# Energy Policy and Industrial Fuel Consumption

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## THE PURPOSE OF THIS PAPER

This paper is concerned with three facets of what could be termed 'Industrial Energy Policy'; they are energy pricing, conservation and fuel choice.These issues are not mutually exclusive and it is impossible to consider any one in isolation from the other two.

Energy pricing is itself one of the most important and pervasive instruments of energy policy[1] and is used to influence both energy conservation and consumer's fuel preference. The level of energy prices is a critical issue. Under-pricing encourages consumers to invest in inefficient energy intensive processes whilst over pricing may lead to excess effort and resources being spent on energy savings, given that energy is not the only scarce resource. Energy pricing can be used then, to encourage conservation in all sectors of the economy and may also affect the consumers fuel preference. This is particularly the case for the industrial sector where energy costs may be a significant proportion of total costs. Assuming firms wish to minimise total costs this can be partly achieved by minimising energy related costs. In addition to this, energy pricing is of particular interest as a subject in its own right, since high energy prices during periods of recession and reduced profitability have caused great consternation amongst the industrial consumers. As it is such an important issue the paper will begin with a review of the developments in energy pricing policy in the recent past, before looking at the implications for increasing the conservation effort and influencing consumers' fuel choice. However, all of these issues need to be considered within the context of energy policy as a whole.

The extent to which governments have pursued an energy policy and the form that policy has taken have changed considerably over the last two decades or so. Until recently energy policy was primarily concerned with the problems of supply. One reason for this[2] is that on the supply side the energy sector has been dominated by a small number of large, powerful public or multinational corporations, whilst in contrast, on the demand side, energy consumers which tend to be large in number but highly diverse have very little power. Any efforts on the demand side were taken on the initiative of the consumer; the government did not at that time pre-occupy itself with the question of energy conservation. It is indicative of the importance attached to this issue, that in the 1967 White Paper on Fuel Policy[3], no mention was made of energy conservation whatsoever. Indeed, even after the oil price shock of 1973 and the belated recognition that oil too was a scarce resource, the government was slow to adjust its policy and to give serious consideration to the energy conservation issue. Only in recent years has any real effort been made to tackle this subject in a comprehensive and coordinated manner, culminating in the promotion of 1986 as Energy Efficiency

Year.

The industrial sector has become the target for much of the government's energy efficiency campaign since it is a sector where opportunities exist for substantial savings.

The traditional objectives of energy policy have been to ensure that the energy requirements of the nation are met at the minimum cost to the nation; that continuity and security of supply are maintained and that energy resources are used efficiently[4].Of course these objectives cannot be divorced from other policy issues such as industrial, social, political, environmental and macroeconomic considerations.

These energy policy objectives still remain today, although the emphasis placed by the present Conservative government has been on permitting market forces to play their role in achieving them. The former Secretary of State for Energy, Nigel Lawson has stated [5] "Our task is rather to set a framework which will ensure that the market operates in the energy sector with a minimum of distortion and that energy is produced and consumed efficiently." The key features of this free market energy policy are as follows[6]

- to price energy economically; where there is a genuine market, as in oil, the price is set by competition; where there is no genuine market, as in electricity, prices need to reflect the costs of supply;

- to allow market forces to operate more freely by removing from the state sector activities which do not need to be there, by breaking unnecessary monopolies and by increasing private sector involvement in energy investment, production and sales;

- to ensure that those industries which remain state - owned are run as efficiently as possible; for fuels which are freely tradeable, energy investment decisions should be taken not with a view to balancing supply and demand of energy, but rather to obtaining an adequate return on capital;

- to provide and disseminate information and advice to help the energy market to work properly on the demand side.

It is the first and fourth of these features which are of particular relevance to the industrial sector as far as energy demand is concerned.

INDUSTRIAL ENERGY PRICING POLICY

The traditional view regarding energy pricing has been that prices must reflect at least the costs of supply, more specifically the long run marginal costs of supply. This has been the view of both Labour and Conservative governments who consider such a policy necessary to prevent considerable government subsidies to the nationalised fuel industries[7] as well as ensuring that all consumers are aware of the costs of meeting their fuel requirements.

Given the present free market approach to energy policy in general one might expect this ideal to apply to energy prices also. However, in practice the absence of a free market (with possibly the exception of oil) must imply that the prices in the UK are either directly or indirectly determined by the government. As far as electricity and, for the industrial consumer, gas the prices are based on the concept of long run marginal costs (LRMC) of supply. Coal is generally priced at a `market clearing level'. The various grades of oil do tend to be close to the level set by the market but even here government intervention is direct by the addition of various petroleum taxes, in particular the imposition of the tax on heavy fuel oil.

Until recently this policy has continued, to all intents and purposes, unchallenged by the industrial consumers. However, in 1980 against a backdrop of deepening economic recession, high interest rates and a strong pound, the industrial sector complained primarily through the CBI that high energy prices were causing significant damage to the international competitiveness of UK industry. This was the beginning of a year-long investigation into the alleged disparities between UK energy prices and those enjoyed by our competitors in W. Europe, Scandinavia, United States and Japan. The industries experiencing particular problems were iron and steel, chemicals, paper, aluminium, glass and ceramics, all of them highly energy intensive industries.

In November 1980 the CBI submitted a memorandum[8] to the Department of Energy claiming that energy costs were a problem to industry in general although certain energy intensive industries were experiencing particular difficulties. The suggestion that the CBI put forward in that memorandum was that the government should consider the international competitiveness of British industry as a major factor in determining energy policy. Specifically they called for abolition of the £8 a tonne duty on heavy fuel oil and an assurance that electricity prices would not be adversely affected by uncompetitively priced coal.

The government's initial response in December 1980[9] to the CBI's memorandum was that the CBI had overstated their case and that in any event the constraints on existing energy policy meant that there was no room for manoeuvre.

Also in December 1980 the Director-General of the National Economic Development Office (NEDO) submitted a memorandum on industrial energy pricing to the National Economic Development Council (NEDC) summarising NEDO's conclusions on the issue. In the memorandum which was also submitted to the Secretary of State for Energy, NEDO stated that for specific industries, paper and board, chemicals, iron and steel, energy costs were in fact "out of line with those of their competitors"[10].

As a result of this communication the Select Committee on Energy decided to investigate for themselves the question of industrial energy pricing. The Select Committee took evidence from the CBI, the Department of Energy, the National Union of Mineworkers and a NEDO Task Force which was established in January 1981. The Task Force which comprised representatives from government, the energy intensive industries and the fuel producers, carried out a detailed and comprehensive study of industrial energy prices and came to the following conclusions[11].

(i) Prices of electricity and gas to over 95% of individual industrial consumers were broadly in line with those on the continent. However these consumers only accounted in volume terms for 50% of total industrial electricity consumption.

(ii) For an important group of energy intensive users constituting most of the remaining 50% of industrial electricity consumption and the majority of gas by volume, UK gas and electricity prices had moved significantly ahead of those being charged to their major competitors on the continent at that time. By the end of 1980 gas price disparities with Europe for such large users were 10% for interruptible gas and 10-20% for firm gas. Electricity price disparities for these large users ranged from 10% to 35%.

(iii) Throughout 1980 oil product prices were generally higher in the UK than on the continent, although prices had moved in line more towards the end of the year. Nonetheless the situation still remained volatile.

(iv) Coal prices were in the main competitive with those on the continent.

(v) UK foundry coke prices were 30% higher than in the rest of Europe.

The causes of these disparities varied from fuel to fuel and country to country. The main reasons given by the Task Force for these disparities were:

(i) Exchange rate movements during 1980.

(ii) Energy resource differences between countries, whether stemming from natural resource endowment or energy programs.

(iii) Differences in market structure and pricing practices.

More specifically for oil, price disparities were caused partly by the structure of the UK oil products markets and the relative isolation from the Rotterdam spot market, and partly by the level of taxation on derv and heavy fuel oil. Table 1 shows the taxes on fuel oil which applied in European countries in 1980.

TABLE 1 TAXES AND DUTIES ON FUEL OIL

| £/tonne | Exise Tax | Other Tax |
|---|---|---|
| UK | 8.0 | - |
| Belgium | - | - |
| Denmark | 27.0* | - |
| Germany | 3.0 | 0.7 |
| France | 0.1 | 0.9 |
| Ireland | 12.0 | - |
| Italy | 0.4 | - |
| Netherlands | 3.0 | - |

* Rebated to VAT registered traders.
Source. NEDC Energy Task Force. Report on Industrial Energy Prices. February 1981.

Apart from Denmark, where the tax is rebated anyway, the UK has the second highest fuel oil tax, after Ireland.

As far as gas is concerned the disparities here were caused by four factors: the appreciation of sterling against other European currencies; the linkage of interruptible gas prices to fuel oil; the renewal price levels set for UK firm gas from September 1980; and the disagreement between the BGC and consumers on the impact and degree of the linkage between firm gas and gas oil or other oil products in different countries.

The appreciation of sterling also caused problems for the price of foundry coke, but three other reasons for the disparities here were offered: the degree of subsidisation given elsewhere; the problems that National Smokeless Fuels Ltd. faced in trying to adjust to a reduction in the size of their market; and the requirement to recover costs through prices without recourse to the NCB.

Finally, the price disparities for industrial electricity were again influenced by exchange rate factors but were mainly due to other factors. Many of Britain's competitors, by virtue of their natural resource endowments or energy programmes, have reduced the costs of electricity generation considerably. France, in particular has substantial hydro-electric resources as well as a growing reliance on nuclear power, whilst Germany has considerable resources of cheap brown coal. In addition many countries on the continent, notably Germany, have favourable

contracts for large industrial users.

No comparison by the Task Force was made with countries other than in Europe, but it did acknowledge that particular countries against which UK industries were competing, were enjoying a competitive edge as far as energy prices were concerned.

The Task Force suggested policy options which the government might consider to reduce the burden on industrial consumers, in particular the energy intensive industries. These suggestions included: the removal of the exise duty on HFO, which in turn would relieve the pressure on gas prices because gas prices tend to be linked to the price of HFO; to restructure gas and electricity tariffs and negotiate discounts to large industrial users; to review the relationship between prices to industrial and domestic consumers; to reconsider the relationship between firm and interruptible gas prices and between these prices and those for HFO and gas oil; to review the hours of the application of off-peak rates; to review incentives for optimal energy management and encourage conservation and improved energy efficiency.

In response to the NEDC Task Force the government announced a package of measures worth £168m on top of those already existing which aimed to help the large industrial energy consumers. The package included: an assurance by the BGC that renewal prices for interruptible gas supplies would remain at their December 1980 levels; a two year grant scheme worth £50m to encourage conversion of oil boilers to coal; a new arrangement to enable large electricity consumers to take advantage of load management provisions and greater flexibility by the area boards in their agreements with industrial consumers; and a review by the electricity supply industry of the terms of the Bulk Supply Tariff which affects the large consumers.

The industrial consumers were not satisfied by the government's response complaining that the measures proposed were inadequate. The NEDO Task Force was commissioned to carry out a further study. The second study of the Task Force[12] showed that the disparities shown up in their earlier report had been reduced by a considerable extent, partly as a result of the measures announced by the government but also because of favourable exchange rate movements and because of fuel price increases on the continent.

The House of Commons Select Committee in their report[13] made their own suggestions for industrial energy pricing policy after considering all the evidence. They were not in agreement with the principle of LRMC pricing arguing that it is inflationary and damaging to the competitiveness of industry. Preference was expresses towards a system of average cost pricing although it was acknowledged that such a system could only work if the energy supply industries were given more freedom to raise finance for medium and long term investment on the capital market together with some relaxation of the External Financing Limit. They could

see no case for reducing or abolishing the exise tax on HFO since although the original purpose of the tax was to protect the coal industry there was a case for retaining the tax to encourage a reduction in the dependence of industrial consumers on oil. Some short term target assistance for energy intensive industries in return for improvements in efficiency was suggested as a means of easing the burden on these consumers, and a more ambitious programme to promote industrial energy conservation generally and greater incentives for conversion from oil to coal. The closure of uneconomic pits would bring about a fall in the price of coal and hence electricity but the Select Committee recognised the social problems associated with the pit closure program. Finally, the committee concluded that energy policy should not compensate for the consequences of macroeconomic policy and that industry should concentrate on other factors which influence competitiveness.

In their reply to the Select Committee[14], the government strongly defended the principle of marginal cost pricing and reiterated its stance on energy pricing and energy policy in general.

The result of this debate was certainly an acknowledgement of the difficulties facing specific energy intensive industries but little radical change. Many of the disparities between UK prices and those of our European counterparts were removed by favourable exchange rate movements. Also, as a result of the report by the NEDO Task Force both the BGC and the CEGB agreed to review the pricing structure facing large industrial consumers. In addition to the measures discussed earlier in this section, the CEGB in 1982 introduced new load management rates which allowed large industrial consumers to benefit from significant price reductions if they were prepared to reduce their load at short notice and undertake stringent demand management.

These discussions and communications have raised several issues upon which little agreement seems to have been reached between government and industry. To a certain extent the root of the industrial sector's complaint, that is the price disparities between UK industrial fuel price and those of our competitors abroad, has fortunately been removed by favourable (from this point of view at least) exchange rate movements. However, the real issues have not been resolved.

The concept of LRMC pricing is one such issue. The government has resolutely stood by its policy that only by LRMC pricing will consumers be aware of the costs involved in satisfying their energy requirements. Although it is not a new idea, LRMC pricing has only been applied by the energy supply industries in the last decade or so. What effectively happens with such a pricing policy is that today's consumers are being called upon to make a contribution towards the replacement costs of providing for tomorrow's consumers. However laudible such a policy may be, much of the burden of the policy has rested on the shoulders of the industrial consumer and has been particularly harder for them to bear because of the sharp transition to the present price

structure from one which merely reflected the current costs of production.

The second issue and one that is a real bone of contention for the industrial sector is the tax on HFO, imposed in the early 1960's to provide some protection for the coal industry against the assault of cheap oil prices, and has remained ever since. We shall return to this issue in a later part of this paper.

Finally, it would appear that the CBI were asking the government to take into account the competitiveness of UK industry when making decisions on energy pricing. As stated earlier energy policy cannot be divorced from other policy considerations, but the question here is to what extent was the poor competitiveness of UK industry a result of energy pricing policy? It is unlikely that high energy prices were to blame entirely for the weak performance of UK industry. However they may have exacerbated the already difficult situation that our industrial sector was in towards the end of the last decade and the beginning of this one. During periods of recession and restricted cash flows, high energy prices only add to these restrictions and rather than stimulate investment in energy efficient equipment as the government intended, may actually have prevented investment taking place.

So far this paper has looked at the various arguments regarding industrial energy pricing policy and the issues arising from these debates. What have been the implications of this policy on energy conservation and consumers' fuel choice?

The government believes that economic pricing is the most important incentive for energy conservation and investment in efficient equipment and technologies. The success of such a policy will depend primarily on the sensitivity of demand to changes in price, or more formally, the price elasticity of demand for energy. However, expectations regarding both energy prices and the security of supply will also affect the investment decisions of firms and hence the potential for improved efficiency.

Empirical evidence on the price elasticity of demand for energy is not altogether conclusive. Table 2 shows elasticity estimates from three studies on industrial energy demand. Much of the empirical work that has been done in this area has focused on the United States. Very little has been applied to the UK and only a handful of studies include the post 1973 era.

It should be borne in mind that there are comparability problems when looking at the results from different studies. The disparities between the results are most likely to be caused by the different methodologies used.

TABLE 2 ESTIMATES OF THE PRICE ELASTICITY OF DEMAND FOR ENERGY IN THE UK INDUSTRIAL SECTOR (EXCLUDING IRON & STEEL)

| Author | Period Covered | Elasticity Short Run | Long Run |
|---|---|---|---|
| Dept of Energy[15] | 1955-1980 | -0.08 | -0.22 |
| Beenstock et al.[16] | 1953-1982 | -0.29 | -0.44 |
| Read* | 1955-1982 | -0.31 | -1.00 |

*These estimates are the preliminary results of work currently in progress by the author.

These empirical results vaty considerably; from showing an almost inelastic response of energy consumption to price changes in the short run to a fairly elastic response in the long run. Clearly, what is meant by the long run will differ from study to study. Since most studies to date have only incorporated data up to the early part of this decade the results will only reflect the response to the first price shock in the mid 1970's. The later price increases of 1979/80 are unlikely to have taken full effect by say 1982, the most recent period covered by these studies.

What these results do show however, is the need for more empirical work and information on the responsiveness of energy demand to changes in prices, in the UK. Such information is surely a prerequisite for rational and informed policy decisions.

There are clearly two sides to the issue of energy pricing policy. Since 1973 successive governments have agreed that economic pricing must play the key role in affecting the consumer's attitude towards the efficient use of energy. Only if consumers are aware of the long term costs of meeting their energy requirements can they make rational decisions about fuel use, investment in fuel appliances and energy conservation[17]. Industry`s argument states that rather than stimulate investment, high energy prices severely restrict cash flows and actually stifle the investment needed to improve energy efficiency.

Despite these controversies the government has strongly defended its policy in this area but has recognised that it needs to be supported by a vigorous programme of information, advice, demonstration and financial support.

## INDUSTRIAL ENERGY CONSERVATION POLICY

The government was first pinpointed as having an important role to play in energy conservation in two reports on the subject which were published in 1974. The first was by the Central Policy Review Staff[18] which was the first recognition of the importance of public awareness and discussion to the successful achievement of energy conservation, and the second by NEDO[19]. Both of these reports contained recommendations about the possible role of the government, although they were general in content and lacked specific recommendations. The NEDO report suggested that the existing mechanisms of energy conservation, namely market factors, institutional policies and social preferences would not be sufficient to respond to the new energy situation unless more information and understanding of these mechanisms was developed. It recommended improved co-ordination between various government departments as well as a programme of information and education and a dispersion of decision making. There was at this time a distinct lack of knowledge or expertise both inside government and without on the whole concept of energy conservation. The NEDO report called for more specific studies in the area and in particular an analysis of the costs and benefits of the efficient use of energy.

Prior to the NEDO report report the then Secretary of State for Energy, Mr. Eric Varley, had set up the Advisory Council on Energy Conservation (ACEC) in June - October 1974 and it was anticipated that ACEC would fulfil some of the recommendations of the NEDO report. The terms of reference of ACEC were " To advise and assist the Secretary of State for Energy in carrying out his duty of promoting economy and efficiency in the use and consumption of energy "[20].

In the same year the Energy Technology Support Unit was established at Harwell under contract to the Department of Energy. ETSU's objectives were to develop a national strategy for research, development and demonstration in the energy field. The Department of Energy and the Department of Industry also set up two schemes jointly to assist in providing advice and information on energy conservation. The Energy Thrift Scheme provides a one day confidential visit to representative companies in different sectors of manufacturing by a team of Department of Trade and Industry research assistant staff and independent consultants to identify energy saving opportunities. The Energy Audit Scheme has as its principal objective the examination of the flow of energy through industry in order to identify activities which use excessive amounts of energy and to encourage energy saving measures. Both schemes produce reports on the results of their findings and now provide a comprehensive guide to the pattern of fuel use and the scope for energy conservation by a large number of industries within the manufacturing sector.

In December 1974 Mr Eric Varley produced the governments first ever package of energy saving measures[21]. This was a twelve point plan of what the Secretary of State described as an "interim"

package with the aim to extend and reinforce it in the future. Of particular relevance to the industrial sector was the proposal of a loan scheme for energy saving investment in industry. Under this scheme £3m was made available for loans on specific energy saving projects. In order for a project to be eligible for one of these loans it would have to produce sufficient energy savings to recoup capital and interest charges within four years. The new twelve point package also included a request to both management and unions to include energy savings as a regular item in their joint consultations and a request to boards of directors to include a statement of fuel expenditure and steps taken to save energy in the company's annual reports, to make clear their commitment to energy saving within their own company and to make someone responsible for achieving it. Measures not specifically aimed at the industrial sector included the famous "Save-It" publicity campaign.

The majority of the measures proposed in this package were by necessity of a voluntary nature relying on the consumers own motivation to reduce energy costs by the more efficient use of energy, rather than imposing and trying to regulate mandatory measures.

At the same time as Mr Varley was making these proposals the Select Committee on Science and Technology was collecting evidence for its first report on energy conservation which was published in July 1975[22]. The Select Committee was not satisfied by the governments measures to promote energy conservation throughout the economy and expressed their concern at the "general lack of urgency".

The Select Committee made several recommendations to the government for further action, including the establishment of a full time task force to report directly to the Prime Minister and an Energy Conservation Bill. It also, somewhat over-optimistically, looked for 15% energy savings in two years without sacrificing output, employment or living standards. As far as industry was concerned the Select Committee called for urgent consultation with large users of energy to agree on energy saving targets and patterns of fuel use; grants and loans to industry should be conditional upon installing the most energy efficient equipment and extended to cover energy saving schemes. To a certain extent this was covered by the twelve point plan. It also recommended that the government bear two thirds of the cost of a consultancy service for smaller firms, the provision of a nationwide fuel advisory service and to regulate certain "good housekeeping" measures subject to inspection if necessary.

Some of these measures would seem quite unrealistic and it has to be borne in mind that energy conservation is not something to be achieved at all costs but rather it should be viewed within a context of other economic, social and environmental objectives as well as the optimal use of other resources in general.

The governments reply to the Select Committee's report was predictable and insubstantial in content[23]. It rejected the idea of a task force but instead appointed a minister in the Department of Energy and other departments with particular responsibility for energy conservation. It also established within the Department of Energy a special Conservation Unit, and it was this unit which was eventually to become a division of the Department of Energy now known as the Energy Efficiency Office (EEO). As far as industry was concerned the government did not see a need for widespread grant finance aimed specifically at stimulating investment. However it did aim to improve the advice and information service provided by making advice available through the regional offices of the Department of Industry as well as providing a free quick inquiry service, the Energy Quick Advice Service (EQAS), which was run by consultants on behalf of the government. In addition the Energy Survey Scheme was initiated. This provided a subsidy up to £30 to be given towards the cost of employing a consultant to make a one day visit to advise on energy saving measures. This was intended to complement the Energy Thrift Scheme which had already been established.

After this burst of action during 1974 and 1975, government activity was depressed for some time. This was mainly because there was considerable public and parliamentary pressure for action on new and renewable energy resources which distracted attention from the conservation issue. However, interest was revived with renewed vigour following the visit of President Carter in May 1977, and his announcement of a major conservation programme in the U.S. This provided a considerable incentive to the U.K government. In December 1977 the Secretary of State for Energy, Mr Tony Benn, announced a substantial reinforcement of the governments energy conservation policies[24]. Some changes were made to existing schemes such as an increase in the amount made available under the industry loans scheme to £25m and the scheme was renamed the Energy Conservation Scheme. Subsidies under the Energy Survey Scheme were increased to £75m. A network of energy managers was established with the formation of the Energy Managers Group, an annual conference, a free monthly newspaper and a pilot scheme of courses for energy managers. £21.5m was made available under the Energy Conservation Demonstration Projects Scheme (ECDPS) for projects demonstrating the potential for energy saving or new or adapted technologies and a 100% 1st year tax allowance was given on the installation of industrial and commercial buildings. These measures were all reviewed in Energy Paper No. 33[25].

The change of government in 1979 obviously had some implications on energy conservation policy. The Conservative government, in line with its free market approach, believed that energy conservation should be left as far as possible to market forces, in particular economic pricing. In reality however, the government has not relied entirely on its energy pricing policy to attain its objectives; in many cases it has endorsed and expanded on the schemes initiated by its predecessor. The one exception to this is the Energy Conservation Scheme which was

discontinued in 1980.

In May 1981 the Department of Industry introduced the Coal Fired Boiler Scheme which provides assistance up to 25% of the cost of converting existing oil/gas fired boilers to coal. This scheme was designed "to promote industrial efficieny in the UK by reducing unit costs, and also assist in reducing the UK's long term dependence on oil."[26]. In the same year the Energy Conservation Act 1981[27] was introduced to set standards for the efficiency of new space and water heating appliances and gas appliances for all consumers. These standards were to be set by the BSI. In October 1983 the Conservation Unit within the Department of Energy was promoted to a division and appropriately named the Energy Efficiency Office (EEO). The EEO was given overall responsibility for the government's conservation policies and efforts throughout the economy and its objective was to increase the visibility and coordination of conservation efforts. With the creation of the EEO the government also announced modest expansion of certain existing programmes and an agenda for potential further work. The subsidies available under the Energy Efficiency Survey Scheme were raised to £250 and to complement this scheme a new Industrial Heat Recovery Consultancy Service was set up in 1983. £3m was allocated to this scheme which provides assistance of up to £10,000 to high energy users in manufacturing industry to commission consultants on a heat recovery project. The introduction of these measures and especially the establisment of the EEO, display the governments commitment to a rigorous energy conservation programme.

Many of the schemes introduced by the various governments have proved highly successful in terms of the response to the schemes.

By the middle of 1984 approximately 250 projects had been approved under the ECDPS, now called the Energy Efficiency Demonstration Scheme (EEDS). Out of these, 180 installations were already operational. In a review of the scheme[28] the EEO estimated that the total energy savings achieved through these projects and replication of the projects were in the region of 0.75mtce (192m therms) per year. The long term target savings from this scheme is 5mtce (1280m therms) per year by the early 1990's.

Table 3 shows the government expenditure under the ECDPS and the ECS. The ECS scheme which was discontinued at the end of 1980 had a considerable take-up in its final year. Similarly with the ECDPS the amount of expenditure is increasing every year . There are two reasons for this pattern of expenditure, in the first place it will take some time for applications to be processed and projects authorised and so there will be some lag before expenditure occurs. In the second place there is likely to be some delay in industry responding to government initiatives of this kind. Information needs to be disemminated, the decision making process may be very lengthy and slow and often the decision makers will want to see what the general response to a

scheme is before committing themselves. A similar response pattern also occurred for the Coal Fired Boiler Scheme as we shall see in a later section, although in that case the delay in response is even more accentuated.

TABLE 3 GOVERNMENT EXPENDITURE UNDER THE ECDPS AND THE ECS

| £m | 1978/79 | 1979/80 | 1980/81 | 1981/82 | 1982/83 | 1983/84 | 1984/85 |
|---|---|---|---|---|---|---|---|
| ECDPS | - | 0.2 | 1.3 | 1.7 | 3.8 | 5.1 | n/a |
| ECS | 0.1 | 2.3 | 9.0 | 0.1 | - | - | - |
| TOTAL | 0.1 | 2.5 | 10.3 | 1.8 | 3.8 | 5.1 | n/a |

Source. Department of Energy. Energy Efficiency Office.

## CONSTRAINTS TO ENERGY CONSERVATION IN INDUSTRY

There are a considerable number of obstacles or constraints to energy conservation that need to be recognised and taken into account when developing policies aimed at improving energy efficiency. These constraints are also an important consideration when evaluating the effectiveness of a particular policy or package of energy saving measures.

The industrial sector faces its own particular constraints. These have been highlighted by the report on energy conservation in industry prepared for the government by Armitage Norton Consultants[29] and discussed in a recent report by ACEC to the Secretary of State for Energy[30]. Three broad categories of constraints can be identified; they are technical, financial and managerial.

As far as technical constraints are concerned either the technology does not yet exist or firms are not aware of its existence.

The attitude of management can be a severe constraint on the implementation of energy conservation measures. In many firms there is a general lack of awareness of the need for energy conservation. Many managers interviewed for the Armitage Norton report were either not aware of the government's energy pricing policy or had not assessed the long term impact of energy prices on operating costs. In many cases future energy prices were not taken into account when carrying out investment appraisals. Even when managers are aware of the need for energy conservation it is not always given a high priority and resources including man hours are not made available to investigate and organise energy conservation investment.

Finance is always a constraining factor. In general the poor investment record of UK industry has meant that industry as a whole has been slow to replace old plant and equipment and this

has undoubtedly limited the introduction of new energy efficient plant and equipment. In recent years this has been exacerbated by severely restricted cash flows during the periods of recession in the mid seventies and early eighties when competition for limited resources was fierce. In addition, during periods of recession industry's time horizons tend to change, firms struggling to survive are preoccupied with the short run and give little consideration to the long run. Investment criteria have also proved to be a constraint on investment in energy saving technology and equipment. The Armitage Norton report looked at the capital investment decision making process in detail. In general they found that energy conservation projects were almost always classified as cost saving investments and were as such given a low priority since firms tend to have a preference for investments which give productivity improvements. Not only are cost saving projects given a low status but the investment criterion used is often only a crude payback requirement of two or three years. Discounted cash flow criteria are rarely used and consequently additional factors such as the longevity of the project, low risk and inflation linked savings are not taken into account. The implication of this is that many energy saving projects are rejected on the payback criteria whereas they may have appeared more attractive if DCF criteria had been employed.

The Armitage Norton report supports the results of a similar survey, this time of energy managers only, carried out by Ray and Morel[31]. One of their main findings was that the low profitability of conservation projects presented the greatest obstacle to energy conservation. In addition 25% of the energy managers could not list any of the measures in the governments conservation programme whilst 10% gave incorrect answers.

## FUEL SWITCHING POLICIES

The UK government is now actively involved in influencing consumer's fuel choice through demand management policies. Its objective is twofold, to reduce the country's dependence on oil and to protect other fuel supplying industries, notably coal. Effective demand management is achieved by energy pricing policies, financial incentives, the imposition of physical and legal constraints and a programme of education and training.

Successive governments have viewed correct energy pricing as the key factor not only as far as energy conservation is concerned but also as a major influence on consumer's fuel choice. The price of oil is kept high by the various taxes imposed upon the market price, in particular the tax on HFO . Table 4 shows the tax on HFO and the price (inclusive of tax) in annual averages since 1961.

The objective of this tax when it was introduced in the 1960's was to protect the coal industry by enlarging the price differential between oil and coal and thereby discouraging large industrial consumers from burning oil when they could use coal. Today the government justifies its retention as an incentive to firms to reduce their dependence on oil.

TABLE 4 TAX ON HEAVY FUEL OIL, ANNUAL AVERAGES 1961-1984

| YEAR | TAX* £/tonne | PRICE OF HFO £/tonne | TAX AS A % OF PRICE |
|---|---|---|---|
| 1961 | 1.33 | 7.5 | 21.3 |
| 1962 | 1.92 | 8.4 | 29.2 |
| 1963 | 1.87 | 7.9 | 31.7 |
| 1964 | 1.87 | 7.4 | 34.5 |
| 1965 | 1.87 | 6.9 | 38.0 |
| 1966 | 1.95 | 7.3 | 35.8 |
| 1967 | 2.06 | 8.5 | 32.8 |
| 1968 | 2.08 | 9.3 | 29.2 |
| 1969 | 2.25 | 9.2 | 31.4 |
| 1970 | 2.25 | 9.2 | 31.4 |
| 1971 | 2.25 | 13.7 | 19.1 |
| 1972 | 2.25 | 13.1 | 20.4 |
| 1973 | 2.25 | 12.8 | 20.9 |
| 1974 | 2.25 | 30.3 | 7.8 |
| 1975 | 2.25 | 37.7 | 6.2 |
| 1976 | 2.25 | 43.2 | 5.4 |
| 1977 | 4.50 | 54.7 | 9.0 |
| 1978 | 5.62 | 51.3 | 12.2 |
| 1979 | 6.19 | 63.8 | 10.8 |
| 1980 | 7.50 | 90.3 | 9.0 |
| 1981 | 7.87 | 108.2 | 7.9 |
| 1982 | 7.87 | 114.3 | 7.4 |
| 1983 | 7.87 | 125.9 | 6.7 |
| 1984 | 7.87 | 149.7 | 5.6 |

* converted from pence/gallon to £/tonne.
Source. Digest of UK Energy Statistics. HMSO

Gas prices to the commercial/industrial sector generally reflect oil prices whereas the price of coal is kept low by the government's support for the coal industry.

Table 5 shows the prices in pence per therm of fuels supplied to large industrial consumers.

TABLE 5 PRICES OF FUELS TO LARGE INDUSTRIAL CONSUMERS 1955-1985
CURRENT PRICES

| YEAR | COAL | HFO | GAS OIL | GAS | ELECTRICITY |
|---|---|---|---|---|---|
| | | | pence/therm | | |
| 1955 | 1.46 | 1.89 | - | 5.37 | 14.40 |
| 1956 | 1.68 | 2.29 | - | 5.85 | 15.38 |
| 1957 | 1.78 | 2.37 | - | 6.14 | 15.97 |
| 1958 | 1.89 | 1.99 | - | 6.42 | 16.29 |
| 1959 | 1.89 | 1.83 | - | 6.38 | 15.59 |
| 1960 | 1.93 | 1.74 | - | 6.44 | 15.32 |
| 1961 | 2.00 | 1.60 | - | 6.55 | 16.14 |
| 1962 | 2.07 | 1.78 | - | 6.69 | 16.47 |
| 1963 | 2.19 | 1.91 | - | 6.70 | 16.76 |
| 1964 | 2.19 | 1.79 | - | 6.69 | 16.67 |
| 1965 | 2.19 | 1.67 | - | 6.61 | 17.43 |
| 1966 | 2.23 | 1.77 | - | 6.68 | 18.05 |
| 1967 | 2.15 | 2.06 | - | 6.64 | 18.49 |
| 1968 | 2.08 | 2.25 | - | 6.67 | 18.87 |
| 1969 | 2.11 | 2.22 | - | 5.85 | 18.87 |
| 1970 | 2.53 | 2.22 | - | 4.52 | 19.16 |
| 1971 | 3.02 | 3.33 | - | 3.27 | 21.13 |
| 1972 | 3.25 | 3.18 | - | 2.96 | 21.59 |
| 1973 | 3.40 | 3.11 | - | 3.07 | 21.68 |
| 1974 | 3.70 | 7.37 | 11.23 | 2.97 | 27.31 |
| 1975 | 5.55 | 9.28 | 12.20 | 4.27 | 36.33 |
| 1976 | 6.87 | 10.63 | 14.71 | 6.48 | 43.63 |
| 1977 | 8.20 | 13.48 | 18.23 | 9.26 | 50.33 |
| 1978 | 8.90 | 12.64 | 18.30 | 11.71 | 55.67 |
| 1979 | 10.36 | 15.70 | 23.83 | 13.67 | 61.53 |
| 1980 | 13.43 | 22.24 | 34.93 | 17.57 | 69.35 |
| 1981 | 15.52 | 26.65 | 40.68 | 21.59 | 79.29 |
| 1982 | 18.43 | 28.15 | 44.27 | 23.24 | 86.10 |
| 1983 | 19.07 | 31.00 | 45.82 | 24.06 | 85.09 |
| 1984 | 19.09 | 36.86 | 47.07 | 26.34 | 84.67 |

Source: Digest of UK Energy Statistics. HMSO

Several points are of interest here. First the prices gas and electricity have increased at a much slower rate than those of oil and coal. Second, there is a considerable disparity between coal and oil and this has been increasing over the past decade. However other factors may mean that this disparity is not sufficient to induce a switch from oil to coal without other incentives being made available. Similarly with gas, the fact that oil and gas are both premium fuels gives them considerable advantage over coal. The price disparity between coal and such premium fuels must be sufficiently large so that the cost savings generated by using coal outweigh its disadvantages as a bulky, dirty and inconvenient fuel to handle. Added to this is the fact that it is not just present price disparities which influence consumer's choice, but also future prices. In a survey carried out by the Chemicals Industry Association[32], 50% of member companies expressed doubts about the future price advantage of

coal and security of supply.

The degree to which substitution will take place between various fuels depends on a variety of factors of which price is only one, and is likely to differ between industries. The end use of the fuel may well determine the type of fuel to be used; electricity is a prime example of a fuel which in general has a highly specific application either for electrochemical processes or for motive power, and as such has limited potential for substitution. The greatest potential for fuel substitution is undoubtedly in the steam-raising market where enormous opportunities for coal firing exist.

What is the empirical evidence regarding the responsiveness of individual fuels to price changes and the degree of inter-fuel substitution?

The table below shows long run own and cross price elasticities of solid fuels, oil and gas for the industrial sector (excluding iron and steel). These were estimated by the Department of Energy[33] for the period 1954-1979.

TABLE 6 OWN AND CROSS PRICE ELASTICITIES FOR INDIVIDUAL FUELS

| | | SOLID FUELS | OIL | GAS |
|---|---|---|---|---|
| | | price | | |
| SOLID FUELS | | -4.60 | 2.84 | 1.76 |
| OIL | quantity | 1.61 | -1.62 | 0.01 |
| GAS | | 0.97 | 0.37 | -1.34 |

These results indicate a strong substitutional relationship between solid fuels and oil and between solid fuels and gas. Gas and oil although still substitutes, have a much weaker relationship.

The implications of such empirical evidence for the government's pricing policy is fairly obvious. By maintaining high oil prices relative to coal and coke prices the government can operate a successful demand management policy, encouraging oil users to switch to coal or at least reduce their dependence on oil and at the same time protecting the nations coal industry. Since much of the oil consumed by the industrial sector is in fact heavy fuel oil, the tax on HFO is an effective way of implementing such a policy.

The government does not rely entirely on energy prices to bring about the optimal allocation of resources. In an attempt to reverse the trend away from coal to oil and gas various incentives have been introduced to encourage a switch from oil/gas to coal.

In almost all cases a switch from oil/gas to coal requires the conversion or replacement of existing boiler plant involving considerable capital investment, particularly if the boiler is not yet at the required age for replacement. Such large investments may themselves be a barrier to conversion or replacement, and this is particularly true during periods of recession or restricted cash flow. By providing a package of grants and other financial incentives which substantially reduces these capital costs, together with significant price differentials the industrial consumer is encouraged to undertake a conversion or replacement project.

In May 1981 the government introduced the Coal Firing Scheme. The scheme initially covered conversions or replacement of oil fired boilers to coal firing but was later extended to cover conversion or replacement of oil and gas fired boilers. Grants were made available to most commercial undertakings in the UK including industry, commerce and agriculture. A maximum of 25% of net eligible costs of a conversion/replacement project is given provided costs exeed £15,000. There is no limit to the amount of grant given to each firm under the scheme but an offer of a grant geater than £5m requires Parliamentary approval. The government initially made £50m available to cover the scheme but in 1984 added another £25m and has twice extended the duration of the scheme.

The industrial and commercial sectors were initially quite slow to take up the scheme mainly because of the long lead times involved in making the decision to convert. Table 7 shows the take up of the scheme since it began in 1981.

TABLE 7 EXPENDITURE UNDER THE COAL FIRED BOILER SCHEME.

| £m | 1981/82 | 1982/83 | 1983/84 | 1984/85 |
|---|---|---|---|---|
| CFS | 0.1 | 1.7 | 5.5 | 11.0 |

Source. Department of Energy. Energy Efficiency Office.

These figures may not reflect the true response to the scheme because of the way payments are made. Payments are made in stages and the first payment is not made until one third of the project costs have been incurred. Therefore projects in the early stages of implementation will not appear in these figures and obviously projects currently being considered are not represented. The table does however show the gradual build up in response to the scheme.

The scheme has in general been considered a success despite fears of security of supply no doubt heightened by the year long miners' strike which began in March 1984.

In addition to the grants made available under the CFS the government has mde provision for other support measures under section 7 of the Industry Act 1972, the Science and Technology

Act 1965, the Capital Grant Scheme of the Ministry of Agriculture, Fisheries and Food and the Regional Development Grants. However, the CFS is by far the most significant measures the government has provided to encourage a switch to coal.

In November 1982 the European Commission Coal Firing Scheme was introduced. Under this Scheme firms may borrow up to 50% of the net eligible costs of industrial conversions at preferential rates of interest for three years. The government has offered up to a total of £15m in exchange rate risk coverage available to all borrowers under this scheme.

Other measures that can be adopted to affect the consumer's fuel choice include imposing physical or legal constraints. This type of intervention has been seen on a few occassions in UK industrial fuel markets. The Clean Air Act 1956, was probably the first example of such a constraint. Although its objectives were environmental rather than demand management, the spread of smokeless fuel zones under the Act was an additional, important factor in the decline of coal.

More recently, as a result of the 'Winter of Discontent' in 1973/1974 three day week controls on electricity consumption were imposed. These controls were introduced in December 1973 and relaxed in March 1974. In 1979 the BGC found it necessary as a result of the `flight from oil' to restrict the number of new contracts taken out; these restrictions were slightly relaxed in 1982/83 and abolished completely in October 1983. Generally speaking, intervention such as this is rarely seen and in almost all cases is only resorted to on a temporary basis.

The dissemination of information is regarded by the government as fundamental to the improvement in energy efficiency and it is equally relevant to the issue of consumer's fuel choice. The Energy Thrift Scheme, Energy Audit Scheme and the various demonstration projects discussed earlier in this paper have proved an effective means of providing information on the potential for changing the indutry's fuel mix.

## CONCLUDING REMARKS

The past ten years or so have seen the gradual development of a rigorous energy pricing policy, criticised by industry and defended adamantly by government. In addition, in more recent years this policy has been supported by a program of information, advice, research, development and demonstration, and limited financial aid to promote greater energy efficiency and a reduced dependence on oil.

It is difficult to say precisely how effective such a policy has been. Clearly industrial energy consumption has declined considerably over the past decade or so from reaching a peak of 25,790m therms(on a heat supplied basis) in 1973 to 16,475m therms in 1984. This decline however is attributable to several

factors not just the efforts of the government. The general decline in the industrial sector has been an important factor; in particular the demise of the highly energy intensive iron and steel industry, has reduced the industrial energy requirement. So too has the changing structure within the industrial sector, with much of the growth taking place in the low energy intensive sectors such as electrical engineering and pharmaceuticals. Nonetheless, there has been a marked improvement in energy efficiency over this period and high energy prices and increased awareness of the need to conserve energy have contributed to this. A simple measure of energy efficiency is the energy-output ratio; a declining ratio indicates an improvement in energy efficiency. Table 7 shows the continued decline in the energy-output ratio for the UK industrial sector.

TABLE 7 ENERGY-OUTPUT RATIO FOR THE UK INDUSTRIAL SECTOR

| YEAR | INDEX OF INDUSTRIAL PRODUCTION 1975=100 1 | INDEX OF ENERGY CONSUMPTION 1975=100 2 | ENERGY-OUTPUT RATIO 1975=1 3=2-1 |
|---|---|---|---|
| 1960 | 74.6 | 97.4 | 1.31 |
| 1965 | 87.2 | 106.1 | 1.22 |
| 1970 | 98.1 | 112.5 | 1.15 |
| 1975 | 100.0 | 100.0 | 1.00 |
| 1980 | 95.4 | 87.2 | 0.91 |
| 1981 | 94.4 | 75.0 | 0.79 |

Source: 1 - Annual Abstract of Statistics
2 - calculated using data from the Digest of UK Energy Statistics

This measure is a fairly crude one since it does not take into account the changes in the structure of the industrial sector such as those mentioned above. However, it does illustrate quite clearly the changing relationship between energy consumption and output.

The decline in industrial energy consumption has been accompanied by a marked reduction in the share of oil in the industrial fuel market from 44% in 1973 to 26% in 1984, while gas and electricity have increased their share. Coal although still experiencing an overall decline in its share of the industrial fuel market since the 1960's has actually picked up in recent years from an all time low of 17.5% in 1980 to 20.1% in 1984. It would appear that there has been a significant shift away from oil since 1973 as a result of increased price differentials and increased instability in the oil market. It is still too early to tell whether or not coal is experiencing some sort of revival but the Coal Fired Boiler scheme has been considered a success and will contribute to a modest increase in coal consumption.

The question to be asked now is how vigorously will governments pursue a policy of promoting energy efficiency and how pressing

an issue will it be if, as now appears to be happening, oil prices and hence energy costs start on a downward trend?

Quite clearly all the investments in more efficient equipment that have already occurred and the tecnological advances that have been made will continue to improve energy efficiency. The problem arises with projects currently in the pipeline. Will they go ahead or be postponed indefinitely, and what will the effect be on future investment decisions? We discussed earlier the difficulties that energy managers already face in trying to satisfy the criteria for investment decisions on energy saving projects. Surely such decisions are going to be even harder to approve with the cost of energy falling.

Most empirical work on energy demand assumes a symmetric response to price changes, implying that a decrease in the price of energy has an opposite and equal effect on demand than an increase in price. Intuitively, for reasons already discussed this is unlikely to be the case. However there is no way of saying precisely how sensitive demand will be to a fall in price. What actually happens will depend on three things: the instability or percieved instability of oil prices; the level of oil prices and hence the price of other fuels; and the longevity of the decision maker's memory.

It is accepted that, for reasons discussed throughout this paper, industry was slow to respond to the oil shocks of 1973 and 1979. Only in recent years has there been evidence of an increased effort towards energy conservation and an awareness of the need for built in flexibility of fuel choice. If decision makers are lured into a false sense of security they may fail to take the necessary steps to reinforce the measures already taken. In such a case it will be up to the government to make sure that the attitude of energy awareness that has been cultivated over the past few years, is maintained.

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