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Open letter from the President of the Institute of Energy

Energy Managers and the Institute

The Energy Managers movement has a valuable and key role in ensuring that industry in this country makes the best use of energy: and it is therefore to be expected that the Institute, as the professional body for technologists and engineers in the energy field, should do all that it can to support and help this movement, particularly where it can help raise the level of technical knowledge and skills of those energy managers who are keen so to do. Now that the response to the questionnaire sent out by the Energy Efficiency Office to energy managers is known (*Energy Management,* Oct '86, p 4) and the Energy Efficiency Office has announced its intention to maintain the *status quo,* the Institute is able to make its position clear.

The Director General of the Energy Efficiency Office, Bill Macintyre, has said recently that he 'is delighted that (the energy managers) have shown strong support for the current arrangement' and he goes on to say that 'I can assure the whole movement that the EEO will continue to show equally strong support for them. We share the same objectives to make sure that the movement grows and develops in the way that is best for its members'.

I and senior officials of the Institute had the opportunity recently to discuss the future of the Energy Managers movement with Mr Macintyre and his colleagues and were able to make clear to him that we welcomed his decision to preserve the *'status quo'* and to offer him and, through him, the movement as a whole the full support of the Institute.

We have been considering how best to do this and in particular how to help the nearly 30% of those that filled in the questionnaire who wanted to be more closely linked with a professional institute such as ours. The first thing I would make clear is that there are grades of membership *already* within the structure of the Institute such that any energy manager can be welcomed into the Institute. For those with modest formal technical qualification, there is the grade of Associate while for those with, or who acquire further qualifications, there are grades such as Associate Member — equivalent to Technician Engineer — through to the Corporate grades for those qualified as Chartered Engineer or equivalent. We do have a significant number of energy managers across the whole spectrum of Institute membership and maybe we should encourage them to come forward and make their presence felt.

Education and Training Committee will moreover be developing, in consultation with the Energy Efficiency Office, schemes by which energy managers and economists, particularly those without formal, technical training, can acquire a certificate or diploma which will signify that they have the practical knowledge and experience to make a valuable contribution to energy saving.

Much of the contact between our members and energy managers takes place at branch level. We would like to encourage our branches and local Energy Management groups to hold more joint meetings. It has also been suggested that the Institute, centrally or through the branches, may be helpful in providing professional speakers able to give a broad or specialised view, for Energy Management meetings.

It is the Institute's intention to support the Energy Management movement in ways which are most useful to energy managers. How the situation develops must depend to a large extent on the response of individual energy managers, particularly those who are anxious to increase their professional standing. The Energy Efficiency Office and representatives of the Institute have agreed to meet from time to time to review progress and seek better forms of collaboration and I hope this will extend to better contacts between Regional Energy Efficiency officers and branch chairmen and between Energy Managers groups and branches.

Please let me know of progress and of any problem that may arise in your region and I will keep you informed of the progress made at headquarters.

J Swithenbank (Prof)

Tidal power from the Severn, volume 1

Severn Tidal Power Group, 1986
96 pp. £14.50

The official policy for electricity generation is to install nuclear plants for the base load and, if necessary, build coal stations as well. Before the oil 'crisis' in 1973 the eventual target was one third oil, one third coal and one third nuclear. Even the recent rapid drop in oil price has not revived interest in oil firing for electricity generation in Britain. The Chernobyl nuclear catastrophe has reduced the likelihood of a major programme of nuclear construction, at least in the short term.

Electricity consumption is increasing in spite of the relatively sluggish economic growth in the United Kingdom. The recent disruption of the coal industry demonstrated the value of a diversity of sources of power generation. It would be therefore unwise for all new power stations to be based on coal.

The report on the two tidal schemes based at the Severn Estuary is therefore timely and is likely to be read with interest and perhaps, enthusiasm. However tidal power is not a complete alternative to nuclear, coal or oil power generation because, although the rate of electricity generation is predictable, it falls to zero for at least a third of the time and also varies with the height of the tides. Such a scheme has therefore to compete as a fuel saver — it cannot be regarded as a full contributor to the electricity base load. In fact the fuel cost for tidal power is effectively zero like most renewable energy sources. Presumably it therefore has higher merit than renewable energies where the electrical output is not predictable. If installed, the Severn barrage scheme could have an operating cost as low, or lower than any other power source.

For such a power source nearly all of the costs of electricity generation are associated with servicing the capital necessary to finance the building of the barrage and its generation equipment. Once installed, the barrage and its generating plant are likely to have a long life with relatively low maintenance costs. The pricing of electricity from high capital cost plant like this therefore depends greatly on the terms and conditions associated with the loan financing the building. The report makes it clear that normal commercial loan terms would lead to an unattractively high electricity generating cost.

The authors of this report consider that there is no prospect of financing the barrage from purely commercial loans because of the long wait for a return on investors' money. Although it is not mentioned, a major project of this type has, from past experience, also uncertanties in the eventual and final cost, and there is a reasonably high possibility that delays and technical problems (subsoil, a long period of storm weather, or labour problems) could lead to a major overspend. The electricity generated could then be much more expensive than the prediction. Alas, in a joint commercial/Government method of funding, any extra money required is unlikely to be forthcoming from private funds because the potential return would be poor. Risks are mentioned in the report, but the adequacy of 9% of the civil and 5% of the mechanical equipment costs as allowances for such risks may be considered to be somewhat optimistic.

This report is one of the three being published as a result of the study by the Severn Tidal Power Group (STPG). The group consists of McAlpine, Balfour Beatty, GEC, NEI, Taylor Woodrow and Wimpey and is funded by them and the Department of Energy. This report includes a summary of the proposals.

There are two schemes: one for a barrage to the west of Cardiff and Weston which would cost nearly £6000M (1984 currency) for an installed capacity of 7.2 GW. The barrage is some 16 Km with locks for ships of up to 150 000 dwt (dead weight tons) close to the Welsh coast

The other scheme which is at English Stones, up-stream from Avonmouth and Newport is much shorter (about 7 km), and smaller in output (970 MW) and cost (£1200M). Although the longer scheme appears cheaper per installed kW when the annual energy output is considered the smaller scheme would appear to offer cheaper electricity. Shipping this far up estuaries would only be 25 000 dwt.

The report, for the first time, gives an engineering, ecological and economic analysis of the two schemes. Comparison of alternatives for energy production is always hazardous but here parallel schemes have been appraised by a single team using the same methods.

The report has much information on the technical, environmental, implementation construction risks, financing and final comparisons and recommendations. It does not provide light reading for bedtime but it does supply a source of information for discussion and study and perhaps future action on a project that seems to have been a serious contender for power generation for many years. Perhaps now the conditions are right for its implementation.

Norman Worley

Renewable energies: sources, conversion and application

P D Dunn
Peter Peregrinus, 1986
373 pp. £40.00

Prof Dunn (Department of Engineering at the University of Reading) has produced a comprehensive account of renewable energy sources and conversion methods.

He has studied and directed research in this field for nearly two decades and has a worldwide reputation for his knowledge and skill in applying renewable energy.

The book should be of value to engineers and scientists who want an introduction to the subject, and it should be of interest to the more general reader.

The material has been used to provide introductory lectures for a one year taught Masters degree course in *Alternative energy for developing countries.*

The book is divided into 10 chapters, each packed with practical applications, illustrations and numerous references. The first two chapters cover the use of energy and the availability of resources. They consider total world energy use, from both commercial and the non-commercial energy sources.

Chapters three to six cover energy and its conversion, heat engines and refrigeration, the internal combustion engine and energy storage. The author makes topics such as basic thermodynamics easily accessible to the complete beginner and then builds on these basic techniques. The final four chapters examine the utilisation of solar energy, biomass conversion, wind energy and water power.

I particularly enjoyed reading the chapter on biomass conversion. The chapter begins with a brief summary of the relevant chemistry of bioconversion methods and then discusses in turn: muscle power; combustion and cooling stove design; vegetable oils; pyrolysis; gasification; anaerobic fermentation and alcohol production.

Many books have been published in recent years on the subject of renewable energy resources. This book stands out from the rest because Prof Dunn has concentrated on the practical applications and limitations of the various technologies.

Andrew W Cox

Wind energy for the eighties

Edited by Prof N H Lipman, Dr P J Musgrove and G W W Pontin
Peter Peregrinus, 1982
372 pp. £27.00

The British Wind Energy Association set out to kill the gap in wind energy literature when they produced this volume. Stating that 'the literature on wind energy is at present very fragmentary, with information on the significant developments that have taken place since 1973 dispersed in the proceedings of many conferences and the reports of many seperate laboratories'.

This is unfortunately all too true. However this text provides a very

comprehensive overview of what has so far been achieved and of areas in which future developments are likely to occur. It has thus fulfilled its task of bridging the gap in literature on wind energy and provides good background information on the subject.

The text is well illustrated and contains numerous references, which enable any area of the subject to be further explored; making it useful for all Institute members whether their interests be more curiosity or research.

As the use of wind energy shows great promise in the UK it is a subject we will no doubt be hearing much more about and this text, compiled by over 60 engineers and scientists from industry and academe, provides all the basic information needed to understand the field. It is a welcome rarity to have all this under one cover, and although progress in this new industry has continued since the text was published, it provides an essential source book on wind energy for the UK.

Helen Taylor

Japan: energy and petroleum sector outlook

The Economist Publications, 1986
117 pp. £245.00

This is a typical Economist Intelligence Unit report in that it is very comprehensive, well written and well researched. It is, however not for the casual reader. It contains many statistics and should therefore be of good use to the energy analyst who is concerned with Japan.

The analysis in this report of Japan's energy sector is well presented, but it does mainly concentrate on the past. Of the 106 tables only approximately 20 deal with forecasts, and many of those are produced by outside institutes. The title of the report is therefore a little misleading. It would have been good to see more independent views of the energy sector in Japan.

In conclusion, although there is a suspicion that the report was written before the present low oil prices and the liberalisation of petroleum product imports into Japan it is generally a good survey of the Japanese energy sector.

C Wilshaw

Trading in Oil Futures

Sally Clubley
Woodhead-Faulkner, 1986
104 pp. £17.50

This is a concise readable book written without humbug by Sally Clubley, a biochemist and research analyst working for an international company of brokers.

The book describes the various energy futures contracts currently traded and is intended as a guide to the use of oil futures markets. The book contains eight chapters, the first two describing the development of the world's oil industry and the oil refining industry. Although the chapters are short they do provide the reader with a useful introduction.

Prior to the 1970s virtually all the world's oil refining capacity was in the hands of the majors, the 'Seven sisters', Exxon, Mobil, Chevron, Gulf and Texaco in the United States with BP and Royal Dutch Shell in Europe.

These majors dominated the oil price for decades, but in the early eighties refining became less economic and long term contracts for crude oil less attractive, the spot markets came more into their own. The book clearly describes the reason for the change together with a concise look at the fine major spot markets.

The oil futures markets were set up to enable traders to offset the financial risks taken, allowing for example gas oil to be purchased by selling futures in order to protect a fall in price before the cargo is sold. In order to explain the strategies employed the author looks at the different ways the futures markets can be used by illustrating fictitious examples of oil trading.

Sally Clubley's final chapter on 'chartists' is of interest in the standard techniques used whereby future prices are predicted by analysing past price movements and identifying trends and patterns.

The book is given a large index considering the book's length is a bare 100 pages. At £17.50 it is perhaps a little over-priced bearing in mind the publishers have made this one of a series in trading futures.

F John L Bindon

International Gas: Prospects and trends

Edited by Paul Stevens
Macmillan Press, 1986
144 pp. £20.00

This book consists of the seven papers presented to the Third International Economics Conference held early in 1985 at the University of Surrey. Whilst the conference was concerned with the general problem of future prospects and trends in the international gas market, its timing was such that it was held just after the decision of the UK Government to block the British Gas Corporation's decision to buy Norwegian gas from the Sleipner field. As a result the discussion was centred on the implications of this decision and on the future supply and demand balance in the Western European context. However it predated the reduction in oil prices and its implication in future supplies of gas.

The first two papers, by Paul Tucker (Philips Petroleum) on market cycles and by David Howden (University of Surrey) on market competitiveness, give a survey of the factors that can inhibit the efficiency of the international gas market. In the chapter on market cycles there is a discussion on the factors that control cyclical processes in gas demand, such as relative prices between gas and competing fuels, marketing strategy and the influence of the long lead times that characterise the gas industry. In a more quantitative paper on market competitiveness a comparison is made of actual transactions with those predicted by a model of the trade of gas. This apparently shows that policies designed to stimulate competition impose very small costs on gas consumers.

The next two chapters deal with Norwegian gas (by Mr Ager-Hanssen, Statoil), and UK gas (by Mr Brierley, British Gas Plc), who present two excellent and timely chapters on the respective market situations and their interplay with the European gas trade. In particular the gas prospects of the UK market are examined in some detail. He concluded that the producers need to be flexible in contract terms and need to be responsive to the relationship between price and volume, and that it is the customers who determine how much gas is used. Soviet gas, its projected output, Western purchases of gas, and the political implications, and the future energy balance of USSR and Comecon are dealt with by Mr Kaser (Oxford University). Prof Odell (Erasmus University) dealt with institutional constraints on the development of the Western European Natural Gas Market, in which he concluded that the market was restrained by high prices on one hand and unrealised potential supply on the other. Dr Shilhada (Organization of Arab Petroleum Exporting Countries) concluded with a wide ranging and detailed survey of gas supplies and reserves for the Arab world, and analysing the situation for a number of Arab countries.

The book is of particular interest to academics concerned with, or interested in the economics of natural gas. However, the book is only 144 pages long and in certain papers lacks detail and penetration. In particular, because of its timing, it lacks analysis of the influence of low oil prices. It gives little insight into the future development of the major gas fields and the role of depletion policy, nor does it come to conclusions about the role of long range gas transmission schemes.

Prof A Williams

World energy — the facts and the future

Don Hedley
Euromonitor Publications, 1986
300pp. £28.00

Don Hedley wrote the first edition of *World energy* in 1981 while working for a major oil company. He is now an independant writer.

Although able to publish his first book in the light of the oil rises of 1973 it was more difficult for him to take full account of the oil price shocks of 1979. This second edition is able to analyse that latter situation as it applies to different fuels and countries.

The author, in his introduction, sees the world's perception on oil dependence exaggerated and examples the reduction

in demand by all consumers, industry, commerce and domestic. We could get by with less.

The higher oil prices of the 70's and the early 80's caused world economic growth to decline. It encouraged conservation by using less energy by being more efficient and by switching to other fuels.

The author sees these latter operations as setting the stage for re-establishment of a reasonable level of world economic growth. The quest for efficiency in energy use is likely to be pursued for many decades.

Environmental considerations are assuming greater and greater importance and these are influencing decisions on the means of energy development.

Statistical tables occupy nearly half of the book but they are presented in a very clear form, and in a way which allows the reader to see well defined comparisons which are immensley interesting. However, of the 115 tables which make up these statistical analyses, more than 100 come from one source, namely BP.

The book contains some 35 diagrams spread across the four parts of work defined as *Outlook*, *The fuels*, *Energy supply and demand*, *Future issues*. These diagrams do not match the standard of the tables already referred to, both in clearness and by the fact that they are not easily related to the text.

It would be a worthwhile addition to a technical library and, one hopes, that we shall see future editions appearing but with improvements in the areas mentioned.

Don Hedley makes a critical forecast in his examination of the outlook for world energy in both developed and developing countries. He examines in detail the fuel options including prospects for nuclear power development. He quotes the industry as having not emerged from the effects of the Three Mile Island accident. Unfortunately this new edition comes too early for the author to put his views on the nuclear topic following Chernobyl.

The sections of Part III, *Energy supply and demand throughout the World*, are particularly interesting and appear to be the main thrust of the book.

F John L Bindon

The art of buying electricity

David Matthews
Rapra Technology, 1986
67 pp. £30.00 (Rapra members), £35.00 (non-members)

This book sets out to examine the various maximum demand tariffs which are made available to industrial and commercial consumers in the UK as of July 1986.

The use of the word 'art' in the title is rather a misleading one implying an inborn skill, whereas the multitude of tariffs made available require a certain application of mathematical skills. Nevertheless such a book is to be welcomed.

The book would, I believe, be of value to those companies who, still in these days of questing for increased efficiency, lack the advice of an energy manager.

The technical terms, such as: power factor; maximum demand; service capacity charges; phase balancing; utilisation factor are all well explained.

Rapra Technology began in the late 1970s as one of eight research associations who, through a Government contract, visited a number of factories to advise on energy saving. Their particular responsibility lay mainly within the chemical industry but did include a miscellaneous number of manufacturing companies.

The company found not to their surprise that many industrial consumers were on an inappropriate tariff, mainly due to not having sufficient energy data. From this work, the author presents in his book a review of tariffs, mainly of the maximum demand type.

David Matthews answers questions on why maximum demand tariffs are used, why they vary from area board to area board and examines a typical structure of a maximum demand tariff. He presents his general conclusions in precise terms and discusses some case histories.

The book contains a number of appendices but no index. One poor aspect of the book occurs in Appendix VIII which looks at the costs of electricity throughout the UK through the use of comparison tables. They are both poorly reproduced and inadequately explained.

F John L Bindon

Fifth E C photovoltaic solar energy conference

Edited by W Palz and F Fittipaldi.
Reidel Publishing Company, Holland

This book presents the proceedings of a conference organised by the Commission of the European Communities in Athens in October 1983. The conference, the fifth in a series which was started by the Commission in 1977, turned out to be the largest international forum for photovoltaics in 1983*. Approximately 500 people attended the conference at which more than 200 oral and poster papers were presented. In addition to the papers, the proceedings include a report of a round table discussion thus making the book an up to date source of reference to present knowledge in the field.

The editors have succeeded in overseeing the production of a very formidable book — no less than some 1200 pages bursting with text, tables, equations, diagrams and photographs. Definitely not a book recommended for serious bedtime reading but, because of the careful arrangement of topics; the use of well defined subject headings and informative, if a little wordy, titles; it is readily possible to take on this encyclopaedia in digestible and rewarding morsels.

For readers with indefatigable appetites and a propensity to insomnia, the full menu offers: 153 pages on *fundamental studies;* 80 pages on *devices and concentration;* 135 pages on *Applications and experience;* 173 pages on *Systems, components and engineering;* 105 pages on *Reliability and monitoring;* 245 pages on *Thin film solar cell technology;* and 224 pages on *Crystalline silicon solar cell technology*.

The fact that certain substances produce an electric current when they are exposed to light has been known since the end of the 19th century. It was just over 30 years ago, however, that the first practical solar cells were developed using single crystals of silicon. The extremely high cost of the early cells restricted their use to providing photovoltaic power for satellite applications in the United States, the first one being in 1958. But photovoltaics as we understand the term today, started in 1973 when the first photovoltaic companies were founded. At present, annual world-wide photovoltaic production stands at some 10 MW with a turnover of about $100 M. Europe's share of the business is put at 20%. 10 years ago, annual production amounted to only 10 kW.

Notwithstanding this rate of progress, it is interesting to note that one of the reasons quoted for progress in photovoltaics being slower than it could have been is that the term 'photovoltaics' is not attractive to people outside the photovoltaic community. But the nub of the problem of failing to achieve greater success is that high cell manufacturing costs coupled with insufficiently high energy conversion efficiences have conspired to bring this about. A reader interested in the innovative energy processes which are being exploited in efforts to achieve an economic breakthrough will find the sections on 'Thin film' and 'Crystalline cell' technologies particularly informative.

This book is authoritative, comprehensive and well put together. It will appeal to readers who wish to familiarise themselves with a relatively new energy subject which will surely grow in importance with the passage of time.

L A N Tozer

Publications received and noted

BP review of world gas, 1986
Copies may be obtained from Miss D Avis, BP Gas International, Britannic House, Moor Lane, London EC2Y 9BU Tel 01-920 3868.

The 1986 almanac of China's foreign economic relations and trade
Asian Oceanic China Services
□

*The proceedings of the *Sixth EC photvoltaic solar energy conference* was reviewed by Dr J C McVeigh in the April issue of *Energy World*

The integrated gasification combined cycle power plant — power from coal with minimum environmental problems — an American view

Arthur L Conn*

Based on a demonstration carried out over a two-year period in a 1000 t/d plant in California, the concept of an integrated gasification/combined cycle (IGCC) power plant has proved to be a leading candidate for future coal-based plants. Results to date have shown that this type of plant can readily meet the most stringent environmental requirements with both low and high-sulphur coals. In addition, new developments in planning and carrying out the various process steps make it likely that this concept will also prove to be one of the most efficient types of power plants that can be built

A review of developments in coal gasification indicates that improvements to the entrained-flow gasifier, as well as demonstrations of the moving bed and fluid bed gasifiers, present several possibilities for an improved design of an IGCC plant.

While sulphur removal and recovery currently require two separate process steps, it may well be possible to effectively carry out these operations in a single step, based on recent development work. Similarly, the concept of hot gas clean-up, also in the development stage, could greatly reduce the amount of heat exchange equipment required and at the same time increase efficiency.

Based on design and development work currently underway on gas turbines, it is anticipated that higher efficiencies can be gained by increasing the turbine inlet temperature from 2000°F to 2300°F or even higher.

It thus appears reasonable to expect that IGCC plants with heat rates of 9000 to 9100 Btu/kWh and efficiencies 10% greater than currently obtained in conventional pulverised coal fired plants can be expected in the future.

Growing interest in protection of the environment has focused much attention, in the United States, on the so-called *Clean coal technologies* — those which permit coal to be burned without polluting the environment. Recently, a major advance in these technologies has been the successful operation of the Cool Water integrated gasification combined cycle plant in California.[1] Not only has this plant demonstrated that pollutants can be reduced to about one-tenth of the most stringent regulations in the US, but it has also pointed the way to potential improvements in power plant efficiency.

Other methods of burning coal in a manner to minimise pollution have been under development for a long time, but tests have not yet demonstrated their ability to meet these stringent regulations that very likely will be applied more widely in the future. For example, improvements have been made in the desulphurisation of flue gas from pulverised coal burning, but the results cannot come close to matching the IGCC performance. Fluidised combustion is another process that is promising, but it, too, cannot match the IGCC performance. Operating this process under pressure with better sulphur removal might ultimately prove to be a possible alternative to IGCC, and funding of a demonstration project in the United States has just been announced by the US Department of Energy (DOE).

Thus, with IGCC having become the 'front runner' in the clean coal technology race, it is the purpose of this paper to present an overview of the technical background for this relatively new development as applied mainly in the United States. Another objective is to examine related developments that should make possible substantial future improvements over the thermal efficiencies currently being realised, while retaining excellent pollution control.

The IGCC process is not a simple development — otherwise it might have been demonstrated a long time ago. It involves continuous, closely coupled operation of several processes operating at high temperatures and relatively high pressures. As indicated in Fig 1, these include continuous coal feeding, coal gasification, high temperature heat removal, ash discharge, particulate removal, sulphur emission control, and operation of a high-temperature gas turbine followed by a conventional steam cycle.

Although improvements in any one of these steps could increase the thermal efficiency of an IGCC plant, those areas in which new developments could have the largest impact are coal gasification, sulphur emission control, heat recovery, gas turbines, and water pollution control.

Coal gasification

Gasification of coal is not new. In fact, long before the discovery of natural gas, town gas was produced from coal by alternately blowing a bed of coal with air and then steam to make a so-called 'producer gas' high in carbon monoxide and hydrogen. When large supplies of natural gas became available in the late 1940's, these coal gasification plants were shut down and the use of coal for making gas was abandoned until the late 1960's, when projections indicated that the demand for gas would soon exceed the supply. As a result, many programmes for obtaining synthetic pipeline gas were started. The processes which ultimately proved most technically acceptable can be grouped into three general categories: moving bed, entrained flow, and fluid bed. A fourth type which has also generated considerable interest involves the use of a rotating kiln.

In general, this discussion is limited to those processes which have been considered for use in combined cycle power plants, or which have been developed to the point where they appear adaptable for possible future use.

Moving bed

The Lurgi process, which employs a moving or 'settled' bed, is the first coal gasification process to have been

*President, Arthur L Conn and Associates, Chicago, Illinois

operated under pressure. Developed in Germany prior to World War II, it has been successfully employed in many locations, is the cornerstone of the three SASOL projects in South Africa[2], and has been employed in the Great Plains plant in North Dakota for producing substitute natural gas[3].

In this process, often referred to as a 'fixed bed' process, the coal, fed to a vertical cylindrical reactor, gradually moves downwards as it is gasified. Oxygen or air is introduced at the bottom to burn a portion of the coal to generate the heat necesary for gasification. Steam, added to generate hydrogen by the water gas reaction, also serves to keep the bed from overheating, permitting the ash to stay below the fusion temperature so that it can be readily withdrawn. The hot gases travelling up the bed serve to gasify the coal, to preheat the incoming coal and also to strip the volatile matter from the coal. In addition to methane and light hydrocarbons, the effluent from the reactor contains heavy hydrocarbons, phenols and tars which are recovered by condensation. The process, however, has several disadvantages. It requires the use of a coal of controlled size, with a high ash fusion temperature to avoid formation of clinkers, while the tars, phenols and other liquid by-products produced require special treatment, thus complicating the system.

In order to overcome these problems, the British Gas Corporation, in conjunction with Lurgi, has improved the process by operating it with oxygen at higher temperatures, thus greatly reducing the liquid by-products and permitting discharge of the ash as a liquid slag. This 'British Gas/Lurgi' slagger[4] has many other advantages, including higher thermal efficiency, much higher specific throughput, lower steam requirement, as well as the ability to utilise coal fines by injection through tuyeres at the bottom of the gasifier, and the ability to recycle tars and liquid by-products to the gasifier, converting them completely to product gas. This development has been demonstrated on reactors of several sizes at Westfield, Scotland, most recently in an 8 ft diameter unit simulating a commercial operation.

As a result of this work, the process was considered sufficiently mature to be employed in a project proposed to the Synthetic Fuels Corporation (SFC) for Virginia Electric Power Co (VEPCO). An important advantage is that the gas leaving the reactor is at a considerably lower temperature than in the Cool Water unit, thus reducing the amount of expensive heat transfer equipment required, while at the same time increasing the thermal efficiency. Although the project was enthusiastically accepted by SFC, regrettably it was one of the victims of the demise of that organisation. Although it is still under consideration by VEPCO and others, future plans are uncertain.

Entrained flow

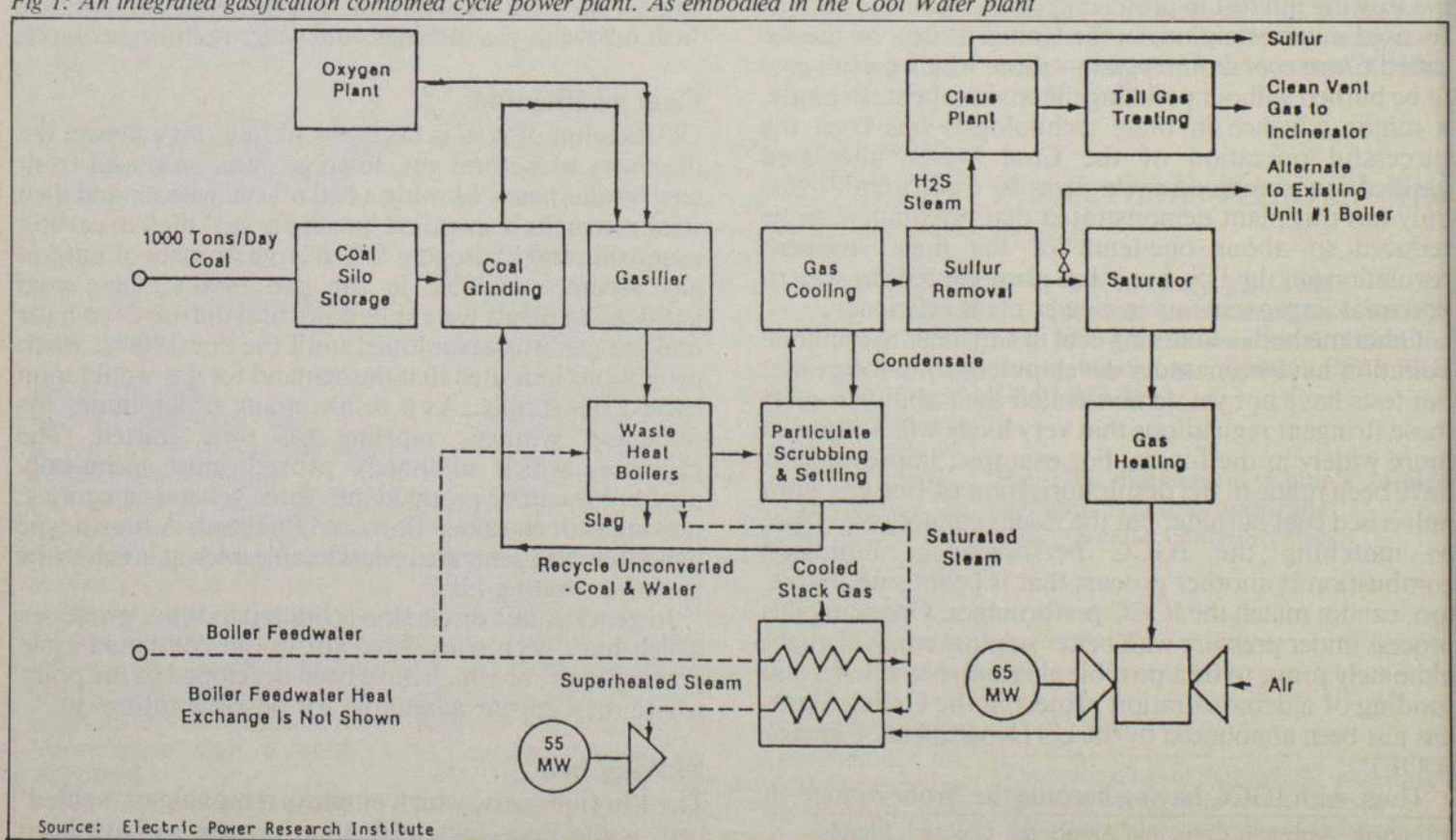
In the entrained flow process, oxygen or air is injected at the top of the reactor where it is mixed with the coal, and temperatures of the order of 2500°F are generated. As a result, the only products are syngas and liquid slag, which, after appropriate cooling, are removed at the bottom. Contact time in this type of reactor is very short.

At the present time, the most successful of the entrained-bed processes operating under pressure is the one developed by Texaco, which had been previously demonstrated in smaller plants of 150-200 t/d capacity at Oberhausen in Germany[5] and at TVA in the United States.[6] In addition to Cool Water, the Texaco process has also been successfully employed in a 900 t/d plant by Tennessee Eastman.[7]

Cooling of the products is accomplished either by means of a radiant cooler in which steam is generated, or by direct quenching with water. Since the radiant cooler is more efficient, it was originally installed at Cool Water, followed by a convective cooler, but a quench-type reactor was also installed as a spare. Both have operated well. In both cases the slag is collected in a water bath, where it forms pebble-type granules which are removed through a lock hopper system for disposal in a lined pit.

Dow Chemical has its own adaptation of the entrained bed process, which is claimed to consist of 'a unique heat recovery system which provides high efficiency on low rank coals.' A 'novel slurry feed technology' and a 'unique technique for continuous slag removal that eliminates high maintenance, problem-prone lockhoppers'

Fig 1: An integrated gasification combined cycle power plant. As embodied in the Cool Water plant



are also claimed.[8] Details are confidential and have not yet been revealed.

A disadvantage of the Texaco process is that feeding the coal as a slurry requires the generation of additional heat in the reactor to vaporise the water; this in turn requires burning more of the carbon, resulting in lower efficiency. Shell, on the other hand, has developed a method of feeding the dry coal as a fluidised solid, which eliminates that difficulty. This has been demonstrated in a 165 t/d pilot plant in West Germany. Dry feeding required the successful development of a highly refined flow measuring and control device to avoid the possibility of an interruption in the coal feed, which could cause an explosion. A larger pilot plant of 250-400 t/d capacity is currently being constructed at Shell's Houston refinery[9] to further demonstrate this process, and completion was anticipated for the autumn of 1986.

Fluidised bed

Fluidised beds have proven to be advantageous for many types of chemical reactions where intimate contact of gases and solids is required. Compared to a fixed bed, a fluid bed permits more precise control of a reaction because of the uniform temperature in the bed, due to mixing. In addition, heat can be readily added or removed because of the excellent heat transfer to adjoining surfaces. Furthermore, there is the possibility of readily adjusting the inventory in the bed by addition or removal of material. The large inventory of material in the bed can serve as a 'flywheel'; thus a short interruption of coal feed poses no safety problems. Finally, fluid beds can be scaled up to extremely large sizes, as has been demonstrated by fluid catalytic cracking and fluid coking in the petroleum industry.

The use of a fluidised bed for coal gasification does present a problem, however, because the high temperatures that are desirable for complete reaction can cause fusion of the ash present in the coal, which in turn can result in the formation of large agglomerates or clinkers which are difficult to handle. This problem has been solved in two different ways. The Winkler process, developed in Germany, is operated in such a way that the ash is maintained below the fusion temperature, while two processes developed in the United States take advantage of the fusion of the ash by carefully controlling the operation to form small agglomerates which can be separated from the major part of the bed.

In the Winkler process, the fluidised bed is maintained in the range of 1300-1500°F, well below the fusion point of the ash. In order to obtain the advantage of higher temperatures and higher carbon conversions, additional oxygen is admitted to the entrained phase existing above the fluid bed, where further gasification occurs at temperatures above 1800°F. Mention has also been made of the use of additives to raise the fusion point of the ash when this had been considered to be necessary.

This so-called 'High Temperature Winkler' process is particularly suitable for the German lignite or 'brown coal', as proven by Rheinische Braunkohlenwerke AG (Rheinbraun) in a 24 t/d pilot plant at Frechen (near Köln), Germany. A 700 t/d demonstration plant is currently being commissioned at Rheinbraun's Ville/Berrenrath refinery.[10] The gas, after appropriate purification, will be piped to another plant for production of methanol.

The two fluidised bed processes developed in the United States are 'U-Gas', by the Institute of Gas Technology, and 'KRW', a process originally developed by Westinghouse, now sponsored by KRW Energy Systems, Inc, a joint effort of the engineering firms of Kellogg and Rust with Westinghouse. Both processes have been demonstrated on a scale of 15 to 25 t/d of coal.

In both U-Gas and KRW, the general principle is the same: gasification is carried out in a fluidised bed, the resulting gases being removed at the top of the reactor, while the ash is removed as agglomerates at the bottom of the bed. The major difference between the two processes is the method of separating the agglomerates from the particles in the bed. In the case of U-Gas, this is accomplished in a high-velocity chamber at the bottom of the reactor, where a jet of gas passes upward at a velocity high enough to strip out all the lighter particles, while the heavier agglomerates move downward where they are withdrawn. In the KRW process, the general principle is the same except that separation of the agglomerates occurs in a dense bed.

Although both processes have been under development for some time, neither has yet been demonstrated on a large scale, principally because of the reductions in programme financing due to falling oil prices. U-Gas was originally to have been demonstrated in a plant by the Memphis Light, Heat and Gas Company in Memphis, Tennessee, and more recently by Charbonnages de France, the French national coal company.[11] Similarly, the KRW process was to have been demonstrated in a combined-cycle power plant in South Africa before those plans were abandoned.

Recently, however, arrangements have been completed with the People's Republic of China to build a KRW gasification plant to supply reducing gas for steel production at the Fularji Heavy Machinery Works in Heilongian Province. Plans are to produce 140 M Btu/h of fuel gas with a heating value of 160 Btu/ft^3 from a lignite feed.[12] In addition, the US Department of Energy has just announced funding of an IGCC plant in Pennsylvania using the KRW process.

Rotating kiln

The concept of a rotating kiln for coal gasification, promoted by Allis-Chalmers, is being tested in a 600 t/d unit located near a plant of the Illinois Power Co, in Alton, Illinois. Advantages claimed for the KILnGAS process are flexibility of operation, ability to realise the economies of scale by building single plants of very large size, ability to handle a wide variety of coals, and the use of air rather than oxygen for gasification.[13] The problems involved in building and operating a rotating kiln at high temperature under pressure appear to have been solved by ingenious mechanical seals and other devices which allow for expansion during heating. An unexpected development, however, has been the formation of large ash agglomerates when operating at high conversion, a problem which is currently under intense study.

Assuming that this problem, together with other minor problems, can be solved, the only potential shortcoming of the KILnGAS process is a likely pressure limitation to about 60 psig. This could reduce the efficiency that can be obtaned in a combined cycle power plant.

Current process selection

Based on the general status at the time of writing, the processes currently in the best position for commercialisation in an IGCC plant are Texaco, Shell and BGC/Lurgi. New developments in the application of other processes, such as the KRW and U-Gas fluid bed, the Dow entrained bed, and KILnGAS, should be monitored.

Sulphur emission control

Sulphur removal

Efficient sulphur removal and recovery constitute one of

Table 1: Sulphur emission control in coal gasification plants

Plant	Location	Coal gasification technology	Feed coal S (wt %)	Coal feed rate (t/d)	Status	Sulphur removal process	Sulphur recovery
Cool Water coal gasification plant	Daggett, CA	Texaco	0.5-3.0	1000	in full operation	Selexol	Claus with Scot
Tennessee Eastman Company	Kingsport, TN	Texaco	NA	900	in full operation	Rectisol	Claus with Scot
Tennessee Valley Authority (TVA)	Muscle Shoals, AL	Texaco	0.4-2.8	225	in full operation (1)	Selexol	Stretford
Great Plains Gasification Associates	Beulah, ND	Lurgi	1.3	14 000	in full operation	Rectisol	Stretford
Shell Oil Company	Deer Park, TX	Shell	0.5-4.0	250-400	complete in late 1986	Sulfinol-M	Claus with Beavon-Stretford
Dow Chemical Company	Placquemine, LA	Entrained Bed	NA	2400	start-up April 1987	Selectramine (MDEA)	Selectox
KILnGAS commercial module	Wood River, IL	KILnGAS (Allis-Chalmers)	3.7	600	performance testing	Stretford	Stretford

Note: (1) Since TVA decided to abandon ammonia production, this unit has been operated to carry out preliminary demonstrations of the Texaco process on various coals.

the most important advantages of IGCC over other types of coal-based power plants. The preferred design of an integrated gasification/combined cycle power plant would employ a method that is carried out at high temperature, thus minimising the need for expensive heat exchangers to reduce heat losses. This has been recognised for years and a number of investigations have been carried out; the current status of this work is reviewed below under 'Hot Gas Clean-up'. Unfortunately, no system has yet been developed to the point where it is considered ready for demonstration plant; hence low temperature scrubbing has been the choice to date.

The decision on which low temperature scrubbing process to use depends on the amount of sulphur in the gas, the efficiency of removal that is required for environmental considerations, the efficiency of concentrating the H_2S for the sulphur recovery process, and a number of other factors. A selection must be made from a bewildering array of processes, of which there are at least three general types: chemical absorption, physical solvents, and dry bed absorption. Furthermore, in each of these processes there are many variations, not to mention a continuing number of new developments and improvements. Summarised descriptions of these processes have been presented periodically[14, 15] and the literature is replete with articles giving details of each process and descriptions of new developments.

In order to focus on those aspects of immediate interest, this presentation concentrates on processes now in operation or currently under active consideration for combined cycle power plants. Included, however, are new developments that look promising for future application.

Table 1 lists information on coal gasification plants currently in operation or being planned in the US, together with the accompanying sulphur removal and sulphur recovery process. For sulphur removal, the first four plants, all currently in operation, are evenly split between Selexol and Rectisol. Both employ physical separation methods in which H_2S is preferentially absorbed from mixtures of H_2S and CO_2. It is not desirable to remove the CO_2, as it adds to the volume handled by the gas turbine, thus increasing the power output.

The Selexol process used at Cool Water and at TVA employs the dimethyl ether of polyethyleneglycol (DMPEG) as the absorbent. Operating at 10-20°F, this process selectively removes the H_2S while leaving a substantial part of the CO_2 in the gas. The Rectisol process, used at Great Plains, and also by Tennessee Eastman, employs methanol at temperatures of about −22°F. This process can reduce sulphur below 1 ppm, which is necessary for some catalytic processes, but not for a combined cycle power plant. It goes beyond the most stringent requirements of a power plant, and would not be used because of the expensive refrigeration requirements. The TVA plant was originally designed to catalytically produce ammonia, while the Tennessee Eastman plant uses a catalytic process to produce methanol.

More recently, chemical solvent processes have been developed which show promise for still better H_2S selectivity, particularly in situations where simultaneous removal of CO_2 is not desired. Two general types are those using alkanol amines for H_2S absorption and those based on alkaline salts. Of the former, methanol diethanol amine (MDEA) is being licensed by various companies, including Dow Chemical, Shell Oil, and Union Carbide. It is claimed to be less costly because of smaller size equipment and lower utility requirements.[16] At the same time, Exxon had improved the Benfield hot potassium carbonate process by the addition of a hindered amine. Exxon's process is claimed to be superior to MDEA, based on tests made at their Baton Rouge refinery.[17]

Still another variation is a process developed by Shell Development called Sulfinol, which uses a physical solvent — sulpholane (tetrahydrothiophene dioxide) — together with an amine, di-iso-propylamine (DIPA), to accomplish chemical absorption.[18]

The Stretford process is appealing because it removes the H_2S and converts it to free sulphur, all in one step. The process employs an aqueous solution containing sodium carbonate, sodium vanadate, and anthraquinone disulphonic acid. It has the advantage that at low pressures the solution reaches an equilibrium with respect to the CO_2 in the gas, and only relatively small amounts of CO_2 are removed.

A number of problems have been encountered with Stretford, however, one of which is that it cannot be used on the higher-pressure processes required for a combined cycle operation, because absorption of the CO_2 causes weakening of the solution and formation of thiosulphates. Another is that the vanadium salts used are toxic, and the need to periodically dispose of spent solution presents a hazardous waste problem.

For some time three processes have been in use for

effluent clean-up.[22] They are SCOT (Shell Claus Off-gas Treating), BSR (Beavon Sulphur Removal) and Ultra (Amoco's low temperature reaction/adsorption process). Although differing in some details, all of these processes employ a catalytic reducing step to convert to H_2S all of the sulphur-containing impurities in the gas from the Claus unit.

In the SCOT process, a scrubber similar to that used on the gasifier effluent is generally preferred, so that the spent solution from both scrubbers can use the same regeneration facilities.

In earlier installations, BSR used a Stretford unit to recover the sulphur, but more recently the SELECTOX process developed by Union Oil has been used.

At Great Plains, at least two problems have been encountered.[19] First, the original equipment, consisting of a venturi scrubber followed by a packed column, was undersized and required design changes. Second, there has been an odour problem. This is attributed to the nature of the lignite feed, which is very reactive, making it possible to gasify at fairly low temperatures. As a result the process generates a number of low-boiling organic sulphur compounds which decompose into mercaptans and disulphides on oxidation, creating odours which have presented a severe environmental problem.

A process developed more recently which also removes H_2S and converts it to free sulphur is called 'LO-CAT'. It uses a chelated iron catalyst which is non-toxic and can be operated at higher CO_2 pressures than Stretford without difficulty.[20] The iron catalyst. however, causes corrosion and erosion of carbon steel, so it has been necessary to use stainless-steel or plastic-lined equipment. Indications are that this process might replace Stretford, and demonstrations are currently in progress.

Hot gas clean-up

In addition to improving the efficiency of heat usage, hot gas clean-up can potentially simplify an IGCC plant by eliminating heat exchange equipment as well as wet scrubbing processes which generate streams of water requiring treatment before disposal.

In a research and development programme sponsored by the DOE, tests on hot gas clean-up are being carried out in KRW's gasification system at Waltz Mill, Pennsylvania.[21] These involve passing the raw gas through a fixed bed of zinc ferrite which collects particulates and selectively removes hydrogen sulphide. The attractiveness of this approach, when used in connection with a fluid bed gasifier, is enhanced by the use of dolomite or limestone in the fluid bed gasifier for removal of a large portion of the H_2S. With a feedstock containing 4.5% sulphur, KRW reports 92% sulphur removal in the fluid bed with a ration of calcium to sulphur of 1.5:1. Interestingly, sulphur removal is much better than in fluidised combustion because in the reducing atmosphere, the H_2S reacts readily with the calcium to form the sulphide. In the oxidising atmosphere of fluidised combustion, however, the sulphur is converted to SO_2, which reacts much more slowly with the calcium.

Since such a large part of the sulphur removal can be accomplished in the fluid bed, DOE and KRW are optimistic that successful clean-up by the zinc ferrite may not be too difficult. In addition, the DOE is carrying out research on various combination of FeO and ZnO to define an optimum mix for both reaction and regeneration.

As in all processes for efficiency improvement, this one also has its disadvantages. One cannot safely dispose of the calcium sulphide removed from the fluid bed without first oxidising it to the sulphate. This requires a second fluidised bed together with means for handling the offgases.

Sulphur recovery

For many years, recovery of the sulphur removed by wet gas scrubbing has been carried out using the classic Claus process, in which a portion of the H_2S is burned to SO_2, after which the H_2S and SO_2 are catalytically reacted to yield free sulphur and water, both as vapours. While the burning of the H_2S is a fast reaction, taking place in a high temperature furnace-type reactor, the reaction of H_2S and SO_2 is relatively slow and requires several stages of catalytic reactors. The vapours leaving each reactor are cooled to condense and remove sulphur and are then reheated prior to entering the next reactor.

Since sulphur recovery in a Claus plant normally does not exceed 98%, and the effluent from the final stage also contains a number of impurities (S, COS, and CS_2), the material must be disposed of by incineration, or by further treatment. As environmental requirements have become more stringent, it has been necessary to provide additional facilities for clean-up of this effluent.

Amoco's Ultra process[23] employs an entirely different concept for final sulphur clean-up. It uses an additional Claus converter operating at a temperature below the sulphur dew point to shift reaction equilibrium and thus increase conversion of the H_2S. The elemental sulphur that is produced is adsorbed on the catalyst, which is periodically regenerated to remove the sulphur and thus ensure continued activity. The efficiency of sulphur removal is satisfactory for application in oil fields and other locations where pollution control requirements are not as stringent as for power plants. For most power plants in the US, however, efficiencies comparable to those for SCOT, BSR or Selectox will likely be necessary. Recently, still more efficient processes have appeared, such as 'Sulften,' developed by Union Carbide (which uses special highly concentrated amine solvents); they can reduce sulphur in the exit gas to less than 5 ppm.[24]

Heat recovery equipment

An important factor in maximising the efficiency of an IGCC plant is the use of efficient heat recovery equipment. This is particularly important if low temperature scrubbing is used for sulphur removal. As previously indicated, the Cool Water plant employs a radiant cooler on the hot syngas leaving the gasifier, followed by a convection cooler. In both coolers, 1600 psig steam is generated. After sulphur removal, the gas is passed through a reheat-resaturator to supply the humidity necessary for control of nitrogen oxides in the high temperature gas turbines. The gas then passes through a series of heat exchangers to maximise heat recovery prior to entering the gas turbine.

The hot exhaust from the gas turbine passes through a 'heat recovery steam generator' which raises 1600 psig steam and also superheats it together with the steam from the syngas coolers. The superheated steam is sent to a steam turbine which drives a second electric generator — hence the name 'combined cycle'.

Gas turbines

The use of a gas turbine to drive an electric generator in a combined cycle power plant is not new; in fact, these machines, often referred to as combustion turbines, have been operated with liquid as well as gaseous fuels for many years in the US and elsewhere to handle peak loads in

power plants. As a result of the energy crises in the 1970's, the US government enacted the *Power plant and industrial fuel use act* in 1978, which greatly restricted the use of natural gas or oil for power generation, forcing many utilities in the US to switch back to coal. Recently, however, with lower prices and increased availability of oil and gas, variances have been granted to permit the use of these fuels, particularly in situations using a phased approach, where the turbine is installed first, to be followed by coal gasification at a later date.

For many years, the major use of combustion turbines has been for aircraft propulsion, and much work has been sponsored by the military to improve their operating characteristics for jet engines. Manufacturers have then incorporated these improvements in turbines designed for power plant use. Since the efficiency of a gas turbine increases as the inlet gas temperature is increased, more advanced materials and better designs have been developed to permit turbines to operate at temperatures higher than 2000°F, the present maximum. It is anticipated that the next-generation models will be available for operation at 2200°F or even 2300°F in the relatively near future. Looking further ahead, one can expect further improvements that will be reflected in still more efficient power plants.

In the case of the Cool Water installation, the use of a turbine originally designed for natural gas required a number of changes and special provisions for handling the highly flammable medium-Btu syngas.[25] These included provisions for safety, environmental control and assurance of continuous operation with the expected variation in syngas production rate. To reduce the probability of an explosion during a start-up or shut-down, dual fuel capability was provided so that oil could be used during these transient operations. This eliminated the possibility of potentially dangerous accumulations of a combustible mixture of air and fuel gas if the turbine failed to fire during a start-up, or if the fuel gas valve failed to close completely during a shut-down.

Environmental restrictions require operating a gas turbine in such a way as to suppress the formation of nitrogen oxides. This is most readily accomplished by diluting the gas with steam to limit the flame temperature during combustion. At Cool Water, the steam is added by saturating the gas as it is heated prior to being introduced into the turbine. Equipment for steam injection has also been provided to take care of a situation in which moisture content of the gas leaving the saturator is not sufficiently high. In addition, a special design of the fuel nozzle was required because of the variable syngas rate expected, and special nozzles were required for dual fuel capability. Full-scale tests were conducted by the manufacturer prior to installation to prove out all of these features and to demonstrate smoke-free operation.

Environmental aspects

During the past two decades in the US, environmental control has grown to have the largest single impact on the cost technology of coal-fired power plants. Of the types of power plants used thus far, the integrated coal gasification combined cycle (IGCC) power plant has shown the greatest potential for meeting the current stringent environmental standards.

Although much attention has been focused on gaseous effluents because of problems caused by acid rain, aqueous and solid effluents have also caused concern. The sources of all three types of effluents from a typical IGCC plant are illustrated in Fig 2.

As previously mentioned, excellent control of gaseous effluents has been achieved at the Cool Water plant. This is illustrated in Table 2.[26] Subsequent tests on coals of considerably higher sulphur content have also shown effluent SO_2 contents well below the US new source performance standard of 0.6 to 1.2 lb/10^6 Btu for these coals. With Illinois No 6 coal (3.1% sulphur), SO_2 emission from Cool Water has been 0.076 lb/10^6 Btu, while the figure for Pittsburgh No 8 coal (2.9% sulphur) has been 0.086 lb/10^6 Btu.

The low nitrogen oxide content of the gaseous effluent

Fig 2: Sources of waste streams from an IGCC plant

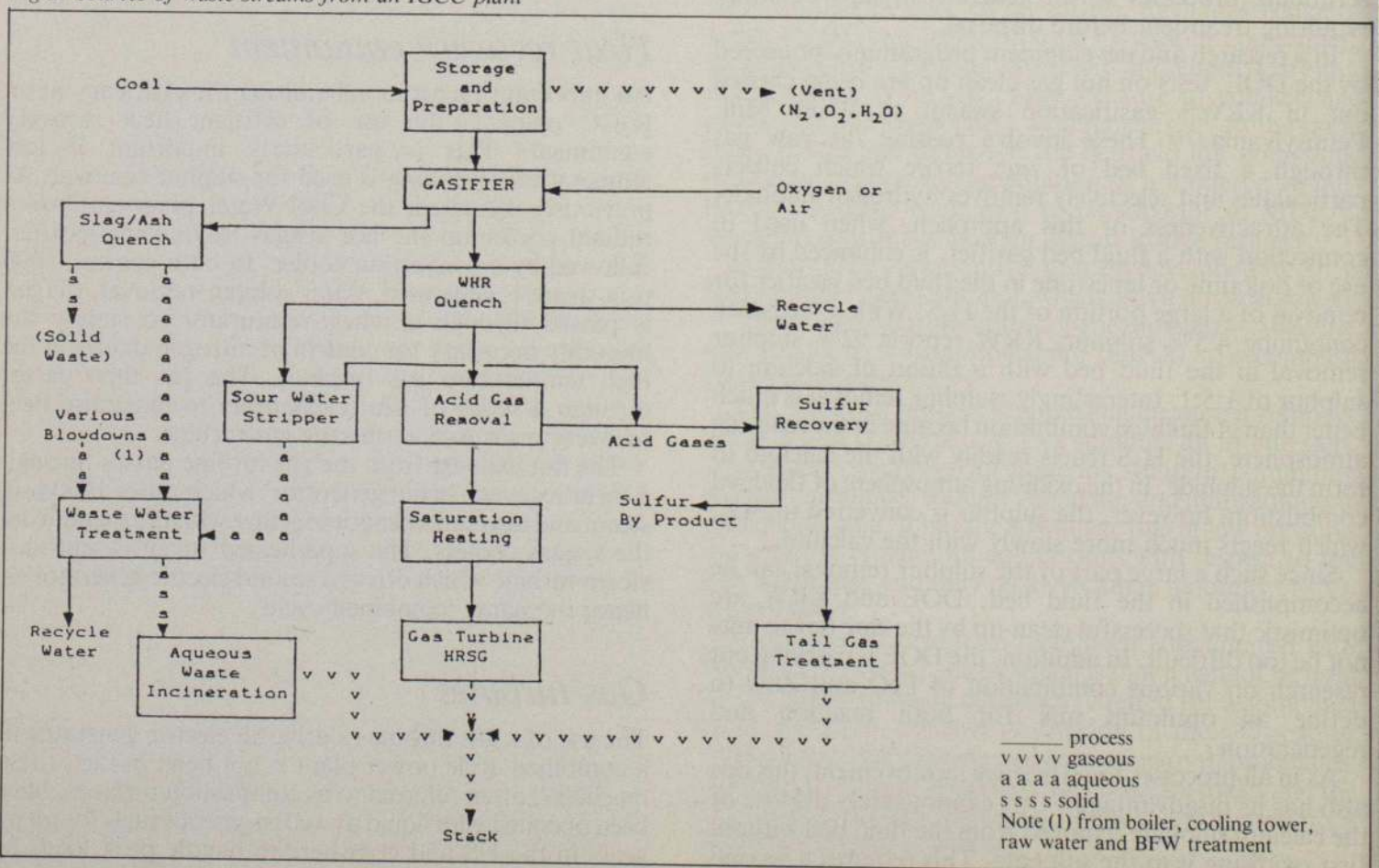


Table 2: Cool Water air pollutant emissions (lb/million Btu)

Pollutant	Coal feed % S	Permit and reg limits (1)	Test results to date	Federal NSPS (2)
SO2	0.4	0.033	0.018	0.24 (3)
	3.1	0.16	0.076	0.6 (4)
	2.9	0.16	0.086	0.6 (4)
NOx	0.4	0.13	0.07	0.6
	3.1	0.13	0.094	0.6
	2.9	0.13	0.09	0.6
CO	0.4	0.07	0.004	NS (5)
	3.1	0.07	0.004	NS
	2.9	0.07	0.004	NS
Particulates	3.0	0.01	0.009	0.03

(1) Limitation imposed by San Bernardino County.
(2) New source performance standards for a coal-fired power plant burning the same coal as Cool Water.
(3) Controlled emission held to 30% of the 0.8 lb/bnBtu standard for uncontrolled emissions.
(4) Emissions controlled to 0.6 lb/bnBtu.
(5) NS: No standard.

is the result of moisture addition to the high temperature gas turbines, as mentioned before. Particulate emissions at Cool Water have been controlled by careful attention to dust abatement during all stages of the operation. The coal is sprayed with dust suppressant during rail transport and is received and handled in enclosed equipment. Dust abatement equipment is provided at all points up to the slurry tanks, including belt conveyors, crushing, and grinding and weighing equipment. Particulates in the raw gas are removed in a carbon scrubber.

The aqueous effluent from the Cool Water facility comprises a relatively small amount of process water blow-down, which is first treated in a sour water stripper and routed to an existing lined evaporation pond at the site.

Solids from the plant include the elemental sulphur recovered in the Claus unit and slag from the gasifier. The purity of the sulphur has been consistently 99%; it is therefore being sold under annual contract. The slag has been determined to be non-hazardous by the California Department of Health Services and efforts are being made by participants in the programme to sell the slag for such uses as paving filler, abrasives, and insulation.

In the case of other IGCC plants of different design, the standards that can be met will depend on the specific processes employed. Entrained bed gasifiers (such as Texaco and Shell, operating at over 2200°F) produce a virtually tar- and phenol-free raw gas. In the case of fluid bed gasifiers, operating at somewhat lower temperatures, small amounts of phenols have been found in the exit gas; however, it is likely that these can be destroyed by increasing the temperature in the entrained phase above the bed. In the Lurgi dry bottom gasifier, the raw gas, leaving at a temperature considerably below 2000°F, presents a more difficult problem because of the presence of tars as well as phenols. The BGC/Lurgi slagging gasifier, on the other hand, operates at considerably higher temperatures than the Lurgi dry bottom, but the presence of phenols in the gas has been reported. The same is true for KILnGAS. Although tars would be destroyed in these gasifiers, significant quantities of phenols might survive.

Particulate control for gasification systems using a dry feed, including Lurgi, Shell, KILnGAS, KRW and U-Gas, will be more difficult than at Cool Water because the feed systems use lock hoppers and fluidised transport. On the gasifier outlet, cyclones are routinely used, and the Cool Water plant uses a carbon filter prior to wet gas clean-up. In the hot gas clean-up system under development by KRW and the DOE, ceramic filters are being investigated for particulate removal.

Disposal of aqueous effluents from other types of plants could also pose problems not encountered under the Cool Water desert conditions. Where possible, designs of most new plants are pointed toward 'zero discharge', in which no waste water streams are discharged. At Great Plains, for example, the plant effluent is sent to cooling towers, where it has been found that biological oxidation occurs simultaneously with evaporation. With conditions maintained for proper control, the result is that there is no net stream for disposal, and zero discharge is being realised.[19]

Possible future improvements

In the past, there has been a strong tendency to build large increments of power plant capacity to realise the economies of scale and also to counter the effects of inflation. This has been particularly effective during periods of constant growth in demand accompanied by high rates of inflation. Recent experience, however, has indicated that such a policy can be expensive when demand growth is uncertain and inflation rates are low. Accordingly, the concept of phased capacity addition is receiving considerable attention. This is a plan in which the design of a large plant is prepared, but small capacity increments consistent with the overall design are added only as needed. This can be accomplished in a number of ways. For example, the first increment can be to install one of the advanced gas turbines that will ultimately be required and to operate it on either natural gas or distillate oil. Additional capacity can be added in several steps. One would be to install part of the ultimate heat recovery and steam cycle. The next increment could be a second gas turbine operated on gas or distillate fuel. Only when it is necessary to reach the capacity of the final plant would it be necessary to install the coal gasification sections and all of the heat recovery equipment. The flexibility of adding plant capacity in this phased approach provides both added financial and capacity-management benefits for the utility.

The IGCC power plant, as demonstrated at Cool Water, is believed to be the world's cleanest coal-fired plant, as it readily meets the State of California's most stringent environmental standards. However, the demonstrated heat rate, ranging from 11 300 to 12 000 Btu/kWh for various coals, leaves considerable room for improvement in efficiency. Accordingly, it has been estimated that in a newly designed 500 MW commercial plant, the heat rate can be reduced to 9100 Btu/kWh by employing the near-term design and operating improvements shown in Table 3.[27] These are based on detailed studies by Fluor Engineers Inc, sponsored by EPRI, and participated in by Texaco Inc and the General Electric Company, who were intimately involved in the design and operation of the Cool Water plant. Included are a reheat steam turbine and other improved technologies which were not part of the original Cool Water design. These do not include longer range improvements that can be expected, but have not yet been fully demonstrated.

Considering first the gasification step, the Shell process, which operates on a dry feed, is expected to be somewhat more efficient than the Texaco process used at Cool Water because it does not have to generate the heat to evaporate the water from a slurry feed. For this reason it is being considered as an alternative in some of the designs currently being made. The British Gas/Lurgi slagger is

also being considered as an alternative to the Texaco process. In this case, the countercurrent operation makes more efficient use of the heat that is generated, with the result that the outlet gas is at a considerably lower temperature than for either Shell or Texaco. Thus, much less expensive heat exchange equipment is required. On the other hand, the lower temperature of the outlet gas prevents destruction of the phenols, which will then appear in the aqueous stream from the wet scrubber, requiring additional treatment.

Table 3: Heat rate reconciliation: Cool Water vs *commercial plant*

Cool Water design heat rate (Btu/kWh)	11 350
Adjustments/improvements for commercial plant	
• Reheat steam cycle	(400)
• 65% slurry concentration versus 60%, 60°F ambient temperature versus 80°F	(450)
• 95% O_2 purity versus 99.5%, increased fuel gas pre-heat	(500)
• 500 MW plant size versus 100 MW	(400)
• Advanced gas turbine (2200°F firing temperature versus 1985°F)	(500)
Estimated commercial plant heat rate (Btu/kWh)	9 100

Source: Electric Power Research Institute

The use of a fluid-bed gasifier would carry with it the advantages of better control, improved heat transfer and elimination of the safety problems posed by an interruption in coal feed. It would also permit the removal of sulphur during the gasification step by the addition of dolomite or limestone, reducing the load on the sulphur removal and sulphur recovery units. Whether or not this would be desirable is not certain; although it would reduce the amount of sulphur to be recovered, it would also present a waste disposal problem.

The heat recovery system is the next large item of the equipment to be examined. While minor changes in the present scheme can be anticipated to make small improvements, the greatest improvement might be realised if hot gas clean-up, which is currently in the research and development stage, can be satisfactorily demonstrated.

Sulphur removal and recovery is an aspect which is still receiving much research and development attention. If current work on an improved method of combining sulphur removal and sulphur recovery in a single step can be adequately demonstrated, this could reduce the amount of equipment required.

As has already been pointed out, the efficiency of a gas turbine depends on the turbine inlet temperature. Therefore, an increase in this allowable temperature beyond the 2200°F maximum now anticipated, which depends on development of new materials and new methods of designing gas turbines, could still further improve the efficiency of the IGCC plant.

As far as environmental aspects are concerned, improvements in sulphur removal and recovery reduce the costs of air pollution control. Much work is being carried out on water pollution control and the use of anaerobic digestion, which not only cleans up the water but also can generate gas which can be burned in the power plant, can increase efficiency and also reduce problems of waste disposal.

Solid waste management is currently receiving much attention and it is reasonable to expect that some improvements may also be realised.

In summary, there are a number of ways in which the efficiency of an IGCC plant can be improved. Thus, in addition to being the environmentally best choice for power production from coal, it can also be expected to be the most efficient method.

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(continued on p 15)

How to tackle an £800 M energy bill*

John Bratley MA MSc CEng MInstE†

Local authorities in England and Wales spend about £800 M every year on their non-domestic buildings, providing heating, lighting and power to schools, offices, leisure centres and elderly persons homes and many other types of buildings. A study† into local authority energy management was carried out for the Audit Commission and the Energy Efficiency Office which culminated in the report *Saving energy in local government buildings* published in November 1985.

The main finding from the study is that savings of £135 M a year are possible without adversely affecting the comfort of building users or the standards of service offered to the public. These savings can be achieved if all authorities adopt a more organised approach to the implementation of energy efficiency measures, a more effective, systematic approach to managing energy and improve their management information systems.

This article describes the approach adopted in tackling such a large energy bill, the key issues to come out of the study and the benefits of such an approach

Approaching the study

With over 450 local authorities in England and Wales ranging from large county councils, through metropolitan districts and London boroughs to small rural districts it was necessary to select a representative sample of authorities for the study. In total 30 authorities were studied with 18 in depth. These 18 authorities were chosen as being amongst those that had addressed the subject of energy and had made significant improvements to the energy efficiency of their building stock.

An extensive series of interviews was conducted with key officers being interviewed in each authority to establish the authority's management structure and the various ways in which they approached the management of their energy. These interviews with people from the chief executive to the building managers enabled the common key elements to be determined and an overall best practice approach to be established.

Additionally data was collected on the energy performance of typical local authority buildings to produce performance indicators that would enable meaningful comparison between similar use buildings and between authorities. Annual energy consumption and cost figures were collected for over 3000 buildings from the 30 local authorities in the study, a major task in itself (Fig 1). The basic steps of the analysis were to:

- ☐ categorise buildings by similar use ie primary school, office over 2000 m², elderly persons home, etc;
- ☐ normalise the basic consumption data to take into account the variation in the severity of the weather between different years and different parts of the country, the exposure of the building and the hours of use of each building;
- ☐ calculate the normalised performance indicators (NPI) in the form kWh/m²pa;
- ☐ analyse the range in performance for each category of buildings to establish realistic yardsticks of efficient operation for each category.

Key issues arising

The key issues to emerge from the study can be divided into the qualitative features of effective energy management and the quantitative aspects of the performance indicator approach. There were found to be seven key elements to effective management of energy by local authorities. These were:

- ☐ commitment to effective energy management by members, chief officers and building users with a single committee responsible for energy;
- ☐ an energy policy statement to define the objectives and methods of achieving them. This coupled with an annual energy report to committee summarising progress savings achieved and forward programme ensures that everyone within the authority is aware of what the authority is aiming for and how well they are doing;
- ☐ financial investment in energy efficiency measures. This investment needs to be regular and in the order of 10% of the annual energy spend. Realistic selection criteria should be used. For example, measures with simple paybacks of up to six years should be considered, as they represent very worthwhile investments;
- ☐ manpower resources devoted to managing energy with a yardstick of one man year per £1 M energy spend. In the larger authorities this will mean an energy management unit of several people, whereas in a small authority energy would be the part-time responsibility of a single officer. The primary functions are to monitor and target energy consumption and expenditure, control the investment programme and monitor and report progress;
- ☐ effective purchasing and tariff analysis of fuels. This includes the regular checking of electricity tariffs, the

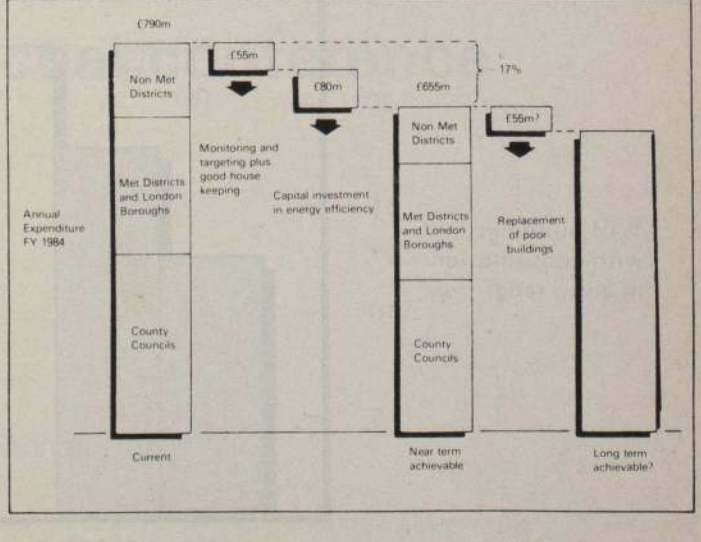

Fig 1: Annual energy costs in non-domestic buildings operated by local authorities in England and Wales

Illustrations reproduced from *Saving Energy in Government Buildings* Audit Commission 1985.

*The article first appeared in the June 1986 issue of *Energy in Buildings*

†P A Management Consultants

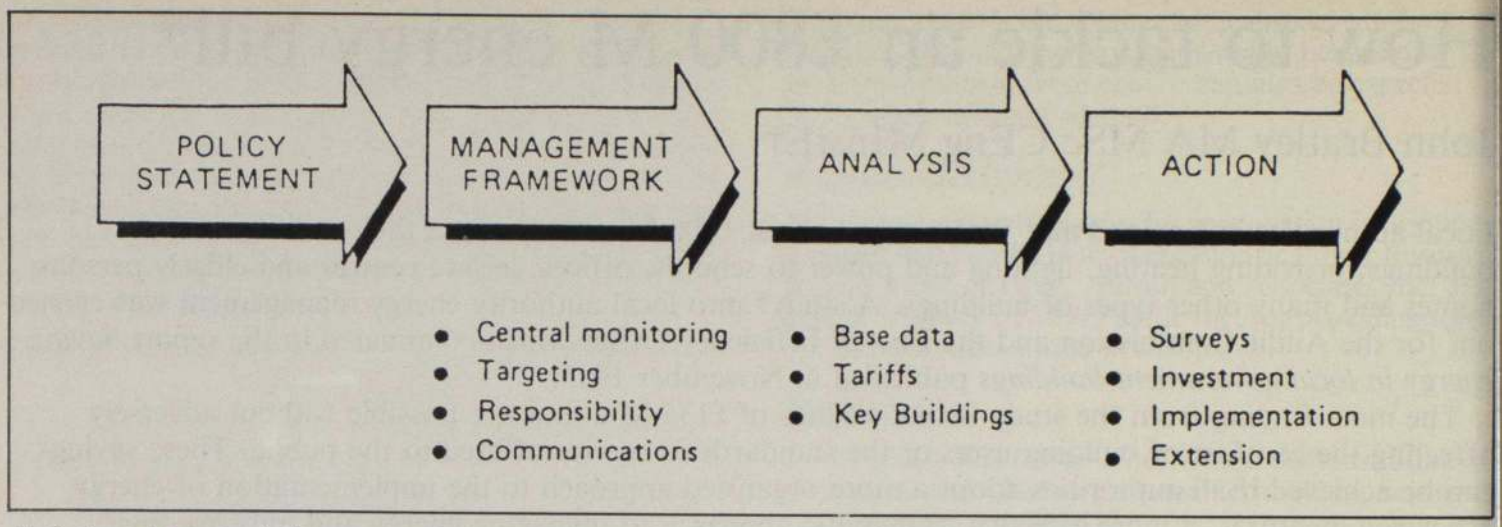

Fig 2: A model approach for energy conservation

coordination of fuel purchasing to ensure that advantageous prices are obtained, and the regular practice of carrying out spot checks on liquid and solid fuel supplies to ensure that the quantity and quality of product delivered is correct;

- creating the right organisational climate. This aspect includes the need to motivate key groups of people within the authority through training and financial incentives.
- management information systems to provide the basic information from which energy management decisions can be made. The main requirements are that energy consumption and expenditure are both monitored and targeted with a very structured approach to both data collection and analysis.

From the quantitative, performance indicator side of the study the following points emerge.

When dealing with a total energy bill and data collection exercise of this size it is important to remember the simple principle that a relatively small number of buildings in each authority account for the bulk of the energy spent. In practice it was found that the top 20% (by number) of each authority's buildings account for between 45-70% of the energy spend. These are the buildings to concentrate on.

The reason for producing the performance indicators must be borne in mind the whole time they are being developed. They must be appropriate, easy to use, not over complicated, use minimum input information and produce maximum useful output. For example, in this study the objective was to produce a means of realistically comparing the energy efficiency of local authority buildings, highlighting buildings requiring priority attention and quantifying efficiency improvements for individual buildings, departments and whole authorities. The performance indicators certainly fulfil this objective but cannot be taken as site-specific targets for individual buildings.

Achievements of the study

The primary benefits of the study are as follows:

- a realistic savings potential has been identified and quantified;
- a model approach has been put forward for the individual local authorities to use to enable them to make improvements Fig 2;
- existing local authority efforts are enhanced by making sure that current best practice is circulated and 'wheels are not reinvented' — many examples of current good practice have been included in the report;
- a robust method of comparing the performance of local authority buildings of similar use has been developed

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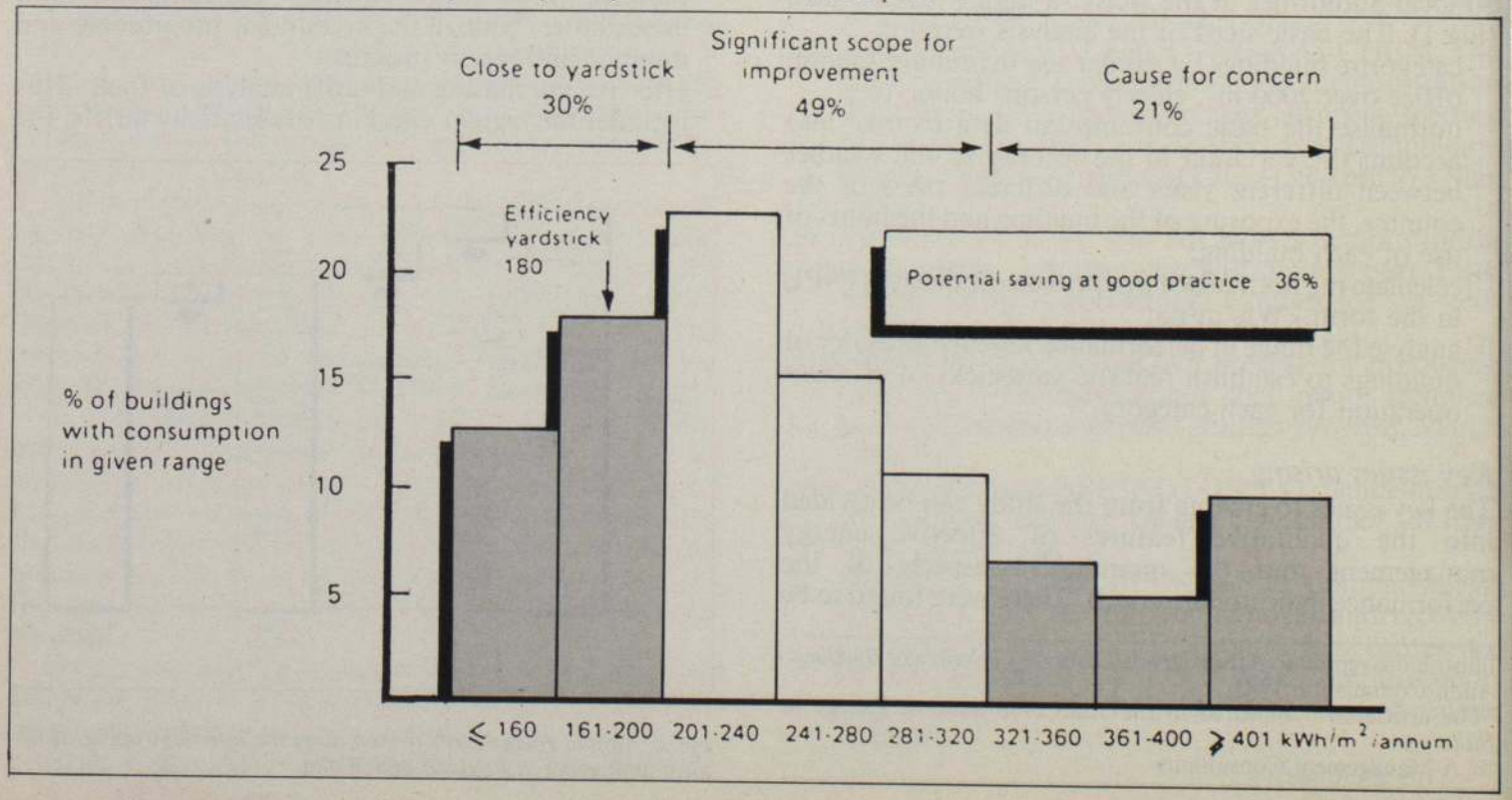
Fig 3: Annual normalised energy consumption in primary schools with no indoor pool



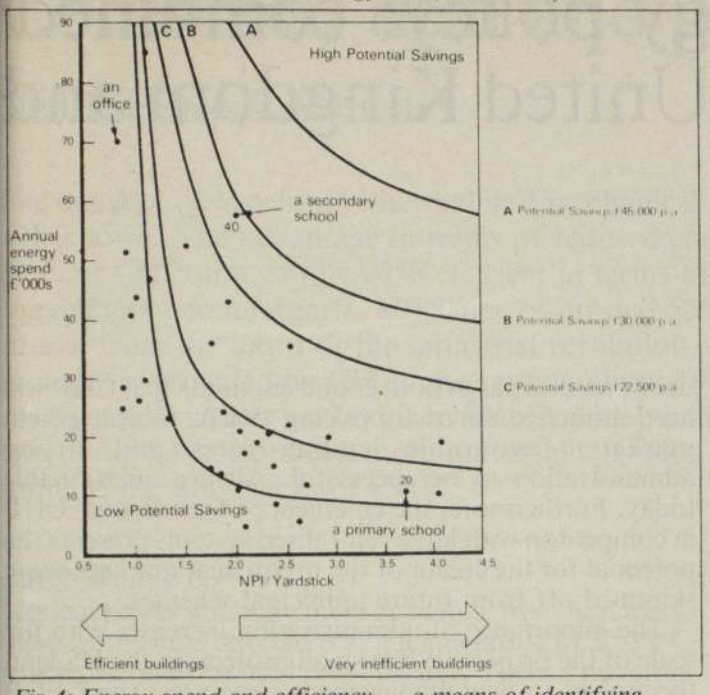


Fig 4: Energy spend and efficiency — a means of identifying buildings with a high potential for energy savings

and tested. In Fig 3 the national distribution of performance is shown for primary schools. By comparing other primary schools to the efficiency yardstick (180 kWh/M²a) it can be seen whether these buildings are efficient, there is significant scope for improvement or there is cause for concern;

- a method has been devised of highlighting buildings requiring priority attention due to their high potential savings. This is illustrated in Fig 4. Each point on the plot represents the performance of a particular building. The position of the point is determined by the annual energy expenditure of the building (*y* axis) and the ratio of the NPI of the building to the efficiency yardstick for the category of building (*x* axis). Lines of potential savings are plotted and immediately the buildings with various levels of potential savings are defined. In a multi-premise situation, such as large local authorities, highlighting buildings for priority attention is very useful particularly when it is important that limited resources are used to maximum effect.

Power from coal with minimum environmental problems — an American view (continued)

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Anglo-American energy policy: combined heat and power in the United Kingdom and the United States

Prof John E Mogk*

Conventional heat engines, generating electricity have an overall thermal efficiency of approximately 35%. A well designed combined heat and power (CHP) plant will produce both electricity and heat at a total thermal efficiency of at least 70%. Not only is the fuel requirement halved, but attendant noxious by-products are also halved, to the substantial benefit of the public at large. This fact encourages a vocal group of advocates to actively promote CHP, in the UK and the US, as an important undeveloped energy resource, particularly for the municipal and institutional sectors. The campaigns in the two countries are markedly different however. A boom or bust mentality prevails in Britain, focused exclusively on the development of large municipal CHP 'lead cities' schemes. Six urban areas are under study: Belfast, Edinburgh, Leicester, Sheffield, Newcastle and London, with the first three receiving Government support. In America activity is centred on district heating systems (frequently heat only), spread over a range of types and sizes, with CHP viewed as a potentially attractive option.

The energy contribution of municipal CHP, as distinct from heat only district heating systems, is of no consequence today in either the UK or US. CHP in the industrial sector provides significant amounts of electricity and heat to several heavy energy consuming industries, making a contribution in the estimated range of 3% to overall power generation in each country.

Although opportunities for expansion are seen as limited, industrial CHP may experience greater growth than municipal CHP, if the scale of the British lead cities programme proves unmanageable and CHP is overlooked too often in designing US heating schemes. Its future rests principally in the hands of private industry which has become increasingly energy cost conscious. The revamping of American and British industry with new facilities and technologies to maintain world industrial leadership can be expected to include, in the larger installations, efficient energy systems, as well.

CHP technology is well established and improving, but its use has been stagnated for decades. The major obstacles to municipal CHP in both countries are identical: Competition from gas, electricity pricing, market penetration, financing and administration. Only the first two factors play a particularly significant role in impeding the development of industrial CHP.

The Government's position on CHP in the UK is viewed as neutral on an international level. PURPA in the US and the comparable British Energy Act of 1983 attempt to ensure fair pricing of electricity for the CHP operator. Nonetheless tariffs governing the purchase and sale of power by the CHP operator remain a matter of major contention. In addition, the UK electricity industry has the legislative duty to 'adopt and support' CHP schemes, but has done very little to date. In the US, Federal programmes which are under cutting budget pressure provide limited financial assistance and incentives for CHP projects.

Facing strong competition from the customers' direct use of natural gas in both countries, municipal CHP will need attractive electricity pricing tariffs, receptive heat markets, favourable lending rates and strong administration to be successful. All are questionable today. Furthermore, the emergence of small scale CHP in competiton with large centralised systems presents the potential for the cream of the urban heat markets being skimmed off from future municipal schemes.

The importance of administration increases with the scale of the project. While small projects in the US lend themselves to new management structures, the CEGB appears to be the only established organisation in the UK with the experience, resources and potential willingness to successfully shepherd an ambitious lead city scheme to completion. Its reluctance to be a driving force in municipal CHP may spell defeat for the programme. The Board's historical apathy could be altered by a change in Government or adoption of a policy which welcomes CHP and decentralised power generation as a complement to its nuclear agenda.

It is unlikely that the US electricity industry will voluntarily 'adopt and support' CHP schemes, as the UK industry is required to do under the 1983 Energy Act. The trend has been in the opposite direction, with the industry attempting to close or dispose of old district heating networks to non-profit operators. Furthermore, the nuclear option is viewed as dead in the US for the foreseeable future, depriving CHP of serving as a conventional complement to a nuclear development strategy. Political support is unlikely to grow in the US as well. Neither major party appears to be particularly interested in municipal CHP as the Labour Party, the Liberals and the SDP are in the UK, and what public interest exists is gained from being associated with other agendas — district heating, industrial CHP and renewable energy technologies.

The UK has the basis for grand strategy which could make it a world leader in municipal CHP early in the 21st century. Success will depend upon extraordinary administration and good fortune. The diffuse nature of the US activity, on the other hand, can mean only measured growth, at best. The two countries are embarked upon entirely different courses. If CHP development were a race, it could be viewed as a contest between the American tortoise and the British hare. □

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Combined heat and power — small is better

Neil F Peacock MInstE*

The concept of generating thermal and mechanical energy simultaneously as part of the same process is well known. The advantage in terms of reduced energy consumption can be very clearly identified — a modern CHP unit can be 90% efficient in terms of primary energy compared to its combined conventional counterparts, efficiency of around 55%. In some manner or form CHP has been practised almost from the dawn of the industrial revolution. At present some 6% of the total UK generation capacity is provided by CHP representing about 1900 MW of installed capacity. If such an effective energy conservation method is available, with equally attractive economic benefits, as will be shown later, why has it not been more universally applied? To answer this question it is necessary to analyse some of the drawbacks of CHP

Large scale CHP

Modern power stations tend to be remote from heat users. Most of the heat rejected is at a temperature of 30-35°C which can rarely be used economically. There is therefore no great potential for CHP systems based on existing power stations.

Purpose built large scale (>10MWe) schemes also face a number of stumbling blocks:

- ☐ *Finance:* the considerable infrastructure usually required by these schemes normally results in paybacks which adversely effect investment decisions.
- ☐ *Administration:* CHP schemes often involve a multiplicity of end users, as in district heating schemes. Gaining agreement on pricing and metering and also administering the sale of power and heat has traditionally been difficult.
- ☐ *Applications:* as schemes become larger it is more difficult to find single users who will provide a base load to enable the CHP unit to operate economically.
- ☐ *Environment:* the requirement of having the CHP generator close to the user raises problems of aesthetics, noise and pollution. The major infrastructure changes that may be necessary are also environmentally unwelcome.

Having attempted to argue why large scale CHP has not been readily adopted the scene is set to argue why small scale CHP should be more widely applied.

The concept of small scale CHP

If we define large scale as >10MWe it presupposes that small scale means <10MWe. However most of the installations of small scale are <100KW and hence are often termed micro CHP.

A desirable feature of any CHP installation is that it should operate in parallel with the electricity supply grid. This has a number of advantages — a higher degree of security can be achieved with private generation and the grid rather than by the grid alone; peak demands and starting loads are met by the grid, the size of the generator is therefore not dictated by load and can be sized on base heat load to give a high utilisation factor; if required, electricity can be generated back into the grid in a cost effective manner; the grid can be used to start and 'regulate' asynchronous generators, and so best economic advantage can be taken of peak and cheap rate electricity tariffs.

Until 1983 permission to generate in parallel with the grid had to be sought separately for each installation. The Electricity Council has now provided an engineering recommendation document (G59) which has been accepted by the electricity supply boards. The degree of consultation and testing with the electricity board required in the past is now so reduced that it constitutes an acceptably small part of engineering a micro CHP system.

Now that this obstacle has been removed the advantages of micro CHP can be exploited. Even though installation costs as high as 70% of the basic unit are encountered, paybacks of two-three years can be achieved. Since power generation units as small as 8kW are now available quite small establishments can operate their own individual micro CHP systems. Even if current economic thinking is applied, ie only paybacks of less than five years are acceptable, there are still a large number of establishments where micro CHP can be very successfully employed.

The micro CHP units currently commercially available share three common factors:

- ☐ They use engines operating on the Otto cycle as prime movers.
- ☐ They use natural gas as their preferred fuel.
- ☐ They operate in parallel with the grid and supply heat in the form of LPHW, although some systems can produce steam.

The manner in which they generate financial savings is also similar and the example chosen below uses typical data.

Economic benefits

Cost savings are sensitive to three factors: the price of electricity and gas, and the cost of maintenance. Investment decisions are of course made on the basis of capital cost, savings and rate of return of investment.

Let us consider the generation of savings.

Savings = Value of heat and power generated — Cost of operating CHP system conventionally

The actual figures used here apply to a micro CHP unit having the following characteristics:

Thermal output — 95kW Electrical output — 40 kW
Fuel input — 170 kW Maintenance cost — 20p/hr

The hypothetical boiler this system is being compared with is assumed to have an operating efficiency of 65%.

A gas price of 35p/therm (1.19p/kWh) and an electricity cost (day time) of 3.8p/kWh is used.

Value of heat generated

$$\textit{Conventionally} = \frac{95\ \text{kW}}{0.65} \times 1.19\text{p/kWh}$$

$$= 173.9\ \text{p/kWh}$$

(continued on following page)

*Applied Energy Systems

Value of electricity purchased from electricity supply board
= 40 kW x 3.8p/kWh
= 152 p/kWh

Total value of heat and power
= 173.9 + 152
= 325.9p/h

Cost of operating CHP system
= Cost of fuel + Cost of Maintenance
= 170 kW x 1.19p/kWh + 20p/h
= 202.3p/h + 20p/h
= 222.3 p/h

$$\textit{Net savings} = \textit{Total value of heat} - \textit{Cost of operating CHP system and power}$$

= 325.9 − 222.3
= 103.6 p/h

$$\textit{Percentage saving} = \frac{325.9 - 222.3}{325.9} \times 100\%$$

= 31.8%

Investment criteria

The most commonly encountered method of making investment opportunities is the simple payback. Capital cost for the supply, installation and commissioning is now well documented with over 200 UK installations having been carried out. The capital cost of the example given would be £18 500. High utilisation or load factor is obviously the key to achieving a short payback. It is assumed in this example that the CHP system operates 17 hours per day 365 days a year giving 6205 operating hours pa.

The annual saving is therefore:

103.6 x 6205p
= £6428.38

Hence the payback for this example would be:

$$\frac{18500}{6428.38} = 2.88 \text{ years}$$

Obviously there is a degree of variation in this payback, difficult installations and low utilisation can extend this figure. Easier installations and the use of low grade heat recovery where possible, for instance swimming pools and domestic hot water, can reduce it. Typically paybacks of between two and five years can be achieved for a very wide range of applications.

Micro CHP in practice

Having shown the economic advantage it is perhaps worth spending a little time explaining what a micro CHP system comprises. All the commercially available systems have the same basic components: an engine, generator, control system and heat recovery system.

Engines: these are mostly reciprocating and use the Otto cycle, they range from small modified car engines through converted automotive diesel engines to purpose built industrial gas engines. The common features they must have in order to be successful is the ability to operate for very long periods reliably and with low maintenance costs.

Minor service periods occur typically at 720 hours with major servicing and, in the case of automotive engines, engine replacement at 20 000 hours. It is of interest to note that the equivalent road mileage of these operating times is about 36 000 and 1 000 000 respectively.

The requirements of the engine for CHP are achieved by factors such as low speed (1000-1500 rpm) operation, automatic lubricating oil top up, electronic ignition and special valve seat materials.

Generators: virtually all CHP systems operate in parallel with the grid. There are however two basic types of generator — synchronous and asynchronous. Synchronous generators have their field excitation applied internally. This means that they can operate independently of the grid.

Compared to asynchronous generators they require more complex control systems and extra ancillaries such as electronic governing, load control, more protection and starting equipment. Some asynchronous generators are self excited, however, more commonly they are mains excited. Using asynchronous generators means that the engine can be started from the grid making use of the generator windings. Also using the asynchronous type of generator results in fewer ancillaries and considerable savings in control complexity.

The control systems of both synchronous and asynchronous machines must contain equipment to comply with the Electricity Council engineering recommendation G59. This is basically to effect safe system shutdown in the event of the supply parameters going out of limits.

Asynchronous machines, being virtually identical to induction motors, merely require some form of starting system. This normally takes the form of a star delta system.

Heat recovery systems

These differ widely in detail but have a common purpose. Usually micro CHP systems deliver their recovered heat in the form of low pressure hot water (70-80°C) although some can produce steam at up to 6 bar. Heat exchangers are provided between the engine jacket water, exhaust gas and lubricating oil. The system is designed to allow jacket, lubricating oil, intercoolers, etc to operate at their design temperature while reducing the exhaust outlet temperature to the lowest possible level. With natural gas as a fuel a condensing exhaust gas is technically acceptable and economically desirable. Shell and tube, plate type and extended surface heat exchangers are all commonly used.

Maintenance

Maintenance costs are a key factor in CHP economies. Typically 20% of gross saving is absorbed by the cost of maintaining the CHP system. Clearly much consideration must be given to the control of this cost both by the manufacturer and the user.

As CHP can be applied to smaller premises personnel with expertise in servicing are often not available. To meet this need manufacturers offer the option of an 'all in' maintenance contract. While this means the user can 'fit and forget' the system it inevitably results in higher costs. Often a partial maintenance contract is the more practical option.

Reliability

High reliability is of prime importance. Not because the power or heating system depends on the CHP unit for this is rarely the case. Reliability impacts heavily on maintenance costs and can adversely effect utilisation.

A number of design features are employed to increase reliability and control maintenance costs, these include electronic ignition systems, bulk lubricating oil systems, removable wet cylinder liners, etc. The low stressed industrially proven gas engine embodies these criteria.

Applications

Having originally asked the question, 'Why has CHP not been more universally applied?' the question 'Where can it be applied?' comes to mind.

In a free market situation, ie one in which energy

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LETTERS

Chemical Engineers in South Africa

In the August/September issue of *Energy World* reference was made by Mr Olinga Ta'eed in his *Viewpoint* article to special arrangements being made by the IChemE regarding subscription levels for black chemical engineers in South Africa. Reference is also made to a South African branch of the IChemE.

The purpose of this note is simply to set the record straight, lest there be confusion. The IChemE's South African branch was disbanded in 1964 and while we continue to welcome having individual membership of South African chemical engineers, a standard overseas subscription is applied. Presumably the arrangements to which Ta'eed refers are made by the independent South African Institution of Chemical Engineers, which I know has always been conscious of its responsibilities to members of the profession who have emerged from the non-white community.

DR T J EVANS
General secretary, IChemE

DIY energy — not the answer!

Your report in *Energy World* (July, pp 13-14) in which Mr David Andrews from *The Observer* put the case for the mini power station, seemed to be very misleading. Was he seriously suggesting that the local electricity board would allow a small consumer to install a generating plant that would enable the 'ordinary electricity meter' to go backwards whilst the generator load exceeds that required for domestic consumption?

While not holding an excessively kind brief for the CEGB on the local electricity boards, it would be quite unfair for a consumer to use electricity during peak hours and repay it by exporting power at a time of his own convenience.

Secondly, in a mini power station I would have thought that 80% of the input fuel is the maximum efficiency that could be achieved — the same as a domestic boiler plant and not the 90% claimed by Mr Andrews.

Thirdly, the reliability of domestic high speed gas engines is such that total replacement after three to five years' operation would be expected. This would be the equivalent of 24 000 h of operation, or 720 000 miles at 30 mph to use a car engine analogy.

This is not to say that mini power generation is uneconomic, but realistic assessment needs to be carried out before headlong conversion to DIY generation.

Lastly I would venture to say that production of 10 M new engines every year would consume more fuel than Mr Dave Andrew's saving on the DIY operation.

S L WINGFIELD
(Fellow)

Combined heat and power (continued)

conservation competes with other economically beneficial exercises, return on investment is the important criteria for investment selection. It appears that outside industry paybacks of less than five years are acceptable whereas industry requires better rates of return ie less than two years.

To achieve these paybacks a CHP system presently needs to operate for a minimum of 4000 hours pa.

This immediatley rules out many types of establishment eg offices 0800 h-1800 h, five days a week, heating season only, gives 1600 generating hours. The ideal application is one which gives 24 operational hours per day, 365 days of the year. Of course the majority of space heating applications only require heat for eight months of the year. In these cases the domestic hot water requirement must be looked to to provide the summer load. To achieve this high level of utilisation it is obviously undesirable to match the peak heating load.

Despite the limitations described above a large ready market presents itself to CHP and the current highest areas of activity are:

Swimming pools leisure complexes
Hospitals
Hotels
Residential academic establishments
Residential grouped accommodation
Prisons and detention centres
Sewage works

Doubtless there are other less obvious applications in existence.

Future development

The key areas of development important to CHP are:

- ☐ The reduction of prime cost;
- ☐ The production of cost effective smaller units;
- ☐ The reduction of maintenance costs.

Cost will inevitably fall with rising volume and there is already some evidence of this.

Conclusions

The technology on which micro CHP is based is well established and needs little further development. The cost benefits are significant, a 30% reduction in cost of delivered energy being achieved.

There are undoubted ecological and national advantages to CHP. With careful application there is a large number of 'free market' users and this will increase as relative energy costs rise.

The next 10 years could see a rapid increase in the adoption of private electricity generation. A cohesive national energy policy would doubtless accelerate this increase further.

☐

National Coal Board
Annual report and accounts 1985/86

A secure future

The past year has been one of great achievement for the British coal industry, following the year 1984/85 which was so dominated by the NUM dispute.

Following the end of the strike in March 1985, output rapidly recovered and major improvements in efficiency were achieved. Productivity reached an all-time record level, and by the end of the year was running 30% higher than in 1983/84.

Inland sales of coal at 111.8 Mt in 1985/86 were some 2 Mt higher than the average for the four years immediately preceding the long running strike. The CEGB and SSEB urgently needed to replenish coal stocks at power stations and sales in this area represented some 87.4 Mt compared to 29.9 Mt the previous year.

The rising productivity from the mines was matched by improved profitability. On a turnover of £5340 M, the Board made a profit on ordinary activities of £389 M before interest payments. After provision for the latter item there was an overall deficit of £50 M, which was covered by a special deficit grant paid by discretion of the Secretary of State for Energy, under section 3 of the *Coal industry Act 1980* and section 1 of the *Coal industry Act 1985*.

The external financing limit (EFL) for the industry, agreed with the Government, was £929 M. By improvements in operating results and working capital requirements, coupled with a reduced capital expenditure programme the external financing requirement was held down to £429 M. This dramatic improvement meant that the industry's need of cash grant was some £550 M less than was originally thought necessary. Capital expenditure by the Board in 1985/86 totalled £660 M, of which £645 M was for mining.

The foundation of all these excellent results is the very low operating costs per gigajoule which were at their lowest level in 'real' terms for eight years. In 1985/86 coal consumption was the highest for four years which included a record sale of 80 Mt to the CEGB. All this was achieved through a vigorous marketing effort, building consumer confidence and gaining new business in the industrial sector.

In recognition of the transformation of the industry's performance and the opportunity for having a new start, with the disasterous problems of the previous year behind them, the Board decided to trade under a new name, British Coal.

Productivity at the coal-face and on an overall basis reached record levels in 1985/86. Total colliery output reached 88.2 Mt with output per manshift at the coal-face being 12.03 t. In December 1985, weekly overall productivity exceeded 3 t per manshift for the first time ever.

Throughout the summer weekly output improved and in the weeks prior to Christmas the figure was only marginally below the level recorded just before the overtime ban and strike.

Total deep-mined output recovered strongly and towards the end of the year (March 1986) the average daily output from all coal faces in operation exceeded 1000 t, a record for the industry, the weekly production being just under 2 Mt.

The number of collieries in operation is now 133 which was a reduction of 27 on the year before the strike. These 27 collieries represented an annual capacity of about 9M They were closed because they could no longer produc coal profitably and their closure took place b consultation and agreement of all concerned, 25 of th 27 were agreed on closure at local level.

Colliery manpower was reduced by 33 000 in the 1 months, total employees now standing at 179 645 (Marc 1986). Of this total, just over 138 00 are now on collier books.

The report shows that the average age of mineworker has fallen over the last 12 years from 44.2 to 36.8 years Voluntary redundancy in the year was concentrated in th older age group, 32% of the total being aged 55 and over with a further 35% aged 50-54 years. Non-industrial staf numbers were also reduced.

Recruitment is occurring with a total of 2914 bein engaged in 1985/86, 1069 being re-entrants. This is a increase of about 28% over 1984/85.

The year 1985/86 is seen as a year of conciliation an improved consultation. During the year, the Union o Democratic Mineworkers (UDM) was formed i Nottinghamshire and South Derbyshire areas and ha emerged as a body representing a substantial proportio of mineworkers. The new union was formally registere on 6 December 1985.

This new body had invalidated the assumption that onl one union can represent mineworkers. To this end, th Board wrote to both the UDM and the NUM on December 1985, to state that existing conciliatio machinery would terminate immediately, but until new consultation arrangements were agreed, the existing one would operate, but that they must reflect the new situation.

At 31 March 1986 the Board and the NUM agreed outstanding settlements for wages in the years 1983 and 1984. Further discussions appertaining to incentive based wages structure as part of the industry's wages strategy continued, but finally the NUM rejected the wage offe package and it was withdrawn on 30 April 1986.

Turning to aspects of health and safety, the Board records with deep regret that 27 fatal accidents occurred at collieries in the year. This was the third lowest figure on record. The lowest, 12 deaths, occurred in the strike year and the second lowest, 22 deaths, occurred in 1983/84. Those who suffered major injury were 704, which in terms of casualties per 100 000 manshifts is a disturbing increase on previous years.

At the start of the year a major safety campaign was launched to secure a safe re-start after the strike. The campaign was called *Start safe, stay safe.*

The Board obviously gives high priority not only to safety, but to the health of all workers and by the beginning of the year the medical service, including X-ray surveys, had returned to normal after the strike.

Pneumoconiosis reached very low levels in most collieries, the average age of underground miners having fallen considerably since 1973. The change in age distribution over the last few years has produced a different pattern of health problems, respiratory diseases becoming less common. Muscular-skeletal problems are now the main cause of sickness absence and is under investigation.

On the Coal Board's marketing front, intensive efforts

ıave been made to recapture business. Assisted by an ıpturn in general economic activity, sales to industry eached 8.8 Mt, an increase over the pre-strike year of 983/84. The collapse of world oil prices in the latter part)f 1985/86 did seriously affect the competitiveness of coal narketing, particularly as far as new consumers were :oncerned.

Coal is the most important source of energy in the UK ıccounting for nearly 36% of total primary energy :onsumption at 11.84 t. Oil follows closely at 104Mtce :onsumed pa.

Of British Coal's output, total sales to power stations n Britain were 87.4 Mt. Of the 7.1 Mt sold to the SSEB, ust over 1 Mt were used by the SSEB to generate :lectricity for sale to the CEGB.

Rebuilding of coal stocks at power stations was ;uccessfully achieved, with stocks rising from a low of 12 Mt to 24.5 Mt.

The exceptionally cold weather of 1985/86 boosted :lectricity sales which further increased coal sales. Some ;igns of growth of the economy also helped marketing.

Prices of coal supplied to power stations were adjusted n November 1985 under the terms of new agreements with CEGB and SSEB. The falling world price of oil ıdversely affected the competitive position of coal in the ndustrial market which necessitated the Board having to :espond commercially in the market. The end of 1985/86 financial year saw a further fall in the price of oil, but ılthough this resulted in a reduction of new applications for conversion equipment to coal, very few of the Board's :oal consumers decided to make a change to oil.

On the domestic scene a summer discount operated for ɔituminous household coal from May to the end of August 1985. However, from 1 November 1985 an ncrease for domestic coal was made of £2.50/t, industrial :oal price being raised by 4.5%. It would appear that the position is flexible, matching competitively the price of ɔther fuels. The sales to the domestic market in the year ımounted to 5.7 Mt, representing a very strong recovery following the end of the strike.

A considerable amount of emphasis is being placed on mining research and development. The Board's technical :xpertise is being directed at formulating and applying new technologies to the mining and preparation of coal, thereby achieving improved performance. At the same time, investment is occurring in new equipment which will enable the workforce to work more effectively and safely. This applies particularly to underground development, tunnelling and transport. Expenditure on research in the year amounted to £57 M. Development at new sites is proceeding especially at Selby and Asfordby. The work at Selby envelops six sites forming a large complex. At Asfordby, contact work on shaft sinking has begun which when the mine is in full operation, will produce two to three million tonnes a year.

Open cast mining is financially attractive and output for the year totalled 11.5 Mt. An operating profit of £287 M or £24.84/t reflects this area of the Board's business. Capital investment in 1985/86 was £16 M, spent mainly on coal processing, disposal and land purchase.

A total of 27 planning applications were made, planning permission being granted for 10 sites. Appeals to some refused applications are in hand. At the end of the year, the Board had rights over 32 700 hectares in England and Wales. Some areas were for contractors site operations, some undergoing rehabilitation the remainder reserved for future use.

The open cast operations in Scotland also produced excellent results, operating profit being £56 M or a profit of £22.13/t.

The Board is keen to ensure that important aspects of the environment are properly observed in all their business, but with a sensible balance being maintained between any aspects of the industry's intrusion and the economic means to preserve such features. This is particularly so in areas such as land use and reclamation especially in open cast mining operations and controlling land subsidence.

The report shows that a large amount of time and effort is directed towards programmes of improvement and restoration along with such bodies as the Ministry of Agriculture, Fisheries and Food, Department of the Environment, local authorities, universities and polytechnics.

The annual report contains a number of accounts appertaining to the industry's various subsidiaries as well as statistical tables covering the years from 1947.

On this latter point, two characteristics emerge and are quoted here for comparison. In 1947, total coal output was 200 Mt produced at 958 collieries by nearly 704 000 miners. Today, the figures are 104 Mt from 133 collieries employing 154 000 miners. Output per man-year has risen from 267 t to 571 t.

On the safety side, the number of fatalities has dropped from 476 in 1950 to 27 deaths in 1985/86.

In his last statement as chairman, Sir Ian MacGregor spoke of the great challenges still to be overcome. There are strong competitive pressures arising from the recent collapse in oil prices and from low priced supplies being available in other countries. The Board had, however, every intention of achieving further reductions in costs to establish a high-volume, fully viable industry which will make a positive contribution to the national economy. Sir Ian spoke of the recent agreements made between the CEGB and the Board, from which the electricity consumer would obtain benefit from lower energy prices.

Sir Ian concluded, 'When I joined the industry in 1983, we were mining coal from many hopeless pits with very high costs, and unsold coal was piling up at the pitheads. Our stocks are now reduced to the lowest level for 11 years, and we are achieving significant reductions in costs of production. Much remains to be done, but British Coal is now well placed to achieve a secure future, in which we will maintain our markets, earn a good return on our capital, and provide well rewarded employment for our employees.'

F John L Bindon (Member)

Tidal power
On the Mersey

The Mersey Barrage Company was formed on 26 June 1986 and in October David Hunt, Parliamentary Under-Secretary of State for Energy, signed the contract for Government funding for a feasibility study for the Mersey barrage scheme. The Mersey barrage is a tidal power scheme designed to harness energy produced by the large tidal range in the Mersey to generate electrical power for the UK. This renewable energy source could supply 0.5% of the electricity demand of England and Wales. It would also provide a significant new tourism and recreational asset for Merseyside.

On the successful completion of detailed studies it is intended that construction will be sanctioned in 1989 and will be completed by the mid 1990s.

The cost of this scheme is currently estimated at £450M (based on 1985 costs) and is expected to show a good return on investment.

The scheme is expected to create a substantial number of new jobs for Merseyside, particularly during the construction phase when approximately 5000 people would be employed on the project.

The original proposal for the scheme came from the Merseyside Enterprise Forum. The idea was taken up by Merseyside County Council who initiated and funded the preliminary feasibility studies. After the preliminary studies were completed a detailed economic feasibility study was subsequently produced in 1985, that study was funded by Merseyside County Council in conjunction with the Marine Technology Directorate of the Science and Engineering Research Council, the Department of Energy and the European Economic Commission Regional Development Fund.

Two locations are being considered for the barrage (Fig 1): Line 1 — New Brighton to Langton Dock and Line 3 — Rock Ferry to the former Herculaneum Dock. The length of the barrage will be 1.7 km — 1.8 km, depending on location.

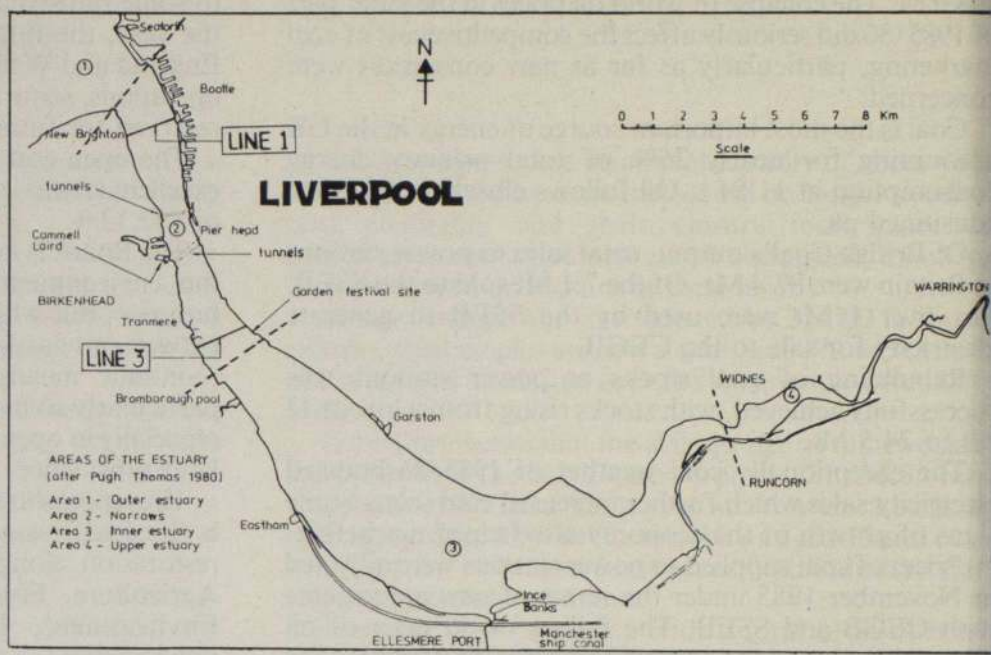

Fig 1: Mersey barrage scheme

The pre-feasibility study recommended a barrage construction using *in situ* diaphragm walling. The system entails progressively constructing a sand island across the estuary, using locally dredged materials, and excavating trenches through the island using grabs or augers.

An innovative but cost effective method has been proposed to form the temporary embankment or sand island: Two redundant large crude oil tankers would be ballasted on the river bed to act as cofferdams and retain the sand filling. Cell walls, up to 32m deep, would then be formed using diaphragm walling methods. Once the walls had gained sufficient strength the tankers would be refloated and moved to their next location.

The trenches for the diaphragm walls would be held open with a thixotropic mud suspension. Steel reinforcement would be installed and then concrete poured in with elephant trunking to expel the slurry and leave a panel of concrete in the ground. The dam would be closed by conventional sand-filled embankments with rock.

Turbines and sluices would be housed in the cells of the barrage structure. The installed capacity of the barrage, depending on the number of turbines and sluices used, would generate 483-621 MW.

Locks, sited at one end of the barrage, would allow shipping to pass through the Mersey to the various docks and facilities upstream.

As the tide comes in the sluices would be opened to allow water to flow up river. Just before high tide the sluices would be closed, trapping water in the Mersey Estuary upstream of the barrage. Once the downstream water level has fallen sufficiently to provide an adequate hydrostatic head, the turbine gates would be opened and the water allowed to flow out through the turbines.

Source: Mersey Barrage Company

China
Royal fellowships

It was reported in *Royal Society News* that, Her Majesty The Queen, on her recent visit to China presented, as a gift to the Chinese people, a new programme of fellowships to enable Chinese research scientists of postdoctoral or equivalent level to undertake periods of research in British laboratories in collaboration with British colleagues. The fellowships are in recognition of the importance both countries attach to scientific cooperation, and it is hoped that not only will the Chinese visitors gain from the opportunity to familiarise themselves with both UK research methods and equipment, but also that their hosts will benefit from the interchange of ideas and techniques. To symbolise the gift Her Majesty presented an illuminated parchment scroll to the President of the People's Republic of China, President Li Xiannian.

The Queen has agreed that this major new scholarship scheme should be known as Royal Fellowships and that it will be administered by the Royal Society, of which Her Majesty is Patron, in collaboration with its main scientific agreement partners, the Chinese Academy of Sciences and the China Association for Science and Technology. There will be about 30 one-year awards offered each year for three years from January 1987.

The Rt Hon the Lord Rhodes KG DFC, who has been active in promoting links with China over many years was instrumental in raising the funds for the programme whose total value is in excess of £1M. Its establishment exemplifies the close collaboration between Government, industry and the Society. It also illustrates the close cooperation that has been built up between Chinese and British scientists and between the Society, the Chinese Academy of Sciences and the Chinese Association for Science and Technology.

Source: Royal Society News

Energy from waste
Commercial project

An energy efficiency project has been set up at the Northern Co-operative Society hypermarket, Aberdeen, which will

investigate the use of retail refuse as an alternative fuel for the store's heating system.* Monitoring equipment has been installed and a proprietary computerised energy management package is being used to monitor progress and calculate savings from a new gas-fired incinerator and waste heat recovery boiler. A full report will be submitted in May 1987 after the six months monitoring is completed.

Although now becoming established in industry, the process of using retail waste to fuel heating systems is relatively uncommon in the commercial sector. It is estimated that the fuel conversion in Aberdeen will create 16% saving in the store's annual heating bill, resulting in a payback of approximately three years. The energy monitoring equipment utilises a purpose-built interface and associated microcomputer for data acquisition; a modem installed in Aberdeen is already enabling the data recorded to be retrieved by microcomputer for analysis on a monthly basis. Energy consumption can be correlated with historical data and projected performance targets stored on the computer to provide graphic representations of results.

The final report will analyse data from the full six months period and will also include details of commissioning and operating experience; a summary of the monitoring programme and its results; analysis of the cost of installation and operation of the new plant; a calculation of the payback period of the investment; and recommendations for any future installations.

Source: Ewbank Preece

Battelle
Environmental study

A $9.6 M, five-year contract to study the environment around oil production platforms off the California coast has been awarded to Battelle by the US Department of Interior's Minerals Management Service.

The study will be a comprehensive programme which will study the effects of oil drilling and production on the marine environment.

Multidisciplinary in nature, the programme will involve internationally recognised experts in biological, chemical, and physical oceanography.

The programme calls for designing and conducting an environmental monitoring and research programme around oil platforms off the coast of central California. Hard and soft-bottom habitats will be examined over a five-year period at study sites in the Santa Maria Basin and off Point Arguello.

Source: Battelle

OPEC output will go up
Says new study

Oil production outside the OPEC bloc will decline by 4 bnb\d to 21 bnb\d by mid-1989.

At the same time, OPEC production will rise to levels not reached since 1981, topping 25 bnb\d by 1989. At that point, OPEC's share of the world oil market will exceed 51%.

These are some of the conclusions reached in a new long-term energy forecast called: *The next oil shock: a planning guide to world energy markets 1986-2000.*†

'Our forecasts indicate that low world oil prices — in the range of $11 to $13 a barrel — could continue for the next several years,' said Scott Jones, who directed the report's preparation. 'Those prices are rapidly driving high cost oil, most of which is produced in countries outside OPEC, out of the market.'

'Compared to year-end 1985 levels, we expect non-OPEC production to be down approximately 1.2 bnb\d by the end of the next year. Then the bottom could fall out: in 1988, another 1.5 bnb\d a day will disappear, followed by a further 1.2 bnb\d in 1989' said Mr Jones.

'United States producers will be especially hard hit. Total production of oil and liquids could decline almost 3 bnb\d by 1999, a cutback of more than 25% from current levels.'

'Right now, the exploration and production drilling in North America are in a depression. Our forecasts indicate that the average number of active rigs in the US and Canada will remain below 900 — less than one fourth of the number of rigs active in 1981 — for the next two years. As a result, the new wells that would normally replace depleted reserves simply will not exist.'

'Non-OPEC producers in Latin America and Asia will resist oil production cutbacks,' said Jones. 'Their oil production costs tend to be lower than in North America, for one thing. For another, many of those countries, like Mexico and Indonesia, are required to maximise oil revenues to reproduce their external debt burden.'

Source: Chase Econometrics

British Standard amendment
Fuel oil viscosity

Following the adoption by the International Organisation for Standardisation of 100°C as the reference temperature for the determination of viscosity of fuel oils, the need has now arisen to modify the British Standard specification for fuel oils, BS 2869:1983. Currently, the viscosity reference temperature for fuel oil grades in BS 2869 is 80°C. After discussion within the British Standards Institution Technical Committee PTC/2, a new set of viscosity limits at 100°C was proposed and adopted following the normal period for public comment. The new limits are shown in table 1.

Table 1

Fuel	New maximum viscosity limit cSt at 100°C	Minimum recommended temperature for Storage °C	Handling °C
Class E	8.20	10	10
Class F	20.00	25	30
Class G	40.00	40	50
Class H	56.00	45	55

The viscosity of Class E fuel is an exact conversion from the existing reference temperature of 80°C, but the limits for class F and Class G fuels have been increased slightly in the process of rounding off. Following the normal period allowed for public comment from a range of interested groups, including equipment manufacturers, users and fuel suppliers, it was evident that all parties accept that the revised limits will not represent any significant change in fuel quality. When measured at the previous reference temperature of 80°C, the change represents an increase of 4cSt and 5cSt for Class F and G fuels respectively.

The implications for the fuel oil user are likely to be small. No change is required for storage or fuel handling temperatures (see table above), but an increase of 2-3°C may be required for atomisation.

Finally, it must be stressed that it is totally inappropriate to convert the viscosity of present day fuels to the Redwood scale. The Redwood method of measuring viscosity was declared obsolete and withdrawn from the Institute of Petroleum Standards in 1972 and all reference to the Redwood procedure was finally deleted from British Standard 2869 oy Amendment No 5 in April 1980. The continued use of this method is likely to give rise to incorrect burner settings and equipment design. It should further be noted that no reliable conversion exists between Redwood and kinematic viscosity measurements.

In conclusion, burner manufacturers, users and the fuel supply industry see no major difficulties in using fuel oils manufactured to the revised specification limits. However, it is recommended that users ensure that fuel oil storage, handling and usage conform to the minimum requirements given in British Standards BS 799 and BS 5410.

UK Petroleum Industry Association

Health and Safety
Action programme

'In Britain today more people die from occupational disease than from accidents at work, but nearly half the working population have no access to an occupational health service,' said Dr John Cullen, chairman of the Health and

*Ewbank Preece Consulting Engineers
†Prepared by Chase Econometrics

Safety Commission (HSC), in October. 'We are failing to control adequately illnesses associated with work and to ensure the best match between people's state of health and their jobs. This situation must not be allowed to continue,' he said.

'Although industry and the Commission have done much, more remains to be accomplished.' With this in mind, Dr Cullen announced a wide-ranging programme to extend health and safety services in the workplace. The programme will be an important stage in the HSC's developing policy on promoting specialist advice and services available to employers, as recommended by the 1984 Gregson Report.

Presenting the programme, Dr Cullen said: 'The Commission aims to encourage employers to attain high standards of health and safety for all their workers and provide much specialist advice and guidance. But unless employers themselves have access to appropriate professional advice then they will face real difficulties in coping with complex health and safety issues and protecting their employees. The advice and services of health and safety specialists may be required for a whole variety of reasons — for example: to carry out environmental monitoring; to advise about fitness for particular jobs or about first aid; to carry out routine health surveillance of workers exposed to certain kinds of risks; or to advise about hazards and control measures.

'Many employers appreciate the need for advice and services, and provide for these. Unfortunately, many others do not, especially in small workplaces. This is often because they do not recognise that they have a problem, particularly where health issues are concerned. So we recommend that as a first step they should systematically review the health and safety hazards in their own workplaces. This will help to identify those problems where specialist outside assistance may be needed. Getting help to assess problems at an early stage could avoid the need for more expensive intervention later, and demonstrates commitment to protecting health and safety at work. The proposed regulations for the control of substances hazardous to health will be a valuable step forward in this direction. When it comes to the provision of services a wide variety of different options are possible; in the case of small firms the use of group practices or the sharing of larger companies' facilities may be cost-effective solutions. But I do not want to be prescriptive at this stage.

'The action programme outlines a series of initiatives to be undertaken by the Commission, the Executive and the Commission's advisory committees. The programme will produce guidance for employers on assessing their needs for advice and on the most cost-effective way of providing it. This will particularly help small firms, which lack the resources to have their own in-house services. Guidance will be supported by publicity campaigns, by conferences to exchange experience and ideas, and by discussions with the organisations currently providing services or training health and safety practitioners. The Commission will be monitoring responses to the new action programme over the next year — for example by industry advisory committees. The Commission will also be discussing responses to its recent consultative document on the ILO Convention 161 and recommendation 171 on occupational health services.'

Dr Cullen concluded: 'The Commission is well aware that this will be a long-term programme. We are aiming to change attitudes and practices by persuasion, which will not happen overnight. This is just the beginning. And we are open to new ideas. Our message is a vitally important one, and I look to employers to give solid commitment to our initiative.'

Source: Health and Safety Executive

Czechoslovakia
Future of coal

Czechoslovakia's extraction of coal and lignite is to drop from this year's 122 670 000 t to 119 Mt in 1990.

This development is closely connected with the continuing restructuring of the Czechoslovak fuel and power complex. An essential part of this is the development of nuclear power plants which will replace to an ever greater extent the production of electricity in classical, ie thermal, power plants.

The extraction of lignite is to drop from the present 97 Mt to 94 Mt at the end of the eighth five year period (1986-1990), to 87 Mt in 1995 and 82 Mt at the turn of the century ie by 15 Mt within 15 years. The extraction of black coal is to drop during the same period by 2.3 Mt.

The gradual lowering of coal extraction is a positive phenomenon, making it possible to create reserves for the future.

Solid fuels will, however, continue to be a significant source of energy. At present their share is 69%. At the end of the eighth five-year period it is to drop to 63.4%, in 1995 to 57.6% and in the year 2000 to 52%.

Source: Czechoslovak News

Beta awards
The first winners

Luton International Airport's new terminal and a pharmacological unit for the investigation of new drug therapies at Merthyr Tydfil are the winners of the electricity supply industry's Beta awards.

Luton International Airport's terminal, which was built over the original building while business continued as usual, won the award for buildings of more than 1000 m^2.

The terminal's air conditioning, which incorporates heat retrieval systems, has a running cost which is 34% cheaper, on a volume basis, than in the building it replaced.

Simbec Research won the award for buildings less than 1000 m^2. Their running costs have been cut by more than 29%.

Sir Philip Jones, chairman of the Electricity Council, commenting on the competition said: 'We launched the award scheme as a practical and constructive exercise in support of Energy Efficiency Year. It focuses attention on the 1½M public and private buildings that hitherto, perhaps, have not had the energy interest of housing and industrial manufacturing.'

Three hundred and eighty buildings were entered in the preliminary rounds of the competition and the 28 finalists were chosen by 14 electricity boards in England, Wales and Scotland. All the entries were required to demonstrate how the adoption of cost-effective electrical techniques had led to significant savings in total energy cost and to list improvements provided by the buildings' amenities and environment.

Jack Taylor, the Electricity Council's central director, marketing said, 'With the drop in oil prices and the consequential fall in other energy costs, not least the recent drop in electricity prices, was there still the same incentive to business managers to pursue energy efficiency? Clearly all those involved in energy management now, more than ever, need to maintain the momentum of energy efficiency marketing.'

In addition to the major prizes which were presented by Mr David Hunt, Under-Secretary of State for energy, Cedar Court Hotel, at Wakefield in Yorkshire, and the Copeland Swimming pool, at Whitehaven in Cumbria, were highly commended in the larger building category. Smaller buildings highly commended were St Mary's Church at Buckland in Oxfordshire, and the Clifton Craft and Coffee Shop, at Tyndrum in Central Scotland.

Source: Electricity Council

GEM awards
South East

The winners of the 1986 British Gas South Eastern Gas Energy Management (GEM) Awards were British Sisalkraft of Commissioners Road, Strood for the Space Heating and Hot Water category; London Borough of Lewisham for the New Technology category; Unigate Dairy of Waterworks Road, Eastbourne for the First Use of Gas category, and Sheerness Steel of Sheerness, Kent for the Process category. The GEM Awards were presented by British Gas South Eastern Chairman, Arthur Dove in October.

The GEM Awards are presented annually to industrial and commercial gas customers, who are judged to have achieved the most outstanding contribution to the efficient and most economic use of gas. There are four categories in the competition — *Process; New technology; Space heating and hot water; First use of gas.*

To win a GEM award, each company co-operated closely with British Gas

South Eastern engineers to save energy at their individual premises. At British Sisalkraft, new gas heaters were installed, complete with the latest energy saving systems. This resulted in a 26% reduction in energy costs per year. At the London Borough of Lewisham swimming pools at Lewisham, Downham and Forest Hill, all the boilers were changed over to gas. A comprehensive programme of works at the Ladywell Swimming Pool, Lewisham included the provision of variable air volume control; special heat recovery coils and two gas combined heat and power sets. The overall programme for the Borough has resulted in a 12.5% reduction in fuel use, saving 37 500 therms of gas per year. The improvements will also save an additional £16 000 in electricity costs.

At Unigate Dairy, new gas fired systems were installed to provide the steam for bottle washing and pasteurising. This new system will mean a saving in energy of 28% per year. A major modification to the gas-fired billet re-heat furnace was carried out at Sheerness Steel. This will mean an energy saving of 38% per year.

The four winning companies will now go on to the National GEM awards to be held in London in February.
Source: British Gas

Electric furnaces
New committee formed

Closer co-operation between the electricity supply industry and the foundry industry will be the result of the formation of the new Joint Committee on Electric Furnaces. The main purpose of the committee is to provide a forum for discussing and examining those factors affecting the choice and efficient operation of electric furnaces.

The new committee consists of representatives from the foundry industry, refractory suppliers, furnace manufacturers, the British Cast Iron Research Association (BCIRA), and the Electricity Council.

The initial programme of work will include the collection and analysis of foundry experience with the operation of medium-frequency furnaces which will be of advantage to potential users in the choice of equipment. The committee will be advising on subjects requiring research, development and demonstration.

Companies and other organisations interested in the work of the committee are invited to make contact with the Secretary, Mr John Powell at BCIRA on 0527 66414.
Source: BCIRA

Home heating
A call for help

Lord Ezra, speaking in a special debate in the House of Lords in November, said, 'Are Her Majesty's Government satisfied with the standard of heating in British homes, particularly in the case of elderly people and people on low incomes'.

Citing the introduction, and then withdrawal, of heating standards by governments of the past decade, Lord Ezra is convinced that unless firm action is taken to improve the heating standards of those on low incomes, then many vulnerable people will continue to be at risk from hypothermia.

Setting out an urgent action programme, Lord Ezra urged the adoption of a three point action plan: 'Firstly — set a desired standard, perhaps around 21°C for elderly people in living areas. Secondly — make sure homes have efficient heating systems and are well insulated. Thirdly — ensure social security measures help meet the cost of keeping warm.'

Lord Ezra continued, 'I welcome the efforts of the Department of Energy to get over the message about better insulation. Much still needs to be done. Indeed, the Government must tell us soon what they are going to do to help sustain the special help for draughtproofing costs that we lose in 1988 as a result of the Social Security Act.

'For too long all of us have ignored the plight of those who go cold each winter. In a civilised society this can no longer be tolerated, and we must all respond to the need for a better heated Britain.'
Source: Neighbourhood Energy Action

Japan
Metal powders

A major expansion programme for two metal-powder plants in Japan,* lifting their combined monthly capacity to 5000 t from the previous 3300, has been completed.

The move is part of the company's strategy of turning itself into a major supplier of diverse materials. The two-year programme brought into service a No 7 finish-reduction furnace and specially-designed, 70 t blending equipment.

The two plants, both sited on the premises of Chiba Works near Tokyo, produce a broad range of powdered metals, from iron powder to the pre-alloyed and partially-alloyed varieties of steel powder.

Both plants share the same finish-reduction furnaces and other down-stream facilities, although the process used in upstream phases is different, with one of them reclaiming iron powder from mill scales and the other one being equipped to atomise an electric furnace-melted mixture of scrap steel and alloying elements by high-pressure water spouting from a pencil-jet nozzle.

The new finishing furnace rated at 3000 t monthly, is the largest of its kind currently in service worldwide. It is geared to use pure hydrogen as the reducing gas, to make its products more compressible by more fully eliminating such harmful elements as carbon, oxygen and nitrogen. It is also designed to save costs significantly by operating according to optimal heat cycle and better controlling temperature.

The existing fifth and sixth finishing furnaces, too, were converted to switch from the cold rolling mill annealing furnace's stack gas to the hydrogen gas as the reductant and regulate temperature in step with optimum heat cycle. The new blending equipment, installed downstream of these furnaces, is designed to ensure the uniformly high quality for the two plant's output, particularly for atomised metal powders.

Some 70% of the company's metal-powder output goes into powder metallurgy parts for cars, tractors, industrial machinery, electrical equipment, office machines, bearings, and electronic devices, with the remainder used in welding-electrode manufacture, gas cutting of metal, and such diverse consumer products as oxygen absorbent, pocketable body warmer, and noise muffler.

Powdered metals are said to be recession-proof. The past decade has seen both production and shipments steadily climbing at annual rates averaging 10%. In the light of this enormous growth potential, the company is now working on plans to expand into high-alloy steel powders, and such non-ferrous varieties as copper, silver, and ceramic powders.
Source: SEAISI Newsletter

*Kawasaki Steel Corporation

Energy efficiency 1986

Lighting costs reduced by about 85%

Set-Lite equipment from **Setsquare** has been installed in the Unipart warehouse used for the storage of automative components. The Set-Lite occupancy light switching system detects movement to give automatically artificial lighting only when and where necessary. The Energy Efficiency Office have selected the project as one of their energy efficiency demonstration schemes.

The warehouse contains 116 aisles of racking from which the required items are picked by forklift trucks. Lighting supplied by overhead fluorescent tubes was usually on 24 hours a day throughout the year before the installation of the occupancy light switching system.

Set-Lite sensors using Doppler shift to detect movement in the aisles are installed at the end of each aisle. The instant a person or truck enters the aisle the lighting for that aisle is switched on. The lights automatically switch off after an adjustable time delay when the area is vacated. The cost of lighting is estimated to be £42 437 a year but based on the frequency of admission into the aisles, this figure is expected to be reduced to about £6600 a year giving a cost saving of approximately 85%.

Reader enquiry no 12/1

Energy control enhancement

E.T.C., UK manufacturers of boiler efficiency systems, announce a new refinement for their well-established Boilermizer oxygen trim system. Designed primarily for package boilers, the Model 2085 re-transmission unit allows the trim to be interfaced with a company's own energy management system.

The unit provides four selectable current outputs and a choice of eight alarm relays. It therefore offers an economical means of energy monitoring and control and will allow transmission of data in a variety of configurations, eg oxygen, efficiency, temperature or fire rate, to establish precisely optimum boiler performance.

E.T.C.'s Boilermizer oxygen trim system for modulating boilers takes maximum advantage of advanced electronic circuitry and is able to achieve a 2½% improvement in boiler combustion efficiency — a figure verified by independent tests by the Department of Energy.

Reader enquiry no 12/2

Working flame burner with lockable slide

A general purpose multi-port ribbon burner is now available with a lockable slide from **Nordsea Gas Technology.** They are designed for all applications requiring a continuous and even flame up to 300 mm long and the new adjustable slide allows variations in length to be obtained without modification. It is claimed that this makes the setting-up of combustion systems on plant much easier. They will operate on manufactured, natural and LP gases with compressed air; a venturi mixer being recommended to obtain maximum flexibility and control. Four ribbon patterns are available with 1 to 4 rows of ports. Capacities are available from 10 000 to 60 000 Btu/h, with larger sizes being made to special order. They are normally made from a press steel or alloy casing. The ribbon is made from stainless steel and the burner has an internal stainless steel baffle.

Nordsea multi-port ribbon burners have been successfully used for flame treating plastics before printing, wire annealing, heat treatment, brazing, soldering, glass working, flame polishing etc.

Reader enquiry no 12/3

Advanced flame scanning system

The design team at **Airoil Flaregas** have developed a new flame scanning system, which accurately monitors and discriminates on combination fuel burners with a single viewing head. Until now it has been necessary to use independent heads and amplifiers to monitor reliably oil and gas on the same burner, but the Dualscan overcomes this problem by combining the oil flame and gas flame sensors and their associated circuitry in a single unit.

The ultraviolet sensitive photo cell and photovoltaic diode are compactly mounted side by side. As the signal from the flame enters the dualhead through the quartz window it is immediately split into two separate light paths via four mirrors; one path for ultraviolet and one for infrared.

The system has been developed to control accurately and reliably industrial multi-fuel burners on the boilers and furnaces widely used in the petrochemical refinery, chemical process and utilities sectors of industry. Dual fuel (oil and gas) burners have, until now, always required a separate flame scanner for both fuels and recent stricter codes of practice have called for two scanners for oil and two for gas with the first scanner incorporating the alarm and the second capable of tripping it. With the introduction of Dualscan, it is claimed that costs can be cut by 50% with safety and reliability unimpaired. On some installations, where it is necessary to use different sight paths for each fuel, both UV and IR heads can be used to feed signals into a single Dualscan amplifier.

Reader enquiry no 12/4

Solid-fuel-fired plants offered by Stone

Following the acquisition of Allen Ygnis, B & E Boilers and Danks by Stone International, the new organisation **Stone Boilers** now offers a comprehensive selection of boiler plant available in the United Kingdom. A large percentage of the boilers cover solid-fuel-fired plants.

The Stone Allen *Black Prince* range using underfeed stokers for coal or waste-derived fuels covers outputs from 146 to 1465 kW. The *Black Emperor* range overlaps the *Black Prince* and covers outputs from 879 to 4690 kW using the sprinkler stoker system feeding onto a fixed grate.

The *Stone Danks* range covers one of the most well-established designs in the coal-fired shell boiler market and offers outputs from 1465 to 11 500 kW using in-house combustion systems of either chain grates or coking stokers. The *Stone Danks Autocoal* system using top feed sprinklers onto a fixed grate covers output ranges from 586 to 115 000 kW.

In addition to the conventional methods of burning coal and other solid fuels to produce steam in conventional shell boilers, Stones have also now designed and developed a *gasifier* working on the principle of burning fuel sub-stoichiometrically, giving rise to carbon monoxide and hydrogen which are then burned completely in the second phase. This allows greater control over the combustion process and results in smokeless, odourless combustion, the products of which can be used for a variety of purposes, for example providing retrofits to existing shell boilers previously fired by oil, or alternatively, for direct drying processes. The fuels which can be used in the gasifier include coal, wood and other refuse-derived fuels.

Reader enquiry no 12/5

New flue stabiliser

An easily installed domestic flue stabiliser, which reduces fuel costs and eliminates the problems associated with flue down-draught, has just been launched in the UK by **Aerocowl Marketing.** It operates with equally high efficiency on all types of solid-fuel or wood-burning fireplaces and stoves, as well as on gas, oil or solid- fuel central heating systems, and eliminates smoke or toxic fumes from polluting premises through blowdown in the flue. The unit also works continuously as a ventilator, which minimises condensation problems.

Constructed of corrosion-resistant materials, the flue stabiliser is located over the top of the chimney by means of a circular fixing ring, and secured in position by four clamping screws and lock nuts. Two sizes cover the full range of flue outlets from 4 to 10 in. diameter.

The Aerocowl has passed trials conducted by independent testing establishments. It has also been approved by the Solid Fuel Advisory Board and, when fitted with an inexpensive adaptor, by British Gas.

Reader enquiry no 12/6

Solid-state SO_2/O_2 stack emission monitoring package

The **Westinghouse** EC960 is a complete monitoring package with, it is claimed, high reliability solid-state sensors for all types of stack SO_2/O_2 emission monitoring applications. It is a microprocessor-based system for *in situ* monitoring and consists of the two stack-mounted sensors, a Westinghouse GPC-1500 micro-processor control room unit and a three-pen recorder.

The solid-state SO_2 sensor is claimed to be the only *in situ* SO_2 monitor currently available that does not use optical or extractive techniques. Another advantage is that it has an expected lifetime of many years, even in the most rigorous conditions.

The EC960 package has been used successfully downstream of a flue gas wet scrubber system and dealt with the high concentrations of water vapour without difficulty. For this application, the Westinghouse EC960 has received US Environmental Protection Agency (EPA) certification.

Reader enquiry no 12/7

Trade publications

Energy-saving furnaces. **LTM Furnaces** have just published a four-page leaflet outlining their extensive range of energy-saving furnaces. Many types are illustrated including: lift-off, bogie hearth, tilting hearth, continuous, vacuum and box, which use the latest technology, materials and instrumentation for a wide range of heat treatment processes. LTM point out that every furnace is custom built to well-proven designs and that units can combine the latest microprocessor control and energy efficient insulation, to give a level of reliability and economy not achieved, it is claimed, before.

Reader enquiry no 12/8

Recupovent ventilation/heat recovery units. **Thermal Technology** have recently re-published their four page leaflet on their successful range of Recupovent ventilation/heat recovery units. The standard range of Recupovent units are capable of handling up to 0.6 m^3/s of supply and exhaust air. Each unit incorporates an aluminium heat recuperator for recovering up to about 70% of heat contained in the exhaust air. The range of optional extra has been extended to include a number of items requested by users. Thermal Technology are also able to offer non-standard units designed specifically to meet the client's requirements.

Reader enquiry no 12/9

ENERGY WORLD — COMMERCIAL
(Photocopy acceptable)

Please send me further information against the reader enquiry no(s) listed below (please tick)

12/1 12/2 12/3 12/4 12/5 12/6 12/7 12/8 12/9

Name .....

Address .....

.....

Organisation .....

Elections for the 1987 Engineering Assembly: Guidelines for 'nominated bodies'

In its policy statement of September 1982, the Engineering Council proposed that there should be an elected engineering assembly 'to debate matters of interest and concern to the profession, and to make recommendations to the Engineering Council'. The publication in June 1984 of the Policy statement on the Engineering Assembly and Regional Structure, *set out in detail arrangements for elections and stated that 'The Assembly should be established as a forum to receive and discuss the Engineering Council's activities and progress. It should also be a channel of communications between the 'grass-roots' of the profession and the Council'.*

Elections to all 19 regions were held in 1985 and elections are now being arranged for regions 7-12 before the third meeting of the Assembly to be held in July 1987. This starts the rotation system whereby approximately one third of the members are elected each year for a three-year term.

To secure a spread of representation across the fields of engineering each candidate must stand for election in one of the five specified groups of 'nominated bodies' which correspond to the five Executive Group Committees of the Engineering Council. However, it is emphasised that the candidate is not in any sense the official candidate of a nominated body, but stands for election as an individual to represent the interests of the engineering profession as a whole.

During the elections for the 1985 Assembly, the Engineering Council received a number of complaints from candidates about the practice of some nominated bodies who published lists of their own 'preferred candidates' and several who gave publicity to each others' 'preferred candidates'. In some cases candidates were led to believe that they were the 'official' nominees of their institution, and even of a regional branch of their institution.

While the Council would welcome and encourage the nominated bodies to give the widest possible publicity to the elections, it hopes that any such publicity will in future reflect the Council's intention that candidates are standing for election as individual engineers and not 'preferred', or 'official' candidates of a particular institution.

The Council was also most concerned that during the 1985 elections there were instances where nominated bodies returned batches of completed nomination forms, and sometimes attempted to negotiate with the election officer on behalf of candidates whose nominations did not comply with the regulations or were received after the closing date. The Council trusts that such practices will not recur during the current elections.

Key dates

List of candidates sent to secretaries of 'nominated bodies' *Mid January 1987.*

Closing date for receipt of overseas affiliation forms at the Engineering Council *30 January 1987,* (UK nomination forms had been received by *19 December 1986).*

Voting papers posted to electorate by *9 March 1987.*

Closing date for receipt of voting papers by Electoral Reform Society *22 April 1987.*

Candidates informed of results of election by *8 May 1987.*

Announcement of results published in *The Times 11 May 1987.*

The Engineering Assembly meets in Edinburgh *21 and 22 July 1987.*

It is hoped that Chartered Engineers and Technician Engineers in membership of the Institute of Energy will take an active interest in the 1987, and indeed future, elections to the Engineering Assembly.

Engineering Council *Shortage of maths and physics teachers*

Mathematicians, physicists and engineers in industry who are near retiring age are to be encouraged to take early retirement and switch to a career in the teaching profession. This is one of several solutions put forward by the Engineering Council in responding to a Department of Education and Science consultative document 'Action on teacher supply in mathematics, physics and technology'.

The Council put the idea to its Industrial Affiliates — some 170 major companies who are employers of engineers — at a meeting last month. Flexible career patterns must be encouraged allowing more interchange between industry and education, says the Council, and this could be achieved by secondments or by shared appointments.

The Council calls for a national programme to provide the country with enough maths, physics and technology teachers so that more youngsters will be eligible to take up engineering and technology places in higher education and become engineers and technicians. It says that, in addition to the shortage of workers with information technology skills, the country is facing a major engineering skills crisis.

The Council puts forward the following suggestions:

- ☐ The Government should encourage local education authorities to join the university and polytechnic 'milk-round' to attract people into the teaching profession.
- ☐ The pool of potential women teachers has as yet been virtually untapped as a source of design and technology teachers. Local education authorities must ensure all pupils have an opportunity to study technology, and that girls, in particular, should be informed of the opportunities afforded by teacher training in technology.
- ☐ The national system of student financial support should give greater priority to students training to teach the shortage subjects.
- ☐ The development of foundation courses should be encouraged in higher education institutions for students without A-levels in maths and physics.
- ☐ 'Career break' schemes for teachers, similar to those promoted by the Engineering Council for women engineers, must be introduced and included in teachers' conditions of service and recruitment literature.
- ☐ Local authorities must offer child-care facilities and give high priority to nursery classes and playgroups to reduce the loss to the teaching service of teachers with young families.
- ☐ Job sharing schemes must be introduced.
- ☐ Some form of differential reward should be pursued in favour of teachers taking up subjects in which there are shortages.
- ☐ The Council feels strongly that the new technologies must be exploited to the full in the classrom. They must be carefully introduced in a planned manner to ensure acceptance and success in improving the achievement of teachers and pupils.
- ☐ The Government must consider making specific grants available to universities, polytechnics and local education authorities to encourage the

development of computer-assisted learning schemes, inter-active video schemes, open learning modules and tutored video work initiatives.

- Courses in maths, and physics and technology, need to be made more relevant, interesting and attractive for all pupils. Physics and technology, in particular, need to be taught in a way which will encourage more girls to pursue them beyond the age of 16.

Council

A meeting of Council was held at the Institute of Energy on Thursday 18 September 1986.

Melchett Lecture

The president, *Prof J Swithenbank,* reported that the Melchett Lecture would be delivered by *Sir George Porter* PRS at the Royal Aeronautical Society at 1730 for 1800 h on Tuesday 24 March 1987.

Annual lunch

The president reported that *Sir Philip Jones* CB, chairman of the Electricity Council, would be principal guest and speaker at the annual lunch of the Institute to be held on 28 April 1987.

Non-corporate member as branch chairman

It was reported that *Prof J C Levy* of the Engineering Council had suggested that, exceptionally, a non-corporate member might serve as a branch chairman but it should not become normal practice.

Council agreed the necessary change to be made in the model rules of Institute branches.

Advertising by members

The question of advertising had been raised with the Engineering Council and was to be discussed at the September meeting of secretaries. In the meantime, *C R Coleman* had agreed to draft a suggested advertising code of practice.

Student packs

Membership Committee chairman, *J P MacCarthy,* reported that specimen student packs had been circulated to all branches. They had been asked to intimate their requirements for packs which they would distribute to appropriate students in their area. Branches were requested, in due course, to report back on reactions to the student packs.

Honorary officers

Prof A Williams was re-elected honorary secretary to take office from the conclusion of the AGM to be held in May 1987.

P C Warner was elected honorary treasurer to take office from the conclusion of the AGM.

Branch report — North East

Electrification of the East Coast main line

At a North Eastern branch meeting, held at the University of Durham in October, Mr Philip Payne discussed the problems and the advantages associated with the electrification of railway lines from London to Leeds and Edinburgh.*

The electrification scheme will lead to faster trains running along the routes, reducing journey times and increasing passenger comfort. The project will also be of interest to estate agents as it will allow commuters to travel longer distances.

From British Rail's point of view the improved service should raise their market share of passengers on these long distance routes which, along with lower operating and maintenance costs, should bring an improvement in overall profitability.

Mr Payne provided cost estimates of the scheme, and of the number of jobs that it would create, giving a detailed analysis of the figures.

He also described some of the engineering and safety problems associated with electrifying a route along which existing high speed trains and freight traffic continue to travel. The engineering problems that have been encountered require new, purpose-built construction equipment and novel techniques in their application. Such developments have allowed work to progress ahead of schedule, and as the GEC-built traction units and BREL coaches become available, these will be gradually introduced into service so that staff may become acquainted with the rolling stock.

It was explained that the existing HST stock would not be scrapped but thoroughly overhauled to provide, in essence, new units. These will then be used on other routes allowing new passengers to benefit from the improved speeds and reliability that they should bring.

Mr Payne concluded the lecture by discussing the energy aspects of the project showing the vast difference in efficiency between diesel and electric units in purchase-to-traction terms. This demonstrated that, despite fluctuations in the price of crude oil, electric traction units are still far more economic to run in fuel terms, as well as being cleaner, less polluting, easier to maintain, quieter and more reliable.

At the end of the meeting Mr Payne answered a wide range of questions from the audience, before the chairman offered a vote of thanks.

Wayne Zakers/Andrew W Cox

*Project manager, BR Eastern region's section of the East Coast main line electrification scheme. He is also president of the York Society of Engineers.

Executive committee chairman

B G Gills was to take office as Executive Committee chairman from the conclusion of the AGM.

Members of Council

The following three members of Council retiring at the conclusion of the AGM were not eligible for re-election.

C R Coleman
B Lubert
W Tipler

The following two retiring members of Council were eligible to be re-elected for one further year.

L A N Tozer
N G Worley

The following corporate members were nominated for election to take office from the conclusion of the AGM, subject to their willingness to be so nominated.

Dr A B Hedley
Dr G A Jones
Dr A M Warris

The two following members of Council were nominated for re-election from the conclusion of the AGM, subject to their willingness to be so nominated.

L A N Tozer
N G Worley

Technician Engineer representation on Council

It was reported that *S M Taulbut* was required to retire from Council at the conclusion of the AGM, but was eligible to offer himself for re-election as a Technician Engineer representative.

A general invitation to make nominations would be circulated, in due course, to all Associate Members registered as Technician Engineers.

Membership subscriptions

It was agreed that membership subscriptions be increased by 3% from 1 January 1987. The detailed figures are shown below.

	1986 £	1987 £
Senior Fellow / *Fellow* / *Companion*	50.20	51.70
Member	43.25	44.55
Associate Member / *Professional Associate* / *Associate*	37.70	38.85
Graduate	31.30	32.25
Student	*8.60*	*10.00**
Collective	151.40	156.00
Concessionary rate for fully retired members	16.35	16.85

**Single payment which covers the duration of the course.*

Additionally, the undermentioned fees fixed by and collected on behalf of the Engineering Council will be shown on the subscription notice of members concerned.

(continued on p 29)

	1986	1987
	£	£
Chartered Engineer	7.00	7.30
Technician Engineer	4.50	4.70

Fully retired members registered with the Engineering Council will pay *half* of the standard Engineering Council subscription.

Energy managers

The Institute secretary reported that a meeting was to be held at the Energy Efficiency Office on 13 October 1986 at which representatives of the Institute would meet *W I Macintyre*, director general of the Energy Efficiency Office, and two of his colleagues.

In the meantime, the Institute was exploring methods of making membership of the Institute more attractive to energy managers, possibly by creating a special grade of membership or creating a specific division for energy managers.

'Energy for the future'

P C Warner reported that the revised edition of *Energy for the future*, first published in 1973, was to be the subject of a press conference to be held at the Institute on 24 September 1986. Copies of the press release were tabled and the president thanked all those responsible for the revised report.

Executive Committee

In the absence of *W Tipler*, Executive Committee chairman, *Dr G G Thurlow*, introduced Mr Tipler's paper, which highlighted the Institute's small number of non-corporate members.

Mr Tipler had visited the Rugby offices of the Institution of Chemical Engineers and found that the IChemE adopts vigorous methods to retain all its members. The importance of the role of Technician Engineers in the Institute was again emphasised and the view again expressed that corporate membership of the Institute should not be confined to engineers.

Special Award

Council approved the recommendation of the Membership Committee that in 1986 the Special Award, in Recognition of Services to the Institute, should be made to the following members.

B Emes (nominated by Midland branch)

D M Willis (nominated by East Midlands Branch)

Membership Committee

Membership Committee chairman, *J P MacCarthy*, again referred to the problem of members who disappear without trace. It was agreed that the present practice of sending details to branches in September, of those members who had not paid their subscriptions, was appropriately timed. Other suggestions made to overcome the problem included periodically publishing the names of missing members in *Energy World*.

Education

It was reported that the Education and Training Committee had recommended to the Engineering Council that the BEng Building Services Engineering degree at Ulster University should be formally accredited. The initiative for this accreditation had come directly from the Northern Ireland branch commitee.

Publications and Conferences

It was reported that an outside publisher had expressed interest in producing *Energy World* on behalf of the Institute; an approach which was being explored by the Publications and Conferences Committee.

B G Gills suggested that an effort should be made to increase the sale of Institute publications and that conferences should be organised with a view to making a surplus.

*Energy World, 1986 (May), pp 2-10

Engineering Council

The Engineering Council report entitled *A call to action* was discussed. It was agreed that the chairmen of Membership, Publications and Conferences and Education and Training Committees should together discuss ways of implementing the recomendations on continuing education and training.

Obituary

As we were going to press, we heard with regret of the death of **Prof N L Franklin** CBE a past president of the Institution of Chemical Engineers, who played a leading part in the development of the British nuclear power industry. Prof Franklin, who was 62, delivered the 52nd Melchett Lecture* of the Institute of Energy: *Nuclear fuel — swords and ploughshares,* at the Royal Institution on 6 March 1986. A fuller obituary will appear in a later issue of *Energy World.*

A H Harwood, a former member, died in retirement on 10 September 1986. A former lecturer, Mr Harwood joined the Institute of Energy in 1961 as a Member and was a loyal supporter of the Institute's activities.

New members

Fellow

Graham Malcolm Hill, Derek Sampson & Partners, Glasgow *(transfer)*

(Institute news continued on p 31)

The Energy Efficiency Office: the director general speaks

The director general of the Energy Efficiency Office, *W I Macintyre,* will speak at the next London and Home Counties branch meeting on **Thursday 5 February 1987.** His theme is: *Energy efficiency policy and the role of the Energy Efficiency Office.*

The meeting will be held in the Bernard Sunley Theatre, Royal Institution, Albemarle Street, London W1 at 1800 h. Tea will be served in the Long Library of the Royal Institution from 1730 h. All are welcome.

Fellowship of Engineering: January/February lectures

Admission to lectures is free, but if you wish to attend *please notify* the Fellowship of Engineering, 2 Little Smith Street, Westminster, London SW1P 3DL (tel 01-222 3912/26688 ext 31/32). An advance synopsis of each lecture will be issued six weeks before delivery.

12 Jan 1987 (M). RAeS, 1730 h. *Working together for Britain,* by Lord Sieff of Brimpton (Marks & Spencer).

27 Jan 1987 (Tu). IMechE, 1730 h. *Research development and decline: Britain's industrial enigma,* by Dr A W Rudge FEng (ERA Technology).

2 Feb 1987 (M). ICE, 1730 h. *Trends in materials science/processing,* by Dr A Kelly FEng FRS (University of Surrey).

19 Feb 1987 (Th). ICE, 1730 h. *The exploitation of university research,* by Prof J M Ashworth (University of Salford).

Combustion research colloquia: Imperial College, Jan/Feb 1987

27 Jan (Tu). A Gonfalone (European Space Agency). *Microgravity research and its relevance to combustion studies.*

10 Feb (Tu). Dr G T Kalghatgi (Shell, Thornton Research Centre). *Spark aider fuel additives and their effect on early flame development in internal combustion engines.*

Colloquia to be held at 1545 h (tea will be available from 1530 h). Visitors welcome without fee or formality. Synopses of colloquia will be available a week beforehand and will be sent on request.

Further information from Prof F J Weinberg FRS, Dept of Chemical Engineering and Chemical Technology, Prince Consort Road, London SW7 2BY (tel 01-589 5111 ext 4360).

The Royal Society Mullard Award

Nominations for the Award are invited, and should be made as soon as possible and not later than *Friday 6 February 1987.* They should be addressed to the executive secretary (ref THB).

The Scheme of the Award lays down that the Award shall be made to individuals who, in the opinion of the Council of the Royal Society, have made outstanding contributions to the advancement of science or engineering or technology directly promoting national prosperity in the United Kingdom of Great Britain and Northern Ireland. *Consideration will be given to proven achievements within the past ten years, judged particularly by their impact on the economy, that emphasise the service science and technology renders to national wealth.*

Please note that where a team or group is put forward, the nomination should show the role of each person concerned and to what extent and in what way each contributed to the initiation, development and exploitation of the subject of the proposal. The details of the economic results in the past ten years will be treated in confidence, as will the rest of the nomination, and will not be made public without the consent of the proposer.

The Royal Society Mullard Award, consisting of a silver gilt medal and a prize of £2000, was first presented in 1967. Further information and nomination forms can be obtained from the Royal Society, 6 Carlton House Terrace, London SW1Y 5AG (tel 01-839 5561 ext 242).

The European year of the environment. Lecture, RSA, 12 February 1987

Stanley Clinton-Davis (Member of the Commission for the European Communities) will be speaking on this subject at the Royal Society of Arts on Thursday 12 February 1987 at 1800 h.

Admission is by ticket only. These can be obtained (free of charge) from Carole Singleton, administrative assistant, Royal Society of Arts, John Adam Street, Adelphi, London WC2N 6EZ (tel 01-930 5115).

Engineering Institutions' Foreign Language Group

The Engineering Institutions' Foreign Language Group is organised with the support of the major institutions and membership is open to all members of Nominated Bodies of the Engineering Council. A class of Associate Members caters for interested people who are not members of one of these bodies.

An annual subscription fee of £9 (£7 for Associate Members) is charged to cover incidental expenses. Application forms and further details may be obtained from A Morton, 26 Durham Road, North Harrow, Middlesex HA1 4PG (tel 01-427 8042).

BNF blueprint for Chinese metal industries

BNF Metals Technology Centre has been commissioned by the Overseas Development Agency (ODA) to assist the People's Republic of China to carry out a major modernisation programme for the production of copper.

A two-man energy efficiency team from BNF has recently returned from China having successfully completed the second phase of a programme in which British monitoring equipment was shipped to China, installed on a demonstration furnace and operated continuously for three weeks to identify shortcomings in the present operations. They are working in close collaboration with Chinese research scientists and engineers at one of the country's largest refinings at Zhuzhou in Hunan Province, the work being coordinated by the Beijing Research Institute for Mining and Metallurgy.

Having assessed the needs on the spot, and advised on a coherent development programme covering energy efficiency, environmental standards and the training of local staff in efficient operating production, BNF is now drawing up detailed specifications for hardware to be installed during the next phase of the project.

P Clarke, senior materials engineer at BNF, believes that there are tremendous possibilities for those companies who can deliver reliable high-quality products that can match the

xacting requirements of the Chinese Government. 'We have ompiled a large computerised data base of suppliers of urnaces and instruments for control and monitoring of metals rocessing but we are looking primarily for companies which re capable of going out there to commission their products nd provide first-class support,' says Dr Brian Denton, senior naterials engineer.

Further information from BNF Metals Technology Centre, Grove Laboratories, Denchworth Road, Wantage, Oxon OX12 9BJ (tel 023 57 2992).

Formation of the Independent Energy Consultants Group (IECG) within ESTA

With increasing awareness of the benefits of energy cost ontrol, the demand for industrial and commercial energy onsultancy services has grown significantly during recent ears. There has been a corresponding growth in the number f companies purporting to offer such services, not all of whom have the necessary expertise or a long-term commitment to the business or their clients. Unfortunately, potential users of energy consultancy services are generally unaware of the credentials of the many consultant firms now serving the market, and run the risk of purchasing a second rate service.

With this in mind, the consulting firms who are already members of the Energy Systems Trade Association have established the Independent Energy Consultants Group (IECG). The members of IECG are all competent, independent energy consultants committed to promoting, encouraging and maintaining the highest professional and technical standards.

The Energy Efficiency Office welcomes the formation of the IECB as a focus for excellence in energy consultancy services. W Macintyre, director general of the EEO, said, 'We very much welcome this important initiative, particularly the self-policing of members which will give confidence to potential clients. It is vital that we have a strong consulting industry, and we are very encouraged by the formation of the IECG.'

Further information on the background and aims of IECG can be obtained from Dr Glenn Brookes, executive director, Energy Systems Trade Association, PO Box 16, Stroud, Glos GL5 5EB (tel 045 387 3568).

Institute news (continued)

Member

Rishantha Elmore Bhareti, Associated Motor-Ways, Sri Lanka
Roger John Dore, Dublin Gas, Eire
William Edward Egginton, Schlumberger Inland Services, Scotland
Michael Patrick Gaunt, NIFES, Yeadon, Leeds *(transfer)*
Andrew McCrea, N Ireland Electricity Services, Co Antrim
Robin Anthony Newnham, Babcock Power, London *(transfer)*
Robert Francis Ryan, J Roger Preston & Partners, Qatar
Andrew John Wolstenholme, Emstar, Staines, Middx
Michael George Fereday, British Gas, Southampton *(transfer)*

Technician Engineer

Roger Frederick Bowden, Buckle & Partners, London
Geoffrey Brown, West Midlands Gas, Newcastle under Lyme, Staffs
Stephen Charles Pitkin, Buckle & Partners, London
Nigel Richard Tully, Buckle & Partners, London

Associate

James Anthony Oliver, ECD Partnership, London
Bryan John Powell, British Aerospace, Bristol

Graduate

Martin Peter Grant, Airoil Flaregas, West Drayton, Middx *(transfer)*
Jonathan Adrian Harley, DMS Energy, Long Eaton, Derby
Peter King Lam Wong, J Roger Preston & Partners, Hong Kong *(transfer)*
John David Hancox, Hancox & Paartners, Glasgow

Student

Jonathan Richard William Foreman, University of Leeds
Helen Maria Taylor, Plymouth Polytechnic

Institute of Energy *1987 Branch conferences*

Midland

29 Apr (W). One-day symposium: *The future of steam.* University of Aston in Birmingham.
For other Institute conferences please see inside front cover. For conferences organised by bodies other than the Institute of Energy please see p 32.

1987 January meetings

Midland

8 Jan (Th). Air knives in industry, by C G Gauden. University of Aston in Birmingham, Senior Common Room at 1900 h.

East Midlands

12 Jan (M). Process plant integration, by Ewen MacDonald (AERE, Harwell). Conference Centre, BSC, Scunthorpe Works at 1930 h. Joint evening meeting with North Lincs Iron and Steel Institute.

North-Western

15 Jan (Th). New developments in electroheat processes, by Dr T Farrel (Electricity Council Research Laboratories, Capenhurst). University of Salford at 1700 for 1730 h.

North-Eastern

15 Jan (Th). Pressurised fluid bed combustion, by J S Harrison (deputy director, CRE). Neville Hall, Westgate Road, Newcastle upon Tyne at 1800 h (tea and biscuits before meeting). Joint meeting with North of England Institute of Mining and Mechanical Engineers.

South Wales and West of England

19 Jan (M). Some applications of flow modelling, by Prof J Swithenbank (University of Sheffield and president, Institute of Energy). University of Exeter, Lecture Theatre 04, Engineering Building at 1830 h. Joint meeting with IChemE (West of England).

Scottish

20 Jan (Tu). *The John Rayner Shield.* Young Engineers Energy Competition. Napier College, Colinton Road, Edinburgh at 1800 h.

Merseyside sub-branch

21 Jan (W). New CHP installation at Liverpool University, by Jack Bottomley (Liverpool University). Feathers Hotel, Mount Pleasant, Liverpool 3 at 1830 h.

Yorkshire

21 Jan (W). Packaged units as applied to CHP systems, by G Tetchner (engineering consultant, Enertech). University of Leeds, Houldsworth School of Applied Science at 1430 h.

East Midlands

29 Jan (Th). The future of gas and latest developments in gas equipment, by Tony Gamble (British Gas, East Midlands). British Gas, East Midlands Exhibition Centre, Parliament Street Showroom, Nottingham at 1800 h (refreshments available from 1730 h). Joint evening meeting with Institute of Hospital Engineering.

Northern Ireland

29 Jan (Th). NI energy resources. The work of the Geological Survey Unit, by T Griffiths. Ashby Building, Queens University, Stranmillis Road, Belfast at 1930 h.

CONFERENCES

January 1987

Low cost CAD for building services

Seminar, Eastleigh (Hants), 22 January 1987.
Details from Mike Palmer, c/o Trane (UK), Gaston Works, Reading Road, Basingstoke, Hants RG24 0TW (tel (0256) 474654).

Engineering for the future: the fast reactor

INucE Industry Year lecture, by C V Gregory (head, Prototype Fast Reactors, Dounreay). Central Suite, Derby, 28 January 1987 at 1430 h (afternoon for schools); 1930 h (evening).
For details please contact 01-461 4842.

The future of electronics technology

Lecture, by Dr D H Roberts CBE FRS (General Electric Company). Royal Soc of Arts, 28 January 1987 at 1800 h. *Admission by ticket (without charge).*
Details *(and tickets)* from Penny Egan, assistant secretary, Royal Society of Arts, John Adam Street, Adelphi, London WC2N 6EZ (tel 01-930 5115).

February 1987

Pacific Rim coal

Second international conference, Hong Kong, 2-4 February 1987.
Details from Harry Baisden, conference co-chairman, Pasha Publications, 1401 Wilson Boulevard, Suite 910, Arlington, VA 22207, USA (tel (708) 528-1244; tlx 248852).

Energy from biomass and wastes

Eleventh annual meeting, Lake Buena Vista (FL, USA), 2-6 February 1987.
Details from Ms Susan Robertson, Institute of Gas Technology, 3424 South State Street, Chicago, IL 60616, USA (tel (312) 567-3881; tlx 25-6189).

EMC: Susceptibility of electronic equipment in civil and military applications

Seminar, Heathrow Penta Hotel, 4 February 1987.
Details from Miss Laura Christie, ERA Technology, Cleeve Road, Leatherhead, Surrey KT22 7SA (tel 0372 374151 ext 290/488; tlx 264045 ERALHD G).

Choice of a microprocessor system

Seminar, Essen (FRG), 9 and 10 February 1987.
Details from Haus der Technik eV, Hollestraße 1, Postfach 10 15 43, 4300 Essen 1, FRG (tel 0201/1803-1; tlx 857 669 hdt).

March 1987

Corrosion 87

Meeting, San Francisco (CA, USA), 9-13 March 1987.
Details from National Association of Corrosion Engineers, PO Box 218340, Houston, TX 77218, USA (tel (713) 492-0535; tlx 792-310).

Powtech UK

International power and bulk solids technology conference and exhibition, Manchester, 17-19 March 1987.
Details from Specialist Exhibitions, 16 High St, Croydon, Surrey CR0 1YA (tel 01-686 5741; tlx 889371).

Stationary combustion/NO_x control

Symposium, New Orleans (LA,USA), 23-26 March 1987.
Details from David Eskinazi, EPRI, PO Box 10412, Palo Alto, CA 94303, USA.

Pitch: science of a future material

Conference, University of Newcastle upon Tyne, 24-26 March 1986.
Details from Dr H Marsh, Northern Carbon Research Laboratories, School of Chemistry, University of Newcastle upon Tyne, Newcastle upon Tyne NE1 7RU (tel (0632) 328511).

March/April 1987

Basic principles and practice of flow measurement

Conference, East Kilbride, 30 March-3 April 1987.
Details from Conference Section, National Engineering Laboratory, East Kilbride, Glasgow G75 0QU (tel (03552) 20222 ext 2154; tlx 777888).

Slurry technology

Twelfth international conference, New Orleans (LA, USA), 31 March-3 April 1987.
Details from Barbara A Sakkestad, Slurry Technology Association, 1800 Connecticut Avenue NW, Washington, DC 20009, USA (tel (202) 332-5751).

April 1987

Industrial and environmental management

European conference, Interlaken (Switzerland), 5-9 April 1987.
Details from ECIEM, Usteristrasse 19, CH-8001 Zurich, Switzerland (tel (01) 2111112).

Air pollution modelling and its application

Sixteenth international technical meeting, Lindau (FRG), 6-10 April 1987.
Details from Han van Dop, KNMI, PO Box 201, 3730 AE De Bilt, The Netherlands.

Energy technology

Fourteenth annual conference and exposition, Washington DC (USA), 14-16 April 1987.
Details from Government Institutes Inc 966 Hungerford Drive, suite 24, Rockville MD 20850, USA (tel (301) 251-9250).

Heat pumps

IEA conference, Orlando (FL, USA), 27-30 April 1987.
Details from F A Creswick, Oak Ridge National Laboratory, PO Box X, Oak Ridge, TN 37831, USA (tel: (615) 574-2009).

Power sources and supplies

First international conference, London (Olympia), 28-30 April 1987.
Details from Miss Laura Christie, ERA Technology (address above).

May 1987

Measurement of toxic and related air pollutants

Symposium, Research Triangle Park (NC, USA), 3-6 May 1987.
Details from Dr R K M Jayanty, Research Triangle Institute, PO Box 12194, Research Triangle Park, NC 27709, USA (tel (919) 541-6483).

Fluidised bed combustion

Ninth international conference, Boston (MA, USA), 3-7 May 1987.
Details from Leslie Friedman, FBC conference coordinator, American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017, USA (tel (212) 705-7788; TWX 710-581-5267).

Biomass

Fourth European conference, Orleans (France), 11-15 May 1987.
Details from Dr G Grassi, conference co-chairman, Commission of the European Communities, DG X11/SDM 3/18, Rue de la Loi 200, 1049 Brussels, Belgium (tel (02) 2356801).

Coal power 87

Australasian Institute of Mining and Metallurgy 1987 annual conference, Newcastle (NSW, Australia), 18-22 May 1987.
Details from Karel Grezl, conference chairman, c/o Tunra Ltd, University of Newcastle, Newcastle, NSW 2308, Australia (tel (049) 685 632; tlx AA28784).

Canadian engineering: the next hundred years

Canadian engineering centennial convention, Montreal (Canada), 18-22 May 1987.
Details from Engineering Centennial Board Inc, 276 Saint-Jacques Street, Suite 410, Montreal, Quebec H2Y IN3, Canada.

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