5th International Conference on

# ENERGY OPTIONS

## The Role of Alternatives in the World Energy Scene

Fifth International Conference on

# Energy Options –

## The Role of Alternatives in the World Energy Scene

7–9 April 1987

*Organised by the*
Science, Education & Technology and Power Divisions of the
Institution of Electrical Engineers

*in association with the*
Association for the Conservation of Energy
British Renewable Energy Forum
British Wind Energy Association
Institute of Electrical and Electronics Engineers Inc
(United Kingdom and Republic of Ireland Section)
Institute of Energy
Institute of Mathematics and its Applications
Institute of Physics
Institution of Chemical Engineers
Institution of Civil Engineers
Institution of Mechanical Engineers
International Solar Energy Society (UK Section)
Watt Committee on Energy Ltd

*with the support of the*
Convention of National Societies of Electrical Engineers of Western Europe
(EUREL)

*Venue*
University of Reading, Reading, UK

# Organising Committee

A C Baker *Chairman*
E J Anthony
Professor P D Dunn
Professor D O Hall
Dr D Lidgate
H J Moorhead‡
W Pascall
M J Platts
Professor W Shepherd*
Dr K H Spring
Dr R H Taylor
Dr R J Taylor
F C Treble§
N Worley†¶

* representing the Institute of Electrical and Electronics Engineers Inc (United Kingdom and Republic of Ireland Section)
† representing the Institute of Energy
‡ representing the Institution of Civil Engineers
§ representing the International Solar Energy Society (UK Section)
¶ representing the Watt Committee on Energy Ltd

Published by the Institution of Electrical Engineers, London and New York, ISBN 085296348 3 ISSN 0537-9989.



Printed in Great Britain by The Chameleon Press Limited.

# Contents

**The Institution of Electrical Engineers is not, as a body, responsible for the opinions expressed by individual authors or speakers.**

# Contents

# Contents

# Contents

# Contents

# Contents

# MAKING AN ECONOMIC ASSESSMENT OF THE ROLE OF ALTERNATIVE ENERGY SOURCES WITHIN GENERATING PLANT PROGRAMMES

T W Berrie

Imperial College of Science and Technology, UK

## ABSTRACT

With the possible exception of large hydro, which has been a mixed blessing to many developing countries because of its high capital costs, events have been against the inclusion of alternate and renewable energy sources in many long-term energy sector development programme almost everywhere in the world. This is partly because energy sector planners still do not regard energy from such sources as "first class" and really "reliable"; in the way that energy from conventional (even nuclear) sources is regarded (by planners) as being first class and utterly reliable. Also some of the proponents of using alternate and renewable energy sources have done themselves a disservice in the past by, consciously or unconsciously, breaking the orthodox rules of cost-benefit analysis when pressing their claims. In the future, the advent of spot pricing applied to electricity, and ultimately to other forms of energy such as gas and coal, will mean no further excuses can be tolerated for not allowing alternate and renewable energy to take their rightful places, as demonstrated by the normal accepted rules of cost-benefit analysis. Even so, such sources are unlikely to form more than 3% to 5% of any commercial energy sector development programme.

## INTRODUCTION

Alternative and renewable energy sources are usually examined from three viewpoints. First, by those who believe that: (i) fossil fuels will become in short supply in the foreseeable future; (ii) nuclear fuels are just unacceptable as a substitute for fossil fuels; and (iii) neither of the fuels in (i) or (ii) can be classed today as acceptable environmentally, i.e the sooner that alternate and renewable energy sources are developed the better, regardless of economics because there is no practical alternative. Second, by the nuclear enthusiasts, who cannot see the purpose of developing alternate and renewable energy sources, except in a very modest way indeed, i.e. for very "special" occasions. Third, by those immersed in the fossil fuel industries who believe that oil, coal and gas sources, will prove to be sufficient for all mankinds needs, or at least until the fast reactor, or possibly nuclear fusion, or the breeder reactor, become technically feasible and economically plus environmentally acceptable, around (say) 2050.

If economic comparisons have been made in the past, they have usually been biased in the direction of one of the particular viewpoints listed above. This is also true for power system planners, who drastically discount the economic worth of alternate and renewable sources, mainly because these cannot be guaranteed as being available at time of peak demand. The recent movement of electricity pricing away from long-run marginal costs, prescribed from a long-term development programme made some time ahead of the prices being used, together with energy management schemes, has indicated that electricity markets in the near future will be operating at or near to real time, probably to be followed by the other non-oil energy markets. Within such markets, where price is set by the demand very near to (or at) the time of that demand, all sources of energy which will do the same job are equal and it becomes at last possible to make an unbiassed assessment of the economic worth of alternate and renewable energy sources, vis-a-vis conventional and nuclear energy sources. Such economic comparisons can take into account the three specific viewpoints mentioned above, by appropriate "shadow pricing", i.e. by marking up or down the value of costs and benefits to reflect possible energy shortages, environmental effects, and similar things.

It is difficult to guess what would be the out-turn from such economic comparisons, but it is likely to be of some surprise to all supporters of the three viewpoints mentioned above. Sufficient studies have been made already to be able to indicate that the optimum position of alternate and renewable energy sources in the mix of future generating plant is likely to be: (i) for more of such plant to be installed in the future; but (ii) not much more than about 3% to 5% of a total plant programme.

In this paper the three viewpoints mentioned above are first enlarged upon in turn. Then the effects of electricity spot pricing on the situation is described, together with the outline of the rules of cost-benefit analysis. To retain credibility it is essential that these rules are strictly adhered to under spot pricing for all comparisons made of alternative energy sources.

Finally, some brief conclusions are reached, together with some suggestions for further work on methodologies, which should be carried out.

## THE THREE EXISTING APPROACHES TO RENEWABLES

### Alternative Energy and Renewables are Good "Per Se"?

This school of thought grew up about 12 years ago after the first oil price rise, when the "School of Rome" were vigorously putting forward a view that there would be a serious world energy gap, i.e. between energy supply and energy demand, by the mid 1980's (i.e. by about now). In such a situation almost anything that could plug this gap was good "per se", especially if the sources of energy were not fossil-fueled, because it was shortfalls in the latter sources of energy which were going to cause the energy gap. Alternative forms of energy, i.e. forms of energy other than from "conventional fossil fuel sources" were thus looked upon by this school of thought as being very good, especially if they could also be regarded as renewable, and most of them could be so regarded.

Therefore, there grew up in the 1960's and 1970's three types of supporter for alternative (sometimes called "new") and renewable forms of energy:

(a) Those who were convinced that a catastrophic energy gap would develop.
(b) Those who believed that from environmental considerations alone, conventional fossil-fueled and nuclear-fueled energy sources were no longer permissible by society at large.
(c) Those who believed in alternate and renewable energy sources "per se", for technical, scientific, and research reasons; also because these forms of

energy were purported to prove that "small is beautiful".

Those who believed in (a) above have been proved wrong in as short a period of time as the last ten years. Three factors have emerged to show the error behind the argument concerning an energy gap:

(i) Energy consumers have been shown in the last 10 to 20 years to be much more responsive in changing their demand for energy when energy prices are changed than in the past they were believed to be.

(ii) Energy conservation has proved to be a real economic alternative to adding extra energy sources and to an extent in the past considered to be utterly unlikely.

(iii) Environmental factors have not by any means been always costed out properly and put into the cost benefit calculations.

It is important when carrying out cost-benefit analysis to include fully, and to an extent much greater than at present, all aspects referred to in (i), (ii) and (iii), especially: (a) those factors on the demand side (benefit side), e.g. consumer reaction to changes in energy price, environmental costs; and (b) the costs and benefits of energy conservation.

Nuclear Energy is the Energy of the Future?

From the early days of nuclear energy in the 1960's, its ardent supporters have derided the place which alternate and renewable sources of energy could play in making up any long-term development programme. This has been for three main reasons:

(a) Because each and every new clear energy sources is very large, taking full advantage of the "vital" economics of scale which are believed to go with being large, whereas alternate and renewable energy sources are nearly always very small, the economic magic having gone out of large hydro.

(b) Because nuclear supporters often do not include all elements in their cost-benefit analyses. Items often left our are; some fuel processing costs, environmental costs, costs of breakdown, costs of scrapping.

(c) Because nuclear energy supporters, alongside their colleagues the fossil-fuel supporters, do not regard the energy from alternate and renewable sources of energy as being "firm" or "reliable" in the way that nuclear energy, or energy from fossil-fuel sources is "firm" and "reliable". For example, wind may not always be there to drive a windmill.

During the past twenty years or so, many of the claimed econimies of scale have proved illusury with respect to both nuclear and fossil fuel energy sources. In any future cost-benefit analysis for comparing alternative energy sources to make up an optimum development programme; this point must be carefully watched. With respect to (b) above, public opinion is coming round to insisting that all fuel handling, environmental and scrapping costs are included when nuclear energy is being compared with any other types of energy source. The argument under (c) above proves to be completely irrelevant under the spot pricing of electricity (see later).

Fossil Fuels will Last For Ever?

The debunkers of the energy gap beliefs described above, have mostly proved to be ardent fossil fuel supporters, who claim that fossil fuels will last for ever, or at least for the absolutely forseeable future, say until 2050 when nuclear fusion will economically and rightfully take over the energy sector. Such fossil-fuel supporters tend to load environmental costs onto their opponents the fission nuclear fuel energy sources, including very few environmental costs in their own cost-benefit analysis. Like their nuclear-energy-supporting colleagues, fossil fuel supporters do not consider the energy from alternate and renewable energy resources as being reliable or firm because of the nature of the energy source. Also fossil fuel energy supporters are very fond of quoting the number of renewable sources (say 1,000 of them) which will be needed to make up the output from one (say 3,000 MW) fossil-fueled source.

What the protagonists of the "fossil-fuel-lasts-for-ever" school usually leave out of their cost-benefit analysis are: (a) the cost of exploration to find further proven fossil-fuel reserves; (b) the incremental cost or benefit of depleting the fossil-fuel reserves at particular rates of use; and (c) the large environmental cost of extracting and using fossil fuels. Under the spot pricing of electricity, both the size and the firmness/reliability of alternate and renewable forms of energy become irrelevent (see next section).

EFFECT OF ELECTRICITY SPOT PRICING

Under the spot pricing of electricity (1), at any instant in time, at any particular part of the electricity supply system, the "buy" price and the "buy-back" price are equal. For spot prices only short-run marginal costs (SRMC) apply and no long-run, capital, investment, capacity charges are relevant. Thus, at any instant in time, one kWh supplied from each and every energy source is economically, financially and commercially equal; i.e. 1 kWh from a nuclear power station is no different in so far as its value to the power system is concerned to 1 kWh from a fossil-fueled power station or 1 kWh from a large hydro power station, or 1 kWh from an alternate or renewable energy source. This means, that under spot pricing, no penalty must be placed alongside alternate and renewable energy sources for not being reliable or firm when carrying out cost-benefit analysis to compare alternative energy sources to make up an optimum development programme.

Again, under the spot pricing of electricity, alternate and renewable sources of energy will not feel as separate as they do today from the main sources of energy, i.e. from the large, monopolistic energy utilities whose nuclear, fossil-fueled or large-hydro energy sources are so hugh, so remote from the point of energy consumption and so institutionally powerful, mainly because of intrinsic monopolistic powers. Under the spot pricing of electricity, there will be very many suppliers of electrical energy (2) to the power system, these being of all output sizes, ownership patterns and commercial types: main electricity utilities; municipalities and local authorities; combined heat and power industrial/local area energy producers (cogenerators); and those with mainly standby generators, who will export electrical energy when it is financially worth their while to do so (autogenerators).

What is the actual optimum mix of such differing types of energy output will depend upon the composition of the power system in question, including the electricity consumers. Also the optimum mix for the short term (next year or so) may well differ from what is the optimum mix for the longer term (fifteen to twenty years on) and so compromise may well be necessary to find a combined optimum mix on this account.

Sufficient work has already (3) been done on the effects of the spot pricing of electricity on the optimum mix of generating plant to be able to speculate the likely out-turn:

(a) There will be a greater proportion than on present systems in the optimum generating plant mix of alternate and renewable energy sources. However, this is not expected to increase the proportion of energy from such sources beyond about 3% to 5% of the total requirements for electrical energy in any development programme. There does not appear to be any grounds for expecting a future "bonanza" for alternate and renewable energy sources, even under spot pricing.

(b) There will be a different type of base-load mix of generating plant than at present. Almost all of base-load plant presently has a high (nuclear) or medium-high (fossil-fuelled) capital cost to running cost ratio. In the future, possibly half of the base-load plant will have either a medium (combined cycle) or a low (diesel) capital cost to running cost ratio.

(c) There will be a tendency to encourage less than at present: (i) large power stations, for economies-of-scale reasons; (ii) early construction of national grids and supergrids to obtain economies of scale in generating plant; (iii) monitoring and control of electricity supply systems solely from considerations of the supply side and by means other than those directly related to price. In other words, there will be a tendency towards joint "homeostatic" monitoring and control of the electricity suppliers' systems operating as one system with the electricity consumers' systems, the main controlling factor being the spot price, and the mix of generating consumption plant settled down over time to a pattern which the particular short-term electricity demand-supply market is indicating over the spell of about a year or so.

## RULES OF COST-BENEFIT ANALYSIS

### Elements to be Included

As indicated above, it is vital to adhere strictly to the normal, accepted rules for carrying out cost-benefit analysis (4) when determining either the optimum long-run development programme of existing and new energy sources, or the optimum short-run sources, viz:

(a) Remember to include <u>all</u> technically feasible alternative energy sources in the economic comparisons made, e.g. do not leave out specific types and sizes of plants because of prejudice, in the manner that alternate and renewable energy have very often been left out in the past, e.g. due to their unreliability and/or lack of "firmness".

(b) Remember to include <u>all</u> relevant costs and benefits. Especially often forgotten in this category are: environmental costs; energy-source depletion costs; loss of consumer welfare due to a poor standard of electricity supply, or no electricity supply at all (outage costs); fuel-processing costs; additional capital costs for public reasons of extra safety-in-operation; temporary shut-down costs; scrapping costs; refuelling costs; full operation and maintenance costs, including an allowance for special costs required on a probability basis after an accident or an incident; reliability-of-fuel-supplies (fuel embargo) costs; essential development costs (one-off costs which cannot be written off); extra foreign exchange costs to the national economy; exogenous costs to the national economy, i.e. due to fuels and capital items both being indigenous; capital-stringency costs, possibly appearing as higher than normal interest rates; labour-shortage costs, possibly appearing as higher than normal wages; commodity-shortage costs, possible appearing as higher than normal commodity prices. In [illegible] of these costs is often looked upon as a type of "shadow pricing" (5).

(c) Remember to <u>either</u> include all outputs (mainly revenues) from each alternative development programme, <u>or</u> make quite sure that the outputs from all alternative development programmes are the same, if outputs are to be neglected.

(d) Never compare two alternative generating projects as <u>individual</u> pairs, i.e. outside the context of the effect of including each project, taken separately, on the already-largely-optimised development programme, on a "with-each-alternative-project", "without-each-alternative-project" basis.

(e) Treat the power system planning process as a circle, i.e. adopt a load forecast from an assumed array of electricity spot prices (basically SRMC) for the future, find the optimum development programme, estimate how this optimum programme will alter the electricity spot prices assumed, adjust the load forecasts, bearing in mind likely consumer demand responses to changes in electricity spot price, and go round the circle again; and repeat the operation until stable load forecasts at stable spot prices result from the iterations.

(f) Remember to carry out <u>sensitivity analysis</u>, i.e. to see how the optimum development programme varies with changes in the main parameters, e.g. capital costs, fuel costs, environmental costs, outage costs, assumed economic life of new plant, load growth, "shadow pricing" (see earlier), load forecasts, consumer response to changes in the spot prices of electricity, etc.

(g) Normally the development programme with the lowest total present value of cost (6) over the economic life should normally be chosen.

## CONCLUSIONS AND FUTURE WORK

The following brief conclusions can be drawn from this paper:

(i) The prejudices of the past must be put aside when examining the place of alternate and renewable energy sources in the optimum development programmes of sources of energy in the future.

(ii) The introduction of electricity spot pricing will favour the introduction of a greater proportion than in the past of alternate and renewable forms of energy, although the proportion of such plant is unlikely to become greater than 3% to 5% of total generation output in any programme.

(iii) To determine the optimum proportion of alternate and renewable forms of energy, the normal rates of cost-benefit analysis must be strictly adhered to.

The following work still requires to be done to obtain a better understanding of the place of alternate and renewable energy sources in the optimum development programme for energy sources in the future:

(i) Improve the accuracy and credibility of the cost data for alternate and renewable energy sources.

(ii) Improve the knowledge about consumer demand response to changes in electricity spot price.

(iii) Improve the value given to some often-forgotten costs attrib[illegible] different types of energy [illegible] e.g. environmental costs, outage costs,

development costs, shut-down costs, safety costs, operation and management costs.

## REFERENCES

(1) Berrie, T.W., "Power System Economics", Peter Peregrinus, UK, 1983, pp. 190-194.
(2) Schweppe, F.C., Caramanis, M.C., Bohn, R.E., "Optimal Spot Pricing : Practice and Theory", Paper 82 WM 115-4, IEEE, U.S.A.
(3) Berrie, T.W. and Anari, M.A.M., "Joint Supply-Demand Optimisation in Electricity Supply", paper to be published in Energy Policy, December, 1986.
(4) See reference (3).
(5) See reference (1) pp. 190-194.
(6) See reference (1) page 289.

# THE DEVELOPMENT OF A EUROPEAN MARKET FOR THIRD PARTY FINANCE

Ian Brown

Association for the Conservation of Energy, UK

All available studies show that investment in energy efficiency within the European Community is not occurring at the optimum rate. The reasons for this are well documented and much discussed - barriers in the marketplace are preventing an adequate take up of energy efficiency opportunities.

Among these barriers are the lack of finance, or, as common, unwillingness to spend available finance on energy efficiency improvements, and a common barrier throughout Europe, a lack of credibility in energy saving technologies. The overcoming of these barriers may be assisted by the use of energy performance contracting, yet such an activity is at a very early stage of development in Europe.

In 1985 research was undertaken in the twelve countries of the EEC into the potential market for 'third party finance' (as defined below). This research was instigated from the starting observation that the level of investment in energy efficiency equipment installed through the mechanism of performance contracting is considerably greater in North America than in Europe. This observation begged several questions, which the research set out, at least in part, to answer.

- Is there a market for third party finance in Europe and how big is that market?
- Why has the concept not developed as fast (or indeed hardly at all) in Europe as in North America?
- What are the barriers preventing the growth of third party finance?
- What actions can be taken (if any) to overcome these barriers?

Research results presented in this paper are the summary of well over one hundred personal interviews with relevant organisations and individuals throughout the twelve countries of the EEC.

## DEFINITIONS

For the purpose of this study 'third party financing' was defined as:-

"The provision of the services auditing, installation operations, maintenance and financing on a turnkey basis, with the cost of these services being contingent, either wholly or part, on the level of energy saving."

The current North American terminology of "performance contracting" can be used interchangably with the activity known in Europe as "third party financing."

## DEMAND FOR THIRD PARTY FINANCE

The "cost effective" potential for energy saving in the European Community has been quoted as being 25% of present consumption, across all energy using sectors, by the year 2000 (Ref 1).

However, the level of investment needed to bring about such savings is not a figure that has been predicted with any degree of accuracy. Nevertheless, using already published data an attempt was made to estimate the potential level of investment in energy efficiency in Europe, but it should be stressed that the numbers quoted below should be treated as orders of magnitude rather than 'exact' figures.

### Potential in the Building Sector

According to the European Commission study 'Towards a European Policy for the Rational Use of Energy in the Building Sector' (Ref 2), the average investment cost per tonne of oil equivalent (TOE) saved each year for existing buildings is 1,300 ECUs for investments with an average simple payback of 3 years or less.

The same study estimated that 12% of the European Community's present energy consumption in the building sector (residential, commercial, industrial and public sector buildings) could be saved by investments with paybacks of 3 years or less.

Using such estimates as the basis for an estimate of the total potential investment in the building sector, based on the total final consumption in the European building sector of 270 million TOE (1984 being the most recent figures available), a 12% energy saving would equate to an investment need of some 42 billion ECUs.

### Potential in the Industrial Sector

The potential for energy saving in the industrial sector has been estimated in a number of European countries, but estimates vary greatly according to the existing energy efficiency of the capital stock, and the methodology used for the estimate. The Netherlands has a target of 30% energy savings by the year 2000, a figure which was recently confirmed as economically feasible by a Dutch Government advisory committee.

Alternatively, a 1982 survey of the UK industry (Ref 3) concluded that the potential for energy saving investments with a payback of under 3 years was 14%. This figure is judged to be more realistic, on a European wide basis, and thus as a basis of estimating the market potential for energy saving investment through third party finance (i.e. average paybacks no longer than 3 years), savings potential of 15% is assumed.

The French Energy Management Agency (Agence Francaise pour la Maitrise de l'Energie) calculated in 1985 (Ref 4) that in the industrial sector an investment of 1050 ECUs will be required to save 1 TOE, assuming that the investment has a payback of 2-3 years (the payback range necessary for third party finance).

Conservation industry sources interviewed have confirmed the validity of this figure, and it is thus used to estimate the market potential for energy saving in the industrial sector.

Using the 1984 (latest figures available) Total Final Consumption in the industrial sector of the 12 European Countries of 279 million TOE as a basis for a market estimate, the 15% potential for energy saving would, using the 1,050 per TOE saved formula, equate to an investment of 44 billion ECUs.

## Total Market Potential

Since transport was excluded from this study, the total potential market for third party finance - being the total potential investment in energy saving projects (with a payback of 3 years or less) is the sum of the two sectors previously quoted - buildings and industrial - being a total potential market of $82 billion across the 12 countries of the European Economic Community.

## Potential by Country

The aggregate market potential figures quoted above mask a wide variation between different countries.

### Industrial Market:

The industrial market for third party finance is most immediately promising in France, Italy, Spain and the United Kingdom. These countries all have relatively energy inefficient industrial sectors, where the concept of third party financing could make a substantial impact on the level of investment in energy saving in the short term.

Among other EEC countries Denmark, Germany, and to a lesser extent, the Netherlands, have a relatively limited potential for third party finance in industry because of the substantial progress achieved in energy saving since the first oil crisis. In these countries most short payback investments have already been made.

There are particular problems restraining the ability of performance contracting to penetrate the industrial market in several countries - notably Belgium and Portugal.

In Belgium, the national government offers an incentive of a tax deduction of up to 20% of the value of an energy saving investment. This tax deduction is open to all industrial and commercial energy users. Under present rules this deduction can be claimed only if the investment is funded by the industrialist. If an energy saving investment is funded by an outside energy service company, then neither the energy service company nor the industrialist may claim the credit, thus putting third party financing at a significant disadvantage.

In Portugal very high interest rates (currently 30%) and a general shortage of capital are barriers not only to performance contracting, but to investment in industry general'.

### Residential Market:

The residential market in Europe, in common with North America, offers considerably less scope for third party financing than other sectors because of the large number of relatively small investments involved and the major role played by occupancy levels and lifestyles in determining domestic energy use.

Third party finance can approach viability only in multi-family dwellings where a central boiler plant is present. In single family dwellings or in multi-family dwellings where individual heaters are used it was judged that the concept was unlikely to be viable in the near future.

Multi-family dwellings likely to be a market for performance contracting are found on a significant scale in Italy, Spain and to a lesser extent France. In other countries multi-family housing forms a much smaller part of the housing stock - in the UK for example multi-family housing with central boiler plant accounts for less than 5% of the housing stock.

In Spain the mild climate and resultant short heating season together with the lack of cooling, imply low annual energy use for space conditioning, resulting in relatively long paybacks for energy saving investments. This problem, when allied to other difficulties of no tradition of multi-year contracts and the legal ability of a single tenant to block any capital investment, mean that performance contracting is unlikely to make rapid inroads into this sector in Spain.

In Italy the problems of the short heating season and long paybacks, a problem exacerbated by the highest percentage of oil fired space heating in Europe, imply little immediate market for third party finance. Paybacks of 6 and 7 years are commonplace, and it was judged that such paybacks are uneconomic for the use of performance contracting.

### Institutional and Public Sector Market:

A substantial market exists for third party finance in institutional and public sector buildings in many European Countries, where restricted capital spending and lack of technical expertise are commonplace problems. Unfortunately significant problems are likely to delay the introduction of third party finance into one of its most promising sectors.

In theory a large potential market also exists in the public sector building stock of the UK, France, and to a lesser extent, Germany, Italy and Spain. Of these countries Spain is the only one that has taken any steps to introduce performance contracting in the public sector, and alone appears willing to show the necessary flexibility to successfully negotiate a performance contract.

In contrast, in the UK and Germany, and to a lesser extent in other countries, public procurement rules do not accommodate the performance element of a third party financed investment, and certainly in Germany, Denmark and Ireland, public officials responsible indicated no willingness whatsoever to consider introducing the necessary flexibility to allow performance contracting.

The potential for energy saving in the UK public sector building stock is very considerable - 50% of all the UK's building stock (of all types) lies in the public sector, and savings of 20-25% of current consumption are economically feasible. This sector is seriously capital constrained, and significant opportunities for energy saving are not being addressed both because of the shortage of capital and also because of skill shortages.

However, despite interest in the use of performance contracting by the UK Department of Energy and also by local authorities, there is a significant barrier preventing the use of third party finance in this sector. The UK Treasury has taken the view that such financing constitutes public sector borrowing, and is thus added to the 'Public Sector Borrowing Requirement' - equivalent to the US budget deficit. Because of very strict controls on spending, in order to keep the budget deficit low, public bodies face severe financial penalties - in the form of 'fines' - if spending rises above prescribed limits. Unfortunately the Treasury have ruled that third party finance is counted as public sector spending in the year in which the contract is signed. It is obviously somewhat illogical to treat third party finance as public sector spending but for wider reason of macro-economic policy the ruling persists.

The most immediately promising public sector markets are those of Spain (as previously discussed), Belgium and the Netherlands. These are countries where the public sector is capital and skill constrained, yet has shown, during interview, more interest and willingness in discussing the ability of third party finance to aid investment in the public sector building stock.

In France and Italy, heat service contracts are widespread in this sector, and in this situation the

attitude of these companies - with whom energy users have signed long term contracts - is critical. This issue is discussed in more detail later, but briefly the heat service companies have little or no economic motivation to reduce the quantity of heating fuel used, and as such are likely to be a barrier to any penetration of this sector by energy service companies offering performance contracts.

SUPPLIERS OF ENERGY SERVICES

Existing Suppliers

The Study revealed that there are only eight or nine companies operating in Europe whose activities can be defined as 'performance energy contracting'. It should be noted that heat service companies were judged to be outside this definition, for reasons discussed fully below. An examination of these existing energy service companies revealed a number of common characteristics.

(a) No company was formed before 1984, the majority being formed in 1985. This shows the early stage of development of energy services in the Community.

(b) All existing Escos are subsidiaries of parent companies, three of the eight being formed by multinational oil companies. No entrepreneurial Escos have yet been established.

(c) Although most existing Escos claim to cover the public/institutional buildings sector, none has yet completed a contract for a government facility. The contract negotiation time has been so lengthy, and the bureaucratic obstacles so great, that no activity has yet taken place in this sector.

Potential Suppliers

If the European market is inadequately covered at present who could enter this business?

Consulting Engineers:

Twenty one consulting engineering practices throughout Europe were interviewed, and although all of these companies specialise in energy consultancy, less than a quarter were previously aware of the concept of performance contracting. Although expressing interest in the concept, there was near unanimity in the view that European engineers are extremely wary of entering the business of performance contracting because of a number of factors:

(a) Increased Risk:

Consulting engineers are by nature risk averse, and are wary of any way of doing business that increases their financial and technical risk. Only two engineers interviewed indicated that they would consider taking their fee on a performance related basis while all were wary of accepting technical and financial risk of the equipment performing as predicted.

(b) Professional Practice:

In some Member States engineers are prevented by their professional code from involvement in any 'commercial' enterprise. Engineers are wary of any overt involvement with any supplier or other service company - particularly if such involvement jeopardised their reputation with existing clients. Consulting engineers are not culturally accustomed to the concept of payment by results.

Engineers interviewed indicated that the concept was more complex than their traditional 'preferred' means of doing business, and thus less attractive.

(c) Entry Cost:

The legal, administrative and marketing costs of establishing an energy service company are high, with the minimum viable figure estimated to be in the region of 300,000 in the first year. Unless an Esco has parent company backing all early deals will need to be funded by equity alone. Few engineers possess the necessary capital to fund an operation.

(d) Investment Funds:

In the absence of a loan or guarantee scheme, engineers would have considerable difficulty raising the necessary degree of bank loans to fund investment in energy saving, since they do not have sufficient capital or collateral.

Equipment Manufacturers:

Although many European energy efficiency equipment manufacturers have expressed cautious interest in the concept, few are likely to enter the business for a number of reasons:-

(a) Manufacturers usually possess technical skill only in their own product sector.

(b) Most Manufacturers are unwilling to hold products on the balance sheet until the end of a performance contract. Managements are usually under much pressure to maintain cash flow by keeping stocks on the company's balance sheet to the minimum.

(c) Equipment manufacturers are very wary of upsetting existing business relationships, particularly with consulting engineers, whose influence on the purchase decision can be often crucial.

Heat Service Companies

The provision of heat services, or 'Chauffage', is often quoted in North America as 'European Third Party Financing'. As previously mentioned, heat services have not been included in the definition of third party financing techniques used in this study, because heat services, as operated in Europe, are concerned principally with the provision of heat. Although energy efficiency is an integral part of such operations, it is by no means the raison d'etre of heat service companies. An energy service company however exists to invest in energy efficiency improvements - not only to distribute or provide energy needs.

Heat service companies offer much scope to expand into the energy services area. They have the technical expertise in heating systems management, and, as established companies, are more likely to have access to capital than an entrepreneurial energy service company.

However, as these companies are contracted to supply a set level of heat, their incentive is to ensure that such heat is produced as efficiently as possible - but there is no incentive to see that it is used as efficiently as possible.

One unusually honest French chauffage company interviewed stated that the actual level of investment in energy saving by that and other French chauffage companies had been low, and that the primary source of profit for the company was the provision and distribution of heating oil.

For this reason this company was uninterested in a concept which implies investment in a package of measures to ensure the maximum possible energy savings. This conflict between heat service and energy efficiency is insufficiently appreciated, both in Europe and in the United States.

Utilities:

Utilities are a logical choice to act as energy service companies in Europe because of a number of factors, including access to capital; the close relationship to their existing business; some expertise in end use technologies; presence in the market and direct contact with energy users.

The attitude of the major European utilities, to the notion of performance contracting can be summed up as uniformly negative. Utilities throughout Europe do not regard energy saving as either a demand reducing tool, or as a possible business venture - two of the motivating factors which have caused North American utilities to promote or indeed enter the performance contracting business.

Gas and electricity utilities throughout Europe see their prime function as ensuring adequate supplies of their fuels. Demand management, as either a business venture as indeed a as 'supply' option is not considered within the remit of these "supply" industries.

However, the ability of energy efficiency to promote increased fuel sales through encouraging switching to efficient (and hence lower cost) use, particularly in the industrial sector, was very much a motivating factor to most of the utilities interviewed. The most characteristic sentiment expressed towards energy efficiency was that it is desirable only where it could be used to lower costs and thus maintain or even increase market share and sales, at the expense of other competing fuels.

A number of publicly owned European utilities indicated that they would face significant legal hurdles if they wished to 'diversify' into the energy services business. Most state owned European utilities are given a remit to provide adequate supplies at the lowest cost. No European utilities are currently active in the third party financing business, and with one exception, none are currently planning such a venture.

The one exception is the monopoly British Gas Corporation, soon to be transferred from public to private ownership. It is known that this utility, at the specific urging of the House of Commons all party Energy Select Committee (Ref 5), is actively investigating the establishment of an energy services subsidiary.

AVAILABILITY OF FINANCE

Third party financing is a highly capital intensive industry. Energy service companies have to meet the cost of marketing, administration and detailed energy audits in addition to the funds needed for the actual investment in energy saving equipment. Energy service companies must be well capitalised, and have access to low cost borrowing, to fund such investments.

In the United States small and medium sized Escos have obtained funding from private investors and local banks. In Europe those some sources of finance are not available to small Escos who lack parent company funding. The venture capital market in Europe is considerably less well developed than in the USA, and indeed there are far fewer sources of risk capital for start up ventures in Europe. European financial institutions interviewed were unanimous in their view that, in the absence of any risk reducing government or EEC scheme, or sufficient collateral, they would not make the necessary funds available. Energy saving investments themselves would not be accepted as sufficient security.

Since the degree and cost of borrowing is the single most important factor in determining the Esco's rate of return, European Escos need to have some access to funds, without which small, or even medium sized, potential Escos will simply be unable to enter the market.

RECOMMENDATIONS FOR FUTURE ACTION

Barriers to Entry

The barrier mentioned above - difficulty of raising finance, is only one of a number of barriers preventing potential energy service companies from entering the market. The principal barriers are:-

(a) Risk:

The business and professional culture of Europe is more risk averse than that of the United States. Several interviewees indicated that as they were making satisfactory profits at present, they saw no reason to increase their risk to try to increase their business.

Consulting engineers are risk averse and are disinclined to accept the technical or financial risks for a project that third party financing implies.

(b) Significant Start Up Costs:

Because of the complexity of the contract, contract negotiations can be very lengthy - six months appears to be the absolute minimum feasible and 18-24 months is possible. This lengthy contract negotiation time implies a very high marketing and administrative start up cost for a possible Esco. This start up cost is estimated in Europe at a basic minimum of $400,000 in the first year.

(c) Difficulty of Raising Capital:

In addition to the high start up costs which imply significant equity needs for an energy service company, such a company will need access to low cost borrowing if it can economically fund the level of energy saving investment needed for viability. Companies not backed by the resources of a major parent company foresee considerable difficulty in obtaining these funds without the necessary security.

(d) Uncertain Energy Prices:

The recent dramatic fall in oil, and to a lesser extent natural gas and electricity prices, which has been seen in the United States, has been less pronounced in Europe.

US dollar denominated crude oil prices do not necessarily translate into a proportional fall in delivered local currency fuel oil. Further, falls in oil are not necessarily being matched in Europe by falls in other fuel prices - indeed energy service contracts may still have an expectation or static or even rising gas and electricity costs, usually supplied by a state owned monopoly supplier, which may be the predominant fuel in a performance contract.

Nevertheless, it is undoubtedly the case that the uncertain energy price picture, and the recent falls in the price of oil, have increased the risks for any potential European energy service company. However, in the opinion of those existing European energy service companies the effect of such energy prices will not lead to any dramatic curtailment of their potential market, for the reasons given above.

Possible Actions to Overcome Barriers

These barriers listed above are the cause of the supply problem for third party finance in Europe. A question which should be asked however is, is the supply of energy services a problem which should be addressed, or should demand be stimulated, which will automatically lead to the growth of energy service companies?

It is certainly the case that knowledge of, and hence demand for, energy services is at a low level, and some of the actions recommended below in this paper