried out by 1986.

This initial joint effort was continued as ESMAP, which basically assists in the follow-up and implementation of some of the major recommendations from the assessments made, particularly in regards to energy sector management.

Against this background it can hardly be surprising that the energy base in developing countries is and remains based on oil, though declining from 66 percent in 1970 to 45 percent in 1995, as is illustrated in Table 7. It is noted, however, that the growth rate of oil production is considerably lower than that of the other major energy sources. It should be noted in considering these figures, that aggregate figures for all developing countries are heavily influenced by the large weight of coal in India and China. Thus the picture will be quite different if further breakdowns, for instance on a continental basis, were available.

The rising importance of the developing countries in global energy markets can be seen in Table 8. The very large increase of LDCs in world incremental oil production is to serve the needs of domestic development in the countries concerned, as well as to continue to supply (on a net basis) developed countries. Such oil exports are needed also to finance the imports necessary for LDC development.

Table 7. Commercial Primary Energy Production in Developing Countries, 1970-80 and 1980-95.

	Million toe*			Annual Growth Rates	
	1970	1980	1995	1970-80	1980-95
Oil	774	919	1375	1.7	2.7
Coal	294	502	886	5.5	3.9
Natural gas	52	116	424	8.4	9.0
Primary electr	56	130	396	8.8	7.7
Total	1176	1667	3081	3.6	4.2

* tons of oil equivalent.

Source: World Bank, 1983.

Table 8. Share of Developing Countries in World Incremental Production and Consumption of Commercial Energy, 1970-95. (per cent).

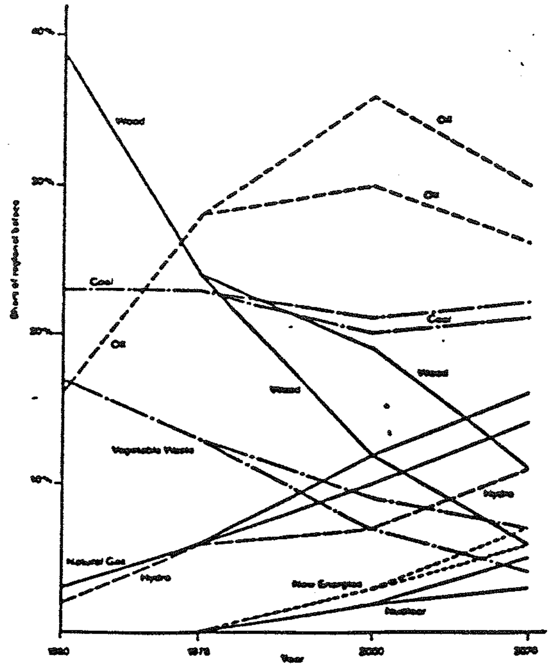
	1970-80	1980-95
Production		
Oil	20.5	158.3
Coal	57.6	38.6
Natural Gas	18.8	44.7
Primary Electricity	26.1	32.8
Total	29.0	50.8
Consumption		
Oil	35.8	106.9
Coal	56.0	44.7
Natural Gas	13.6	33.2
Primary Electricity	26.1	32.8
Total	33.8	44.8

Source: World Bank, 1983.

The World Energy Conference, of 1983, projected the following evolution of energy use and of the energy mix for the developing countries (see Figure 7). Oil dependency remains large because other sources of primary energy, other than wood and crop residues, grow rapidly but from a very low base.

It is evident that the growth of energy use in developing countries will grow relatively faster than in the industrialized countries. As this growth is largely based on oil, it is important to see the relationship between the oil and gas reserves and cumulative production. It appears from Table 9 that the addition to reserves stays abreast of consumption by a relatively narrow margin. These figures suggest that the energy expansion path of many developing countries, especially those with few energy alternatives, seems vulnerable.

Figure 7



Third World energy consumption: evolution of supplies

Table 9. Changes in Oil and Gas Reserves
in Developing Countries, 1973-81.
(billion barrels of oil equivalent)

	Oil importing developing countries.	All developing countries.
Reserves, year end 1972		
Oil	12.4	488.8
Gas	7.3	170.0
Total	19.7	658.8
Gross additions to reserves 1973-81		
Oil	4.9	177.3
Gas	19.2	121.6
Total	24.1	298.9
Cumulative production 1973-81		
Oil	5.4	119.0
Gas	3.4	9.2
Total	8.8	128.2
Reserves, year end 1981		
Oil	11.9	547.1
Gas	23.1	282.4
Total	35.0	829.5

Source: World Bank (1983).

Rural Energy.

By the mid-1970s, the prevailing view in developing countries about strategies for energy development was based on the expansion of urban based, and integrated grid systems, the tentacles of which were gradually expected to be extended into rural areas through expanded programmes of rural electrification. The speed of progress was dependent upon the rapidly growing urban priorities and what resources could be spared to expand outward.

The cost of power transmission over longer distances and with small loads made many energy authorities rather reluctant to push rural electrification aggressively. In as far as rural electrification schemes were uneconomic, the power authorities argued, sometimes successfully, but sometimes in vain, for subsidies from the national treasury.

Transmission losses in grid systems are also rather high, adding substantially to energy losses in the generation and in end-use applications of the total energy chain (see Table 10).

Table 10. Electric Power Lost
in Transmission and Distribution Systems
in Developing Countries, 1980.

Losses as percentage of generation1	Percentage of Countries2
0-10	17
11-15	33
16-20	21
21-30	21
31-40	8

1. includes technical losses and unmetered consumption.
2. sample of 76 developing countries.

Source: World Bank, 1983.

At any rate, power authorities had their hands more than full in coping with the building up of local expertise after independence and with the maintenance of existing and construction of new energy development plans for the modern urban sectors of their economies. In many cases plans do not extend to the sprawling urban squatter areas in the large cities.

Because the emphasis was on integrated grids, the case for decentralized, stand-alone systems for the more outlying areas could not be discussed with energy authorities of many countries.

The implications of such conceptualization of a rural energy strategy was that electrification would only proceed very slowly indeed. For the long term, large segments of the growing population in rural areas in many developing countries would remain dependent on traditional sources of energy: crop residues, dung and fuel wood.

Proponents of decentralized electric power, and donors trying to promote such developments, had to often bypass the traditional, highly centralized energy authorities. They had to find different institutional channels and arrangements, such as Departments for Integrated Rural Development, or of Local Government. These agencies, however, often lacked sufficient relevant skills to promote decentralized energy supply policies.

In general, therefore, little attention was given until well into the 1970s to the energy needs of the rural population. For the urban population, the use of kerosine was growing rapidly, and in a number of countries fuel wood plantations had been developed for the urban charcoal market.

PROBLEMS IN ENERGY PLANNING.

Policy making and resource allocations in the energy field were, and, to a considerable extent, are still dominated by those in charge of commercial energy development. This energy policy framework is similar to the configuration of the energy sector in developed countries. The same concepts are used, analogous solutions are conveyed and similar priorities are set. The World Bank, too, is part and parcel of this global profession of the commercial energy establishment. The Bank has, from its inception, stressed economic infrastructure development, especially in the electric power field.

In such an environment it is very difficult, if not impossible, to introduce alternative concepts on energy development and use strategies. The dominance of conventional, supply oriented 'energy thinking' is reinforced because of the near universal lack of information, until well in the 1980s, of comprehensive and reliable information on rural energy production, consumption and marketing patterns.

For instance, in most of the World Bank Sector Review Reports on Energy, non-commercial sources of energy received until recently scant attention, even though these sources are of major importance in many of the low-income countries. Though the World Bank 1983 report provides much useful information on the energy situation in the developing countries, and stresses its traditionally important role in this field, it says little on what under present day conditions are appropriate energy strategies for the developing countries. Playing "hide and seek" in stating that the Bank responds to country requests, obscures the fact that the Bank has interests of its own, and that energy planners in rich and poor countries and the Bank itself, are all members of the same "energy fraternity" which holds similar views, apply similar methods and use similar techniques and technologies world wide. We thus have to turn to the problems of energy planning.

Energy planning has to be framed in a rather long time frame, at least twenty to thirty years. This is so because the time required for the design and construction of energy plant is easily 10-15 years, and much more when the technology itself is still in process of development. This is generally the case for nuclear energy, but it also applies to offshore and deep sea oil exploration, such as in the North Sea. A second reason for long planning horizons for energy is that a number of major energy users have planning and investment perspectives which also require substantial lead times.

Beliefs are strongly held that economic development is stimulated by prior investment in economic infrastructure. This implies that the energy sector takes on strategic importance as a leading sector. The attributes of this status involve priority treatment in investment planning decisions. The sector needs to be developed even when no clear ideas exist about the volume of future demand and the character of future energy users. Uncertainties for planning increase exponentially, with sharply increasing forecasting ranges, the longer the time horizon. These problems for energy planning are of course well known.

Attitudes and expectations do not differ much between developed and developing countries. Whereas we noted above that recent long term projections in the United States again appear to imply a return to high energy demand scenarios, the situation in developing countries is no different.

The recent World Bank review of Capital Expenditures for Electric Power in the Developing Countries in the 1990s (1990a) puts the problem succinctly and well:

> At a time when many developing countries are struggling with severe debt repayment problems and low economic growth rates, the electric utilities and governments in some of these same countries are continuing with fairly ambitious expansion plans for their electricity supply systems. This indicates the high priority placed on having an adequate electricity supply for economic development, apparently because electricity is perceived as a combination of the dynamo of development, an engine for industry, a premium form of energy, a basic need of the people, and a sign that the country has graduated from underdevelopment. Nonetheless, the vast financing demand for electricity supply, --in the order of $ 1 trillion (12 zeros) with an expected regional breakdown of Asia 61 per cent, Europe, the Middle East and North Africa 16 per cent, Latin America and the Caribbean 21 per cent and Africa 2 per cent-- has major implications for macroeconomic policies as well as for power sector financing.

The debates of the 1970s about possible limits to growth, and concerns about the state of the natural environment have added to the energy discussion two elements which previously received, in retrospect, much too little attention. The first element is one of aggregation. Hitherto, energy authorities planned their expansion individually. Higher levels of aggregation remained limited to the level of the nation state, when more than one authority existed within the states. Harmonization of energy planning was undertaken in cases where cross-border exchanges were considered. Such cross-border linkages function mostly as back-up facilities for emergencies, and not as structural sources of international supplies.

Aggregation of rapidly expanding energy demands across all countries of the world, obviously, is a new phenomenon which brings into focus the discussion about global supply availabilities. The problems are then compounded by the thrust of modernization, which, in many areas of development, consists essentially of copying models of energy use which had evolved in the industrialized countries. Catching up with the leaders was the watch word, and, as was shown above, the fastest rates of energy demand growth is precisely in the newly industrializing countries.

Aggregation at this level brings out the difference in linear growth versus exponential growth. Most people are accustomed to think in terms of linear growth. For short slices of time exponential growth may resemble linear growth, and this is deceptive.

The deceptive character of exponential growth is also that it introduces an element of apparent suddenness in reaching a fixed limit. This may be illustrated by the following parable (from Limits to Growth, 1974, 37). Suppose you own a pond on which a water lily is growing. The lily plant doubles in time each day. If the lily were allowed to grow unchecked, it would completely cover the pond in 30 days, choking off other forms of life in the water. For a long time, the lily plant seems small, and so you decide not to worry about cutting it back until it covers half the pond. On what day will that be? On the twenty-ninth day of course. You have one day to save the pond. The question then is whether this remaining time span is sufficient to plan for and take decisive action to remedy the problem.

It is useful to think of exponential growth in terms of doubling time, or the time it takes a growing quantity to double in size. World population has been growing at over 2 percent per year: this implies a doubling time of 30 to 35 years. GDP growth of 5 percent per year implies a doubling time of 14 years. These time spans are within the ranges of the individual human experience. Yet, these time frames imply major transformations of society and present problems which in many respects are incomparable with earlier historical experiences. Whole (sub) sectors of the economy may emerge, disappear, or may be relocated to other countries or regions. Markets and market shares may be lost, as for African agricultural exports in the 1970s, in irreversible developments. Less comfortable is that history provides little guidance for coping with such rapid transformation, either in anticipating, or accommodating, their occurrence or in organizing alternative strategies to overcome undesirable consequences of such major transformations.

Energy planning, in a time frame of 20 to 30 years thus inevitably takes place in a somewhat futuristic and visionary environment, where imagination and reason vie for credibility or at least plausibility.

The <u>environmental effects</u> of resource use add to the visionary future the effects of stocks in addition to flows. Most economic variables are in terms of flows of current use. The by-products of economic growth, of emissions and residuals, accumulate as stocks, in as far as they are not degradable by processes in nature itself. The environment then acts as a 'sink'.

At some point in time, however, the sink is full and further additions lead to overflow. To then obtain again some margin of safety, current flows must be reduced. In addition, the sink itself must be cleared up. This will necessitate an extra investment effort to curtail resource use to facilitate such needed regeneration of the natural environment, if that is still possible in some form.

There is, however, a creeping and nagging fear, that many forms of environmental degradation --the tropical rain forest, the ozone layer-- are irreversible processes with unknown consequences. Examples of "over-flowing sinks" or of potential "time bombs" waiting to go off, are the transformation of Los Angeles, Manilla or Mexico City from relative paradises to smog cities in less than 25 years, the effects of chemical wastes dumped in the ground 20 to 30 years ago, and the pollution of streams and rivers acting as sewers. In as far as major conurbations have grown up where rivers enter the sea (such as for the Rhine, the Nile and the Mississippi deltas) such polluted rivers threaten the supply and safety of drinking water in the area. The information becoming available about environmental conditions in Eastern Europe points at probably a large number of environmental hazards being present.

In some cases Eastern European countries have hosted chemical dumps from Western European countries. The exports of untreated waste materials from Europe and North America are seen as new foreign exchange opportunities for poor developing countries in Africa. The waste disposal industry may well become the latest growth industry, with vast opportunities for profits especially because the obligations to dispose of waste materials in an environmentally safe manner prove to be difficult to control.

Scenarios for environmental futures (50 to 100 years) must take time horizons well in excess of those used by energy planners (20 to 30 years). They invariably yield gloomy pictures, which tend to defy the imagination of mankind. Economic planners, who think that 5-year planning horizon are already excessive for planning, simply cannot cope with such time horizons. For a number of countries and many individuals, especially the poor, time spans are shorter still: they live from one meal to the next.

The specter of the environmental future thus cannot be visualized in the time frame of many individuals or disciplines. Hence, consensus about the need for, and the timing of sustained corrective action, will then be difficult to reach. The consideration of the means that may be available or can be mobilized to meet the challenges, assuming political consensus can be reached on what to do, may present further and formidable problems to be considered.

Past energy planning has involved often no more than the most rudimentary extrapolation of long term trends. Trend breaks are indistinguishable in the trended past record, and are thus absent in most projections. Short term disturbances are usually ignored, and with good reason, in view of general uncertainty about the future, and long the long investment gestation periods for new and lumpy energy plants.

From the brief review of the responses to the upheavals of the 1970s, it can thus be readily comprehended that they are seen, by many energy planners, not as marking actual or needed trend breaks, but as temporary and short lived disturbances which by now have been successfully overcome.

Few seem to realize, however, that there is general agreement that global oil production levels will peak around the turn of the century, and will gradually decline thereafter. Of course, at sharply increasing international oil prices additional supply responses, though again with considerable time lags, will again be forthcoming. But some of the impending constraints on energy supplies may be very real.

It is not inconceivable that the environmental dimension of fossil fuel energy consumption may become the key factor in moving towards a quantitatively and qualitatively different energy future.

Especially the developing countries may be courting future dangers. Current and projected rates of energy use are higher and their energy mix continues to be more heavily based on fossil fuels, as was indicated above. They are thus more vulnerable for again sharply increasing international oil prices. The prospects of, and scope for global energy conflicts could well increase.

Lack of planning incentives.

Planners of commercial energy until recently have had virtually no incentives to plan supplies for slower than historical rates of energy demand growth. Various factors may be cited. Turning points in energy demands may lead to under-utilized capacity as new plants under construction come on stream. Energy planners, unlike most other producers of goods and services, are not normally penalized for faulty forecasting and misguided investment decisions.

The costs of excess capacity are of limited concern to them, as these are easily charged to present consumers, who have no choice in this monopoly supply situation. New actions, by tariff policy manipulation or the promotion of new energy uses, could always be undertaken to stimulate off-peak capacity uses. On the other hand, major outcries and public upheaval will result if capacity short falls in the generation of electric power were to become manifest in "browning" (reducing voltage in peak demand periods), or when supply shortages were to occur leading to queuing before gas pumps. In this asymmetric planning environment, energy planners have thus every incentive to plan the "required" supplies to meet future demands on the optimistic side.

Looking at energy demand from the end-use side, energy planners can only plan for lower rates of growth if (a) all categories of end-users are firmly committed to energy saving investment programmes, and (b) the effect in energy savings per unit of output is not mitigated or overcompensated by increasing rates of use of the products produced. Increasing the fuel efficiency in automobiles, for instance, may be overcompensated by consumers travelling more kilometers per year.

Suppliers of primary energy do not influence or control the investment plans down stream, and these industries, in turn, do not control consumer preferences. Energy saving investment decisions are inter-linked between sectors, and concerted overall investment and consumption planning is absent in most countries.

Where then is the pressure to turn the corner coming from and how will a concerted attack on energy saving behavior be organized?

The issue is not only one of reducing overall energy use per unit of output. Additional problems exist in terms of energy switching. In some uses, alternative primary energy sources can be substituted for each other, such as heavy oil for diesel in power generation. In other uses this is not possible without major new investments in plant and equipment. Small relative price changes may induce only minimal shifts in the use of primary energy sources. Sometimes one should think in terms of energy combinations: solar power may provide the base load but diesel will be needed to meet peak demands.

The importance of relative price changes should, however, not be over estimated. For strategic reasons one may decide to maintain balance between different primary sources of energy, to avoid excessive dependency and vulnerability of total supply. In such calculations prices are averaged by the producers of primary energy and major input switching in response to relative price changes, is avoided.

In other uses, switching is not possible and the effects of short term, and not-sustained, changing relative prices will have little or no impact on users. Modern society is locked into patterns of resource use as a result of past decisions in respect of urbanization strategies and policies for industrial locations. The interaction between transport developments and differential treatment, in priorities and subsidization programmes of transportation modes such as rail transport and the automobile, zoning regulations separating industry from housing in spatial planning, and mobility patterns is well known. The railways were developed to provide point to point transport. Sub-urbanization policies encouraged the people to use private automobiles and to move out of the cities. This led to congestion on traffic corridors. Belt-ways, or ring-roads, intended to relieve urban congestion, in turn became major traffic arteries and prime locations for industrial and services oriented developments. Many such trends, which affect and are affected by urban land prices and thus the costs of subsequent desired changes, tend to be difficult to reverse.

The increasing vulnerability of many work places under current patterns of technological change forces people to change jobs and often job locations in an unpredictable manner. Workers are then reluctant to change homes with each job change. Rather, they prefer to commute for considerable periods and over longer distances. In such situations the neoclassical world of economic theory, which postulates that people change behavior rapidly and efficiently in response to changes in relative prices, is not very useful.

Intractable as many of the urban and energy related problems are in developed countries, many of these problems are dwarfed by the complexity of the growing numbers of the megacities developing mostly in the developing countries.

A shift to different patterns of energy use and different mobility patterns could thus only be expected if relative price changes were seen to be major and lasting. Unfortunately, from the energy saving point of view, the oil price increases of the 1970s were major but not lasting (see Figure 1 above). This explains why many industries would be rather reluctant to commit themselves voluntarily to long term energy saving and energy switching policies.

In as far as investments in energy are lumpy and for long periods, the sharp variability of interest rates, another major cost factor in <u>ex ante</u> project analysis calculations, provides additional sources of uncertainty. Also real interest rates, which tended to be low or negative in the 1970s, have risen to historically high positive levels in the 1980s, thereby substantially adding to the costs of investments.

<u>New beginnings in planning</u>.

Nevertheless, despite these problems in energy planning and structural and institutional difficulties, which seem to work against trend changes, something has been accomplished. In this section we shall identify the major factors and approaches in the industrialized countries and we shall try to assess their relevance and applicability to conditions in developing countries. In as far as the energy sector is a truly global industry, as suggested above, the transferability of new trends may be important.

In the <u>industrialized countries</u> consumer groups and the environment movement have had sufficient clout to force corrective government action.

From about 1970 Environmental Protection Agencies or Ministries or Departments with similar functions came to be established. This is not to say that they were immediately effective and powerful, as the energy sector and the major energy using industries are usually well organized and had advocates within the government itself.

In many other countries such pressure for corrective action is not present or has not yet become powerful enough to influence policy. Current evidence shows that in the socialist economies consumer groups had little opportunity to develop, and bureaucratic action has, until very recently, been effective in ignoring the harmful environmental effects of development policies. In most developing countries the situation is similar or worse.

Two additional factors should be added to explain or at least to understand the apparent slowness in organizing for a decisive energy using turning point at the global level. A firm commitment must be made and sustained to induce research and development expenditure to be directed to energy saving devices. The irony of the current collapse of the socialist regimes is that they have to turn en masse to the West for energy saving technologies which were developed, often reluctantly, over the last twenty years. Developing countries, with absolute scarcities of foreign exchange will have to make painful choices whether to import energy saving devices for the currently existing industries, or to import capital goods for the development of new, additional industrial sectors in their economies.

One should recognize the major role which non-governmental organizations (NGOs) have played and continue to play in attempting to bring about changes in a different energy direction. By taking the initiative for numerous pilot projects they have contributed greatly to the development of alternative technologies in the energy field. In this connection NGOs should not be confused with organized consumer groups. The latter may act as pressure groups on utilities and regulatory bodies on issues as prices and rate structures, but this need not imply that they share or support new initiatives on energy innovation and energy conservation.

A second important role of NGOs has been as environmental lobbies on governments, industry and on international agencies, to put pressure for them to change their ways. In a number of cases with increasing success. One might mention that the role of NGOs with the United Nations Environmental Programme has been especially important. In turn, UNEP has also actively sought the support of the NGOs to increase its otherwise very limited influence from size on the international community. The NGOs have Consultative Status also with other United Nations organizations, but there they are mostly treated as to be 'heard but not listened to'.

Where action groups begin to develop and exert pressures at the relevant political levels, action may still not be forthcoming. Action in isolated or limited areas, are often resented and blocked on the ground that it will lead to distortions in the international competitiveness of industries. In densely populated and interdependent Europe, major environmental strategies to reduce energy production and consumption levels cannot be mounted at the national level for this very reason. Such policies should be undertaken at the European level, and in some cases perhaps even at wider levels of collaboration to be effective. More suitable fora may be the OECD or the GATT. To reach consensus at such levels will be even more difficult and will take even more time.

The exploration of some of the substantive and institutional constraints to a turning point in energy use trends is not altogether gloomy in outlook. Evidently, a number of initiatives have been undertaken and some accomplishments can be noted.

Before turning to some of the more positive developments, it may be useful to first present some data on the accuracy of energy forecasts, and on the scope and potential for energy saving in some alternative scenarios.

Forecasting accuracy

First, it may be useful to present the annual projections by the North American Electric Reliability Council (see Figure 8).

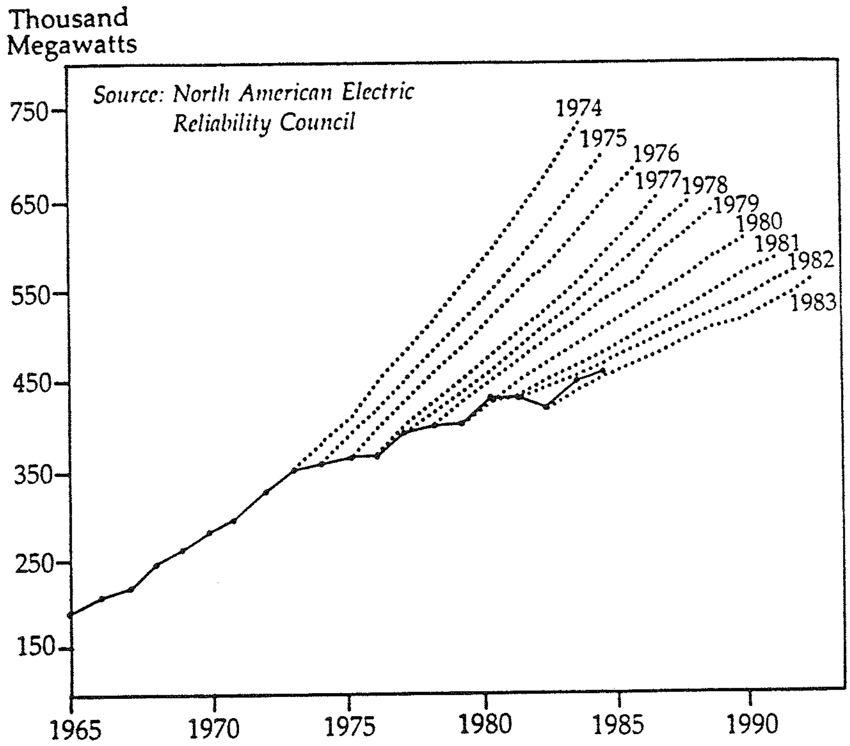


Figure 8: Summer Peak Electric Demand, 1965-84, And Projections Made from 1974 to 1983

For ten consecutive years the Council lowered its forecast, invalidating the previous year's efforts almost before the ink had dried, and calling into question billions of dollars of investments that had been premised on the previous year's predictions.

Apparently, forecasts give heavy weight to past trends and it takes them a long time to incorporate more recent experiences. The early projections treat the last year(s) as one-off shifts, after which the original trend is expected to resume. But all further years turned out to be below the projected trend values.

Reading the graph horizontally thousands of MegaWatts are apparently not needed. However, given the long investment lead times, capacities may have been ordered, many of which subsequently had to be cancelled, as was shown in Table 6 above.

A rule of thumb for electricity planners is that generating capacity should exceed peak demand by about 20 per cent. But due to the type of forecasting uncertainties alluded to above, most utilities in industrialized countries now have 'reserve margins' of 30 to 50 per cent (Flavin, 1984, 24). For developing countries the situation is no different. For instance, the World Bank recently estimated that "seven East African countries currently have 3,000 megawatts of excess power generating capacity over and above reserve margins. At $2,000 per kilowatt this represents a needless cost of some $6 billion in investment capital, which could be applied productively in other sectors. Latin America shows similar patterns of inefficiency. In Colombia, energy investments (mostly for power) made up about 50 percent of public sector investments in 1985, even though there was already 50 percent surplus generating capacity in the system" (Hume in World Bank, 1988a, 15). The systems,with large hydro-power components, of Brazil have surplus energy and capacity in four years out of five (World Bank, 1989e, 7). In as far as these investments involve sizeable foreign borrowing, these investments add substantially to the debt burden of these countries.

Such large generating capacity margins would seem excessive. It reflects mis-investments and it may provide strong inducements to stimulate energy uses in a new round of increasing energy intensive production and consumption in developing countries, a danger already referred to in the case of the United States.

More systematic evidence on the historic electricity forecasting experience of demands and costs, has recently been undertaken by the World Bank (1989f and 1989g).

The analysis of demand forecast accuracy was based upon comparing actual versus forecasted sales, as identified in over 200 separate forecasts in over 100 separate power systems/regions in 45 World Bank member countries for the period 1960-85. This resulted in a database with 1600 data points, defined by three numbers: actual sales, forecast sales and year.

The results support the following conclusions (World Bank, 1989g, 56):

1. There have been three over-estimates for every under-estimate. This strong historic bias toward over-estimation cuts across all regions, for different time periods and horizons, and economic environments.

2. Forecast deviation and uncertainty increase with the forecast horizon. The mean absolute per cent deviations were 11.9 percent for a forecast horizon of 3 years, 19.9 percent 7 years out, and 29.1 percent 10 years out, with wide ranges and thus large standard deviations around these averages.

3. There has been no trend toward improved accuracy over time. Pre-1975 forecasts outperformed their successors, perhaps due to the greater variability in GDP growth rates since the mid-1970s. The record of large utilities seems to be better than smaller ones, especially in the short run; wealthier countries have achieved better accuracy than the poorer ones.

4. Poorest forecast performance tends to occur in countries which received relatively low World Bank funding in their power sector. High Bank funding, however, does not appear to assure forecast accuracy.

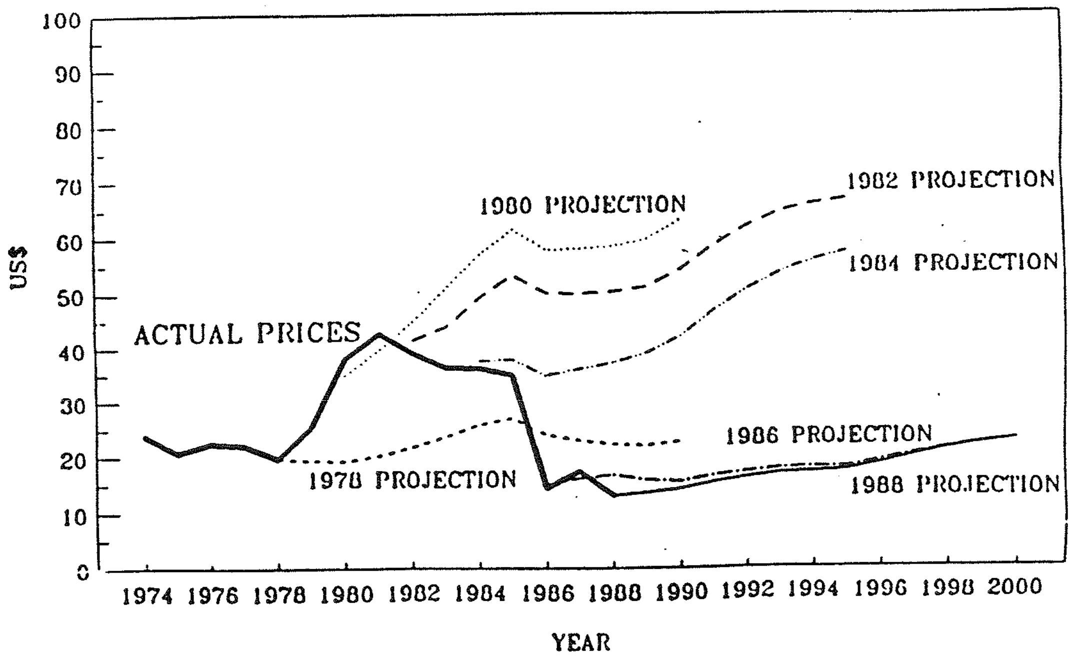
5. More recent forecasts have not tended to become more accurate, despite the general increase in effort and sophistication in forecasting techniques. This appears to suggest that the scope for reducing uncertainty in load forecasting appears to be

insufficient to support the deterministic approach to power system planning.

6. Forecast accuracy for utilities in the Bank's member countries was close to that of smaller United States utilities in years 4 and 6 of the planning horizon, but markedly poorer in year 2.

Too optimistic demand forecasts are only one of the causes of risk and uncertainty in energy planning. Track records of forecasting oil prices (see Figure 9) reveal that they have been always highly unsuccessful in providing reliable predictions of price increases and declines over the past 15 years. By way of contrast, forecasts for coal prices have been closer to outcomes.

Figure 9: WORLD BANK OIL PRICE PROJECTIONS IN CONSTANT 1987 US$ PER BARREL



Due to their volatility, oil prices have become one of the main sources of uncertainty in power planning. Technological choices based on oil price forecasts carry a high cost penalty.

In addition to demand forecasting errors, there are other factors in energy planning which tend to systematically affect decision making. Cost overruns and implementation times are substantial sources of bias in energy planning.

In a recent study (World Bank, 1989f,4-5) it was shown that, in nominal terms, the average cost overruns for about 40 hydroelectric projects was 40 percent, with isolated cost overruns of up to 200 percent. In real terms (constant prices) the average overrun was 9 percent and the range of deviations observed ranged from -25% to 100%. For all types of Bank power projects implemented during the period 1967-84, the average overrun in nominal terms was 19 percent, and those projects approved before and completed after the 1973 oil crisis were subject to the most serious cost overruns largely due to the effects of unanticipated inflation.

Adherence to project implementation schedule is another key measure of project performance. On average, power projects approved by the Bank between 1967-78 were estimated at appraisal to be completed in 46 months but actual average implementation time amounted to 66 months, an average delay of 43 percent. For 41 hydroelectric projects the average delay was 30 percent, but with a fairly uniform distribution from 0% to 100%.

In sum, these results reveal two principal features. First, the average deviations are, for all variables, quite high and clearly based in one direction: overestimation of demand growth, underestimation of cost and implementation schedules. This results in a systematic overestimate of the rates of return on power sector investments. Second, the great dispersion found in all variables indicate a great degree of uncertainty faced in decision making, leaving wide scope for misleading conclusions. The wide spread in the key variables are only very seldom captured by the usually narrow margins of error in sensitivity analysis.

In principle, uncertainty can be handled in various ways. In practice it is sometimes ignored focussing on short-term strategies and assuming that long term uncertain issues will resolve themselves. But more systematic options exist: (a) to defer decisions until more information becomes available; (b) sell risks to other parties through forward contracts for inputs and sales; (c) plan very carefully for all reasonable contingencies, but this is only useful for the short run; (d) adopt flexible strategies that allow for relatively easy and inexpensive changes.

The test for future developments in the energy field is therefore whether developments contribute effectively in coping with pervasive uncertainties. This is the message from the oil crises.

Scope for energy savings

Forecasting on the basis of past (long-term trends) is rapidly falling out of favor, as they are unsuitable for future planning in the configuration of the world economy as we now begin to understand it.

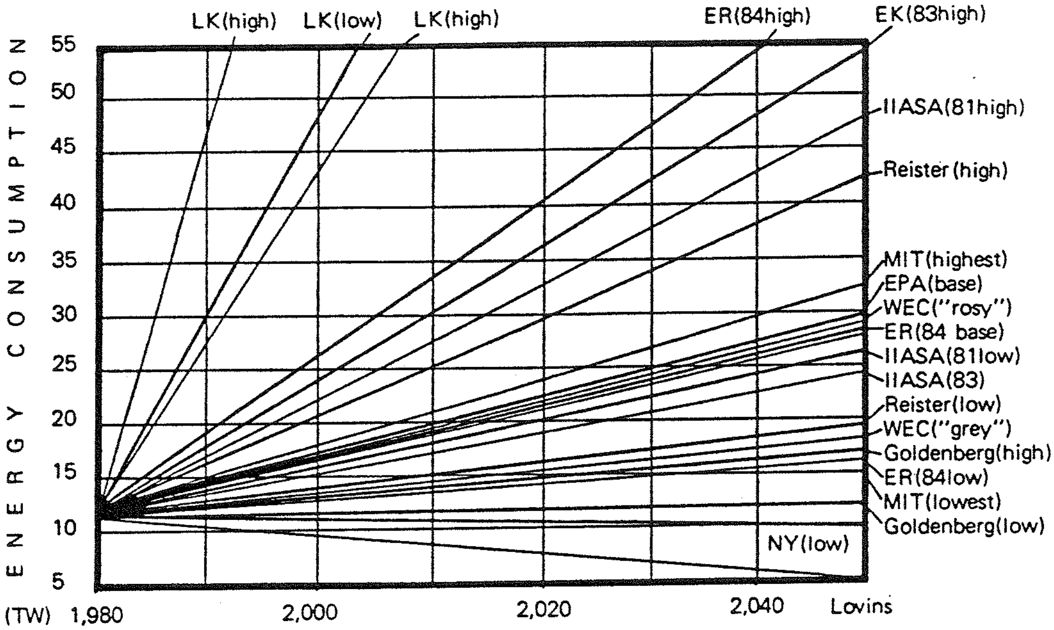
A compilation of recent energy projections by different agencies (see Figure 10 on the next page) shows that, indeed, energy forecasting has fallen into a complete disarray.

Energy forecasting is to be increasingly seen as a planning instrument within the frame work of an overall production and consumption planning process. A whole range of new assumptions is then introduced in the planning models to be used. Supply management is to be complemented by demand management.

Conventional energy planning is based on supply side approaches. Critics of these approaches who favor demand side approaches, come from two quarters. Those who believe that future sources of primary energy are insufficient to accommodate both the energy needs of the

Figure 10

PROJECTIONS OF PRIMARY ENERGY CONSUMPTION



Source: Keepin - 1985 Bill Keepin et al.: Future Energy and CO_2 Projections, The Beijer Institute, Stockholm, Sweden.

developing countries and the needs of future generations, and those who are primarily concerned about the effects of energy use on the environment through green house gasses and climatic change.

These two groups need not share the seem outlook. In developed countries environmental consciousness may increase, thus leading to the installation of emission controls, to energy saving production processes and to, possibly, changes in personal behavior.

In developing countries the pressures for development may be so overwhelmingly strong that environmental pollution is seen as inevitable in industrialization strategies which must be pursued. In as far as much technology is imported from the industrialized countries, and energy efficiency was not a design characteristic, pollution levels will increase in the developing countries, possibly and probably negating progress in environment management in the developed countries.

It is quite conceivable that China and India, basing themselves on the abundant supplies of environmentally harmful coal deposits, may become the largest contributors to environmental pollution by the beginning of the 21st century.

To forestall such developments may require compensation from the industrialized countries, either in terms of stepped up foreign assistance, or by offering alternative sources of energy. In this connection the suggestion has been made for Japan to 'buy off' China by selling them a number of nuclear energy plants in the near future!

Critics of supply-side energy planning argue that energy is not an end in itself. Energy is useful only insofar as it provides energy services like cooking, lighting, heating, refrigeration, mechanical work or transport. They focus their analysis on understanding better the role of energy in society by examining in detail the patterns of energy end uses, how and by whom different forms of energy are used today, and how the energy end-use system might look in the future. This leads them to a normative approach to energy planning.

Environmental critics allege that, in reality, huge amounts of energy are being wasted and a 'supply-side mentality' prevents planners from realizing the potential of energy efficiency and decentralized, renewable sources. They contend that the focus must change from meeting predetermined energy 'needs' through production of more energy, to supplying energy services in ways that impose the least economic and environmental costs.

Special problems and energy predicaments are created as a consequence of the recent and ongoing changes in Eastern Europe. The Soviet Union has announced that in future it wants to be paid in hard (convertible) currencies and that it will charge world market prices for the oil and gas supplies to the increasingly independent Eastern European block countries. It presently supplies 80 percent of the regions energy imports at implicitly low prices in the barter trade arrangements prevailing in the COMECON block.

These countries thus will have to shift international trade patterns to Western Europe and other hard currency countries. Their economically uncompetitive, technically inefficient and energy wasteful production structure will have to provide new export earnings for modernization as well as to pay for energy imports.

This will be a formidable task. The regions current dominant energy source is coal. It is burned with virtually no environmental-control equipment. In as far as developing new export markets for the Eastern European countries is less successful, it will induce these countries to resort to even larger dependence upon dirty domestic coal and lignite, with grave environmental consequences.

In aggregate terms, the energy needs of the Eastern European countries are not large at present. In total perhaps the equivalent of the consumption of Western Germany. The effects of any transformation in Eastern Europe on world market prices thus may not be all that large in the medium term (International Herald Tribune, May 31, 1990).

Energy demand management advocates rightly emphasize the shortcomings of conventional supply side energy planning. In considering the significance of demand management one would need to consider the possible contribution which demand management policies could make to energy conservation. What is the scope for energy savings in future energy scenarios? Some systematic, though still partial data, have become available in recent years.

What might be the scope for energy savings in future energy scenarios?

(a) United States

The basis for energy demand management is to look more in detail into energy aspects of different end-use sectors. Consider the following example from the United States.

By studying energy use in each sub-sector, the most efficient of presently available technologies could be used as industry norms for the projection period. Such periods could be taken to be longer or shorter, to require firms to comply to the new industry energy efficiency standards and, depending upon the policy choice, whether one would wish to accelerate such transitions. This time frame can be linked to the GDP growth and capital investment outlook in the countries concerned. The same methodology can be used in respect of establishing permissible emissions into the environment.

This is the approach followed by a study commissioned by the WorldWatch Institute. Such forecasts can then be compared with conventional trend extrapolation scenarios such as those of the US Department of Energy, referred to above (see p... above). In the comparison of the two options presented below, other planning assumptions in the projections used, such as economic growth, consumer price response, and a host of other assumptions are for the most part taken to be the same.

The results are startling, and they are shown in Table 11 (Chandler, 1985, 40, and Goldemberg, 1985).

Table 11. World Energy Consumption, and Carbon Dioxide and Sulfur Emissions, with alternative projections for 2000 and 2025.

Scenario	Assumed Annual Energy Efficiency Improvement. per cent.	Annual Energy Use exajoule.	Annual Carbon Dioxide Emissions bln tons.	Annual Sulfur Emissions mln tons.
1984 (actual)	2.3	300	5.0	100
YEAR 2000				
USDOE Medium	0.8	460	7.2	170
Worldwatch				
Avail.Techn.	1.8	360	5.8	120
New Technology	1.8	360	5.8	120
YEAR 2025				
USDOE Medium	0.8	675	10.3	265
Worldwatch				

Avail.Techn.	1.2	500	7.9	170
New Technology	1.8	450	7.0	135

Sources: in Chandler, 1985, 40.

The above estimates indicate that there is considerable scope for increasing energy efficiency across a wide range of end uses. Yet, even under rather optimistic assumptions, considerable volumes of emission are off-loaded in the environment, as the 'sink'. It may postpone, though not eliminate the need to seriously consider volume restrictions which would affect life styles and growth and development strategies. But this issue is currently still studiously avoided in public decision making. Calls for more studies on the long term effects of accumulated emissions on climate change continued to be offered as a palliative, among others by President Bush of the United States, and by Ms Thatcher in the United Kingdom.

These two countries increasingly diverge from policy thinking and practices in a number of other European countries. Underlying this divergence is a philosophical issue. The laggards prefer to refrain from corrective environmental action until environmental damage has been overwhelming proven by science. The progressives adopt the precautionary principle. It implies a willingness to act if there is a strong suspicion of possible negative effects of production on the natural environment.

(b) Global demand for electricity.

One of the most comprehensively documented examples of a conservation scenario for global energy use is that developed in "Energy for a Sustainable World" (Goldemberg et. al. 1988). In their strictly normative approach, they give as much attention to the energy problems of the developing countries as to those of the industrialized countries. The projections are for the year 2020 against 1980 as the base year, and their scenario --known as the NGO alternative-- is contrasted with the conventional trend extrapolation scenario of the World Energy Conference of 1983, some of the findings of which were presented earlier in this paper.

The ESW and WEC scenarios have been scrutinized recently by the World Bank (1989e), in terms of their feasibility and implications. Key figures in these scenarios are given in Table 12.

The comparison of the ESW and the WEC scenarios implies that a greater deliberate energy conservation effort will be required from the developing countries under the ESW scenario, in terms of absolute quantities and as a proportion of present energy use, compared to the energy conservation efforts of the developed countries.

Table 12, Scenarios for Global Primary Energy Use, 1980 to 2020.

	DCs	LDCs	World
Actual 1980 (TWh/year)	61320	28908	90228
ESW 2020 Change (%)	- 39	+110	+ 9
WEC 2020 Change (%)	+ 31	+317	+123
ESW Additional Conservation Effort (%1980)	+ 70	+207	+114

Source: World Bank, 1989e.

Economic development is accompanied by a shift from lower to higher quality energy. This leads to further electrification. ESW expects the share of electricity in final energy use to increase from 10% in 1980 to 18% in 2020, which implies a near-doubling of global electricity use. The 1980-86 actuals are not included in the scenario of ESW, but are added by the World Bank (1989e, 5).

Table 13. Growth Rates in Electricity Use Under ESW Scenario: 1980-2020

	1980-2020 ESW Projection All Energy.	1980-2020 ESW Projection Elecr.	1980-1986 Actual Electricity.	1986-2020 Rev.Projection Electricity
DCs	-1.2	+0.4	+2.3	0
LDCs	+3.4	+4.4	+6.9	+4.0
World	+0.6	+1.6	+3.5	+1.3

Source: World Bank 1989, 5.

In a historical context these growth rates are relatively low in the case of developing countries, being 4.4% compared with actual growth rates of about 7% for 1980 to 1986, about 10% for the 1970s and about 14% during the 1960s. This trend is seen to be consistent with the decline over time in the growth rate of electricity use in developing countries, following a similar rend in industrialized countries and reflecting the substantial conservation efforts that are presumed to take place in the ESW scenario.

The substantial increase in electricity supply required for developing countries, even with the greatest feasible conservation efforts, involve significant environmental issues. Thus, trade-offs will be required to balance environmental issues against the need for electricity in these countries.

Of considerable interest is the suggested mix for the generation of electricity. In other words, what type of facilities will need to be built?

In the ESW scenario nuclear power is regarded as a technology of last resort, to reduce the risks of proliferation. Fossil fuels use is constrained by the imposition of an allowable ultimate level of atmospheric carbon dioxide: in this respect, coal is the worst source and natural gas the least damaging. The ESW scenario demands that coal use in the long run would fall to about one quarter of known coal resources.

Since 90% of world coal resources are concentrated in only three countries: USSR, USA and China, the energy futures of these three countries would bear close watching indeed. Would the USA be willing to reduce the use of coal? To what alternatives will energy use in the USSR be geared and what alternatives are open to China: Would that be the nuclear power option?

Non-conventional renewable energy are still in too rudimentary stages of development. They cannot play a significant role until the second decade in the next century. Hence a quadrupling of hydro power in developing countries is foreseen between 1986 and 2020. Hydropower, and thus the construction of large dams, will be the major battle grounds between environmentalists and energy planners in the coming decades. Issues will arise on reservoir area population resettlement, flooding of fertile valleys, disturbances of river flushing patterns, increases in parasitic infestation and diseases, etc.

Table 14, Indicative ESW Scenario for Global Electricity Supply Mix in 2020 (TWh/year)

Year		Fossil	Hydro	Nuclear	Renewable	Total
1980	DCs	4941	1270	668	10	6889
Actual	LDCs	855	489	17	3	1364
	World	5796	1759	685	13	8253
1986	DCs	5095	1366	1482	42	7985
Actual	LDCs	1292	661	74	11	2038
	World	6387	2027	1556	53	10023
2020	DCs	2400	1600	2000	2000	8000
	LDCs	3382	2430	628	1153	7593
	World	5782	4030	2628	3153	15593

Source: World Bank, 1989e, 14.

Comparing alternative speculative energy scenarios made by relative outsiders, interesting enough for specialists, is one thing. But what is likely to happen is more important, and this requires to consider the actual plans which energy authorities in developing countries have developed, often with their governments' support, for the 1990s.

These planned power development programmes, as compiled by the World Bank from known national sources, are based on utility forecasts of growth in demand for electricity in the LDCs during the 1990s. These are expected to average 6.6% per year, as against 7% during the 1980s. This is only a slight reduction in the historical growth rate, and the expected demand growth is therefore substantially higher than the 4% growth rate in the ESW scenario.

The World Bank estimated the capital expenditures for electric power in developing countries at US$ 1 trillion, and it is greatly concerned whether financing on such a scale will be available (World Bank, 1990e).

It should be stressed that the study rests on a compilation of LDC programmes and is not a World Bank forecast. There were, however, a few cases where the planned programmes were too large and would result in excessive reserve generating capacity, and where the programmes were correspondingly reduced. In general, the forecast is probably too high because it does not take into account the limited availability of funds for the power expansion plans in some countries.

Of interest at this point however is the implied excess generating capacity being planned according to the forecast, as this may give some indication of the strength of supply-side pressures on demand generation. Would again plans be made for excessive generating capacity margins such as in the past?

The comparative distributions of expected generating reserve capacity margins is indicated in Table 15. It shows that the frequency of countries with excessive generating capacity being planned is reduced. In 1989 40-59% is the typical capacity reserve margin, but the typical range is expected to lower to a more reasonable 20-39%.

This range is still on the high side, as the World Bank feels that on large well maintained systems the normal range is between 20-30%, though higher where seasonal hydraulic or temperature considerations limit capacities. On balance, therefore, energy planners have been somewhat restrained in their high cost investment spending plans.

Table 15, Comparative distributions for 1989 an 1999 generating capacity reserve margins in 69 LDCs. (nr of countries)

Range	1989	1999
0-19%	5	12
20-39%	11	28
40-59%	27	17
60-79%	14	5
80-99%	4	0
>100%	8	7

Source: World Bank, 1990a, 10.

Cogeneration.

Cogeneration --the combined production of heat and power-- is the technology that appears to be most promising in the short term in industriali as well as in developing countries. Several developing countries, such as Pakistan, Turkey and Thailand are adopting strategies to promote it.

The impetus to this new trend seems to have emerged through developments in energy legislation in the USA in the late 1970s. USAID has been taking the lead to promote its use, and to the required legal and administrative regulations required for this new concept in developing countries.

The structure of the electricity generating industry may well change in future under the impact of cogeneration, in that the traditional monopoly of the utility over power generation may be broken. Competition is introduced in the traditionally monopolistic energy sector, and this may lead to greater caution in planning energy systems as no guarantee is provided that future tariff adjustments will enable the cost of excessive capacity to be passed on to consumers. Technological dynamism may be introduced again in a sector which was widely judged to have 'matured' and correspondingly to have lost its innovative edge.

Cogeneration is a simple concept. Two kinds of energy are needed in most industries: electricity and heat (usually in the form of steam). In recent decades most companies have produced their own steam (using an oil- or natural gas-fired boiler, but wasting a lot of power through condenser losses) and purchased electricity from a local utility. Steam production is 90 per cent efficient, but electricity generation and transmission capture only one-third of a fuel's energy value, making electricity a more expensive form of energy.

In the USA at the turn of the century self generation by industry was quite common. Industry capacity was 60% as against 40% for utilities. By 1980 Industry capacity was reduced to only 3% and 97% of generating capacity was through public utilities. Cogeneration thus aims to redress this historically grown imbalance. In Europe, cogeneration has not been historically eclipsed, but has always remained a sizeable element in the energy production scene.

Cogeneration can increase the overall energy efficiency of the plant to between 80 and 90 per cent, as compared with an overall efficiency of 50 to 70 per cent under separate facilities: own steam and purchased electricity (Flavin, 1984, 30ff, World Bank, 1989d, 29ff).

Cogeneration plants are not only more energy efficient but they are also cheaper to install, and they are being developed for smaller units. In the mid-1980s total generating costs are less than half those for nuclear plants being built and one-fifth less than coal costs.

The US Public Utility Regulatory Policies Act (PURPA) of 1978 directs utilities to inter-connect with small-scale independent power producers (Qualifying Facilities), and to pay a fair market price for the electricity. To the extent that electricity is bought from such private sources, the utilities save in creating new capacities of their own, and this may act as restraining factors in their investment plans.

This Law has prompted a new spirit of entrepreneurship to the utility industry, especially after the resistance and 'feet dragging' on the part of the utilities, which saw PURPA, obviously, as a threat to their monopoly power, was broadly resolved in 1983, in a series of Court cases which went up to the Supreme Court.

Several hundred US companies have entered the power generation business since 1980, working alongside established companies to harness new technologies. They have been aided by generous tax credits and other subsidies, and this may negatively affect market penetration once these starting up facilities are withdrawn or expire.

Current data indicates a possible market penetration of 40-60 thousand MW of industrial cogeneration by the year 2000, plus several thousands of megawatts in the commercial and residential sector. On a nation wide basis, this would represent over 10 percent of presently installed capacity (World Bank, 1989d, 37)

Deregulation, privatization and the encouragement of competition, in sectors which were often thought to be natural public sector monopolies, has been spreading over the last decade.

Privatization of public utilities is currently implemented in the United Kingdom. The USA knows mixed systems of public, private and investor owned utilities. Also in New Zealand and in Australia restructuring is being considered.

The continuing balance of payments and fiscal crises in many developing countries, and the discussions surrounding structural adjustment lending in developing countries, may also induce new initiatives in those countries. The enormous investment needs of utilities in the future may not be met, in part by foreign financing, unless they are seen to be "lean and mean": technologically strong, financially sound and managerially strong.

In developing countries cogeneration may develop, despite the to be expected traditional opposition against decentralized and stand-alone systems, for a different reason. In a number of countries industries have been forced to be self-sufficient because the power supply from the utilities turns out to be unreliable. In such cases there is no trade off between capacity avoidance cost for the utility against private purchases from qualified facilities, but, rather, there would seem to result a duplication of capacity creation.

The experience with PURPA and the spread of similar principles to other developed and developing countries, also points at a number of possible problems and new issues of which one ought to be aware.

Pitfalls to be avoided pertain to the following issues:

1. Pressure on utilities to purchase from private generators at prices that exceed their full avoided costs, including cases where the utility is obliged to pay capacity costs to the private supplier, while having excess capacity.

2. Utilities being obliged to offer incentive payments to encourage private generators (in excess of avoided costs), or having to deviate from optimal load dispatch or system operation because of such purchases.

3. Restrictions on the utilities ability to solicit bids for private capacity, on a competitive basis.

There are other troublesome issues emerging for the energy sector in the United States and, perhaps at a later stage, elsewhere. Perhaps the most controversial and complex issue that cuts at the very heart of the industry's concerns and fears is the so-called 'wheeling' of QF power, the two aspects being access and pricing. The wheeling issue arises in situations where QF supplies exceed the local utility's needs and hence any excess must be wheeled to other systems or to another plant operated by the owners of the QF. More aggressive QFs are interested in going one step further and having their excess capacity wheeled directly to another retail end-user, thus engaging in direct competition with the established utilities. Whereas this interest at present is a minority segment, it is one that is growing. (World Bank, 1989d, 41ff)

These new initiatives --to foster competition in what hitherto was seen as a static and mature industry --seem to have been inspired by a feeling that traditional regulation has not worked. There is, according to the World Bank, widespread disillusionment in developed and developing countries with the ineffectiveness of regulation in meeting economic efficiency, financial and operational objectives. Discontent surfaced during the uncertainties and chaos in the energy markets of the 1970s.

Responsibility for regulation has often been shared with several ministries. Power regulations have been either incomplete or not formalized, contradictory or open to arbitrary interpretation. This situation is often due to lack of regulatory expertise and resources. In some cases the utilities, with their concentration of expertise have been too powerful for the regulators.

Often governments limit the autonomy of poorly performing utilities which in turn impairs the utility's technical efficiency and financial strength. This tends to provoke government intervention in operational matters and increases pressures on public finances for operational subsidies and government budgetary grants.

The view that the electric power sector is essentially a natural monopoly is being challenged both in developed countries and in many developing countries.

In sum. For a variety of reasons traditional energy planning scenario's may not be valid at the present time, when a transition to greater energy efficiency is needed in view of possible global supply constraints and harmful effects of emissions on the environment leading to acidification and global warming. Planning methods and energy planning objectives will have to be rethought. The traditional monopoly of utilities may have to be broken to avoid costly investments in possibly not needed capacity creation. Breaking up such monopolies, by allowing competition, offering consumer choices and stimulating cogeneration may mean greater flexibility, lower cost, better adaptation to uncertain futures and greater energy efficiency in power generation. In combination these factors may shape a new era for the global energy sector.

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