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Contents: February 1986

nstitute of Energy
3ranch conferences 1986

Aerseyside

3/19 Mar (T/W). Two-day seminar: *uel trends: economics and utilization.* iverpool Polytechnic.

orkshire

Apr (W). One-day symposium: *ombined heat and power.* University of heffield. Joint symposium with ChemE.

986 March meetings

cottish

Mar (Tu). Modern stokers for coal ring, by J R Kelsy (Kellhill Engineering). oyal Scottish Automobile Club, lythswood Square, Glasgow at 1830 h ea/coffee and sandwiches at 1800 h). oint meeting with Institute of Hospital ngineering.

lational

Mar (Th). 52nd Melchett Lecture: *words and ploughshares — nuclear fuel,* y Prof N L Franklin CBE FRS FEng mperial College). Royal Institution, lbemarle Street, London W1 at 1800 h ea at 1730 h).

Aidland

Mar (Th). The role of thermography in lant condition monitoring, by L Green mechanical plant services engineer, BSC, cunthorpe). University of Aston in 3irmingham at 1900 h.

Mar (F). Dinner and social evening. 3irmingham Chamber of Industry and Commerce.

South Wales and West of England

1 Mar (Tu). Safety aspects of energy ases, by V C Marshall (University of 3radford). Dept of Chemical Engineering, University of Exeter at 1800 1. Joint meeting with IChemE (West of England section).

Yorkshire

1 Mar (Tu). The search for efficiency — he EX project, by a speaker from Austin Rover. Mansion Hotel, Roundhay Park, Leeds at 1930 h. Joint meeting with Yorkshire branch, Institute of Petroleum.

South Coast

11 Mar (Tu). Developments in boiler flue gas desulphurization, by R H Teague (Hamworthy Engineering). Crest Hotel, Pembroke Road, Portsmouth at 1900 h.

East Midlands

13 Mar (Th). Fluidized bed coal gasification for industrial applications, by R Green, K G Wright and D B Corry (Otto-Simon Carves) and R Green (CRE, Cheltenham). Orgreave Social Club, Orgreave, nr Chesterfield at 1915 h. Joint meeting with COMA.

North-Eastern

13 Mar (Th). Coal water mixtures, by D Vincent (Foster Wheeler Power Products). Lecture Theatre, Merz Court, University of Newcastle upon Tyne at 1830 h (tea and biscuits before meeting). Joint meeting with IChemE.

Northern Ireland

13 Mar (Th). Annual dinner Culloden Hotel, Craigarad.

London and Home Counties

13 Mar (Th). Energy saving through pinch technology, by Prof Bodo Linhoff (Dept of Chemical Engineering, UMIST). Royal Institution, Bernard Sunley Theatre, Albemarle Street, London W1 at **1800 h** (tea at 1710 h). Followed by buffet supper (by application only).

South Wales and West of England

17 Mar (M). Emergency power generation plant, by a speaker from the CEGB. CEGB, Barnwood, Gloucester.

Merseyside sub-branch

18 (Tu) and 19 (W) March. Seminar. *Fuel trends: economics and utilization.* Liverpool Polytechnic.

North-Western

19 Mar (W). Lecture, by Prof T Kletz (Loughborough University). Mercury Motel, Backford Cross, Nr Chester at 1900 for 1930 h. Joint meeting with Stanlow branch, Institute of Petroleum, and IChemE.

South Wales and West of England

19 Mar (W). Young People's Papers Evening. University of Bath, Room 3E2.2 at 1730 h. *Please note venue and time.*

Yorkshire

22 Mar (Sat). Annual dinner dance. Cairn Hotel, Harrogate at 1915 for 1945 h.

Loose insertions this issue:
(1) Annual Luncheon ticket application
(2) O R Society conference
(3) Scottish meeting (Scotland only)
(4) Coal technology course

*The 1985 Robens Coal Science Lecture**

Coal and our atmosphere

P F Chester BSc PhD FIEE FInstP†

From an energy viewpoint, coal is simply a hydrocarbon. Not, in fact, a single compound but rather a complex and irregular network of hydrogen and carbon atoms. When a pure hydrocarbon burns to completion in pure oxygen the products are simple — water and carbon dioxide. If the supply of oxygen is not quite adequate we produce some carbon monoxide instead. If it is grossly inadequate we are left with partially decomposed material in the form of volatile organic compounds and soot, which is mainly unburned carbon and tar.

But coal is not a simple hydrocarbon (Fig 1). It contains many minerals — mainly silicates but also iron sulphide. Sulphur is also chemically bound in the hydrocarbon matrix. During combustion the minerals melt or sinter to form ash, which traps a few percent of the sulphur but most of the sulphur is oxidized to sulphur dioxide gas. Coal smoke is made up of particles of carbon, tars and ash (Fig 2). Another minor constituent of coal, particularly British coal, is chlorine. Some of this may be retained in the ash but most combines with hydrogen to escape as hydrogen chloride gas. Last, but by no means least, the element nitrogen is also embedded in the hydrocarbon matrix. During combustion some of this is oxidized to nitric oxide. If combustion takes place in air rather than oxygen there is a further supply of nitrogen in the air and this too makes a small contribution to nitric oxide formation.

Here then we have the main products of the uncontrolled combustion of coal. All, bar one, have been the subject of environmental concern, and some still are. In this lecture I shall touch on some of those concerns and on the science and technology that has been mobilized to resolve or reduce them.

Recorded complaints about coal smoke in Britain go back to the visit of Queen Eleanor to Nottingham in 1257. London already had a problem from the burning of Newcastle coal as early as 1273. By 1661 the situation was such as to prompt John Evelyn (Fig 3), a founder of the Royal Society to write to Charles II in the following terms:

> *'Her inhabitants breathe nothing but an impure and thick mist, accompanied with a fuliginous and filthy vapour, which renders them obnoxious to a thousand inconveniences, corrupting the lungs and dis-ordering the entire habits of their bodies; so that catarrhs, phthisicks, coughs and consumptions, rage more in this one city than in the whole earth besides'.*

By the early decades of the 19th century the tonnage of coal burned per square mile of London had trebled and the year 1819 saw the appointment of the first of a long series of Select Committees. The root of the problem was of course incomplete combustion, resulting from boiler designs in which coal was introduced on top of the fire bed, from the habits of untrained stokers and from the British love of the 'pokable, companionable fire'.

The designers of industrial and locomotive boilers responded to the need in ingenious ways to create better, and hotter, mixing of coal with the combustion air. A late example is the chain grate. But the penetration of nev designs took time; they were not proof against careles operation and domestic habits remained virtuall unchanged. Scenes such as this (Fig 4) were commonplac in British towns right up to the second World War. In th 1930's it was estimated that 6% of the carbon in domesti coal was lost in smoke — corresponding to an annua domestic smoke production in Britain of over thre million tonnes. The corresponding estimate for industria coal was a 1.5% loss in carbon — corresponding to ar annual soot and smoke production of six million tonne — nine million tonnes in all.

Much of this soot and dust was soon deposited fron the atmosphere — about 250 g per square metre pe year in London before the first World War. But the fine particles remained in the air for some time and providec the condensation nuclei for the notorious fogs of Londor and other cities (Fig 5). The absorption of sunlight b smoke in the atmosphere encouraged the persistence o temperature inversions in the atmosphere above London frustrating convective dispersion and allowing London' pollutants to accumulate for days at a time (Fig 6). Suc fogs were commonplace throughout the last century bu the most notorious occurred in 1952 when some fou thousand premature deaths were recorded among the ol and the infirm during the episode — due, presumably to the respiratory stress associated with the fog (Fig 7)

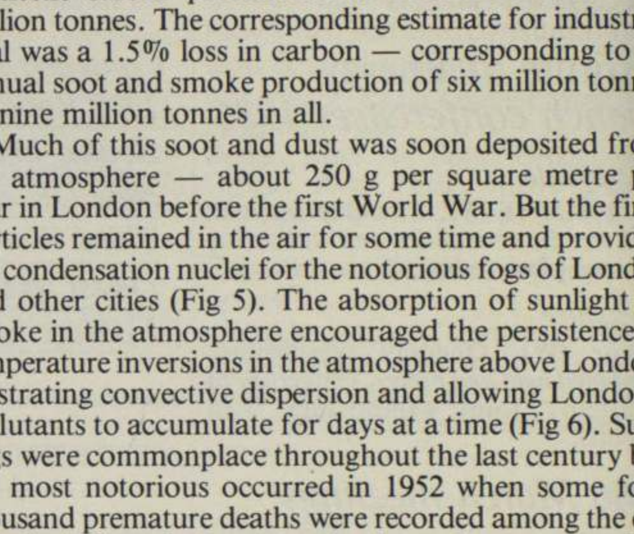


Fig 1 Main components of coal

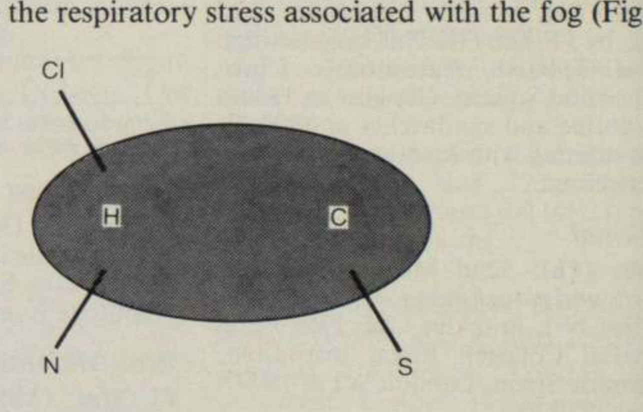


Fig 2 Main products of coal combustion

*Presented 7 October 1985 at the Royal Institution, London
†Research director CEGB Central Electricity Research Laboratories, Leatherhead, Surrey

Fig 3 John Evelyn, 1620-1706 (Courtesy National Society for Clean Air)

Fig 4 Stoke-on-Trent, 1925 (Courtesy National Society for Clean Air)

Fig 5 Heavily polluted London fog (Courtesy National Society for Clean Air)

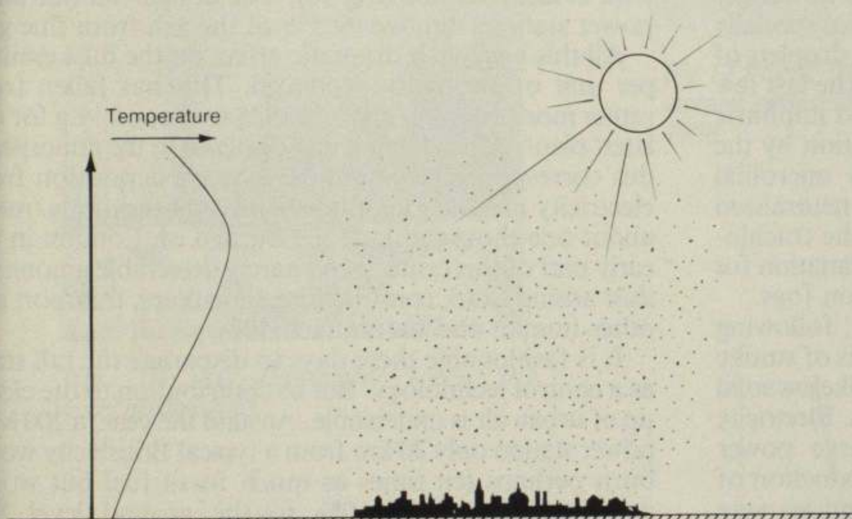


Fig 6 Temperature inversion reinforced by absorption of sunlight by smoke particles

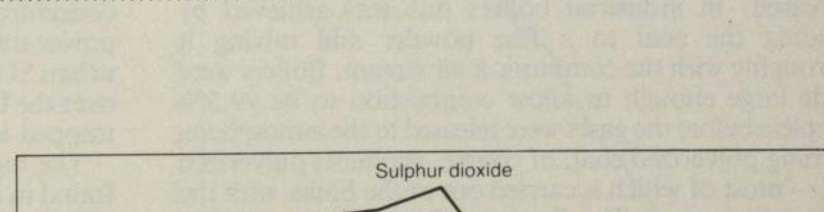


Fig 7 Excess deaths in London during the December 1952 pollution episode (after Macfarlane, 1976)

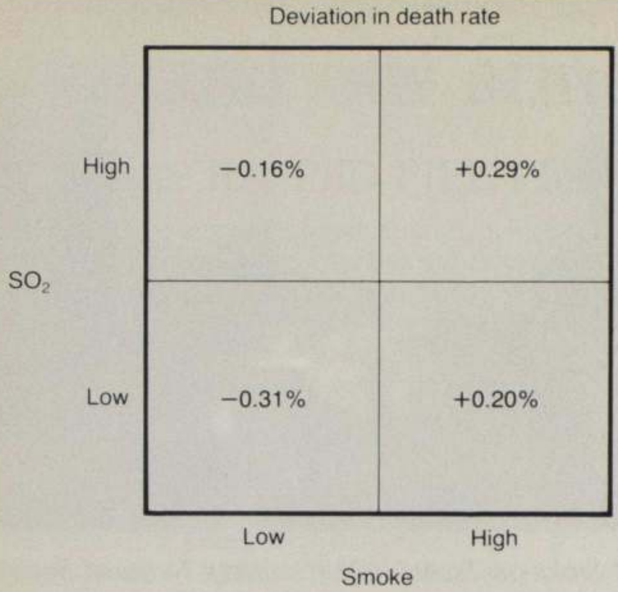


Fig 8 Deviation of daily death rate from 15-day running mean in relation to smoke and SO_2 levels, New York City, 1963-76 (after Schimmel, 1978)

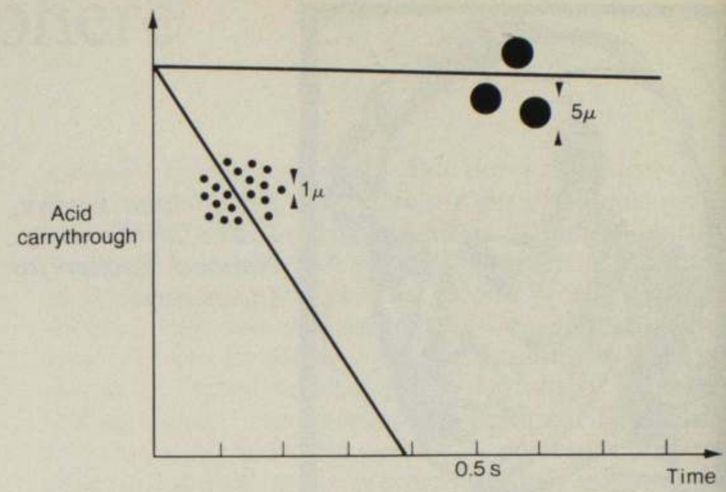


Fig 9 Relative neutralization of 1 μm and 5 μm acid droplets by ammonia in the human airways (theoretical calculation after Cocks and McElroy, 1984)

For a long time it was thought that the sulphur dioxide was the main stressful agent but, in London, high sulphur dioxide was usually accompanied by high smoke and one could not be sure which was most to blame. In New York the situation was different and a more recent statistical analysis for that city suggests a better correlation of excess mortality with smoke levels than with SO_2 (Fig 8). As the smoke in London's air has fallen and fogs have become rare, excess deaths of this kind are no longer observed. It would appear that the fog itself was specially irritant and we know that large, quite strong, droplets of sulphuric acid were present in those fogs. In the last few years it has been established that micron-sized sulphuric acid aerosol is rapidly neutralized on inhalation by the ammonia gas generated in our airways by microbial processes. But larger droplets cannot be fully neutralized before they impinge on the upper walls of the trachio-bronchial tract (Fig 9). This might be the explanation for the particular irritancy of the historic London fogs.

With the introduction of smokeless zones, following the Clean Air Act of 1957, domestic emissions of smoke fell progressively as coal was displaced by smokeless solid fuels, town gas, electricity and later natural gas. Electricity production moved increasingly to new large power stations well removed from urban areas. Production of soot and smoke declined as combustion efficiencies were increased. In industrial boilers this was achieved by grinding the coal to a fine powder and mixing it thoroughly with the combustion air stream. Boilers were made large enough to allow combustion to be 99.5% complete before the gases were released to the atmosphere. Burning pulverized coal, of course, produces pulverized ash — most of which is carried out of the boiler with the combustion gases. The fineness of this ash is such that the cyclone grit arresters used on the best of the chain gate installations would not have been able to capture it.

Fortunately a new and very suitable filtration principle had already been identified by Lodge, and applied by Cottrell, to other emissions — electrostatic precipitation. The principle is deceptively simple. Combustion gas, carrying the fine ash particles, passes through a system of electrodes consisting of large flat plates between which are suspended wires. These are maintained at a negative potential of some 40 kV with respect to the plates — sufficient to produce a corona discharge. Electrons from the corona attach themselves to individual particles of ash which are then repelled from the wires towards one or other of the plates on which they are deposited and discharged. From time to time the accumulated dust is dislodged from the plates by a rapping process and the pulverized ash falls into a collecting hopper. Commercial systems came into service in Britain in the late twenties. Nechells Power Station in Birmingham was fitted in 1934 with evident success (Fig 10). The designs on our latest power stations remove 99.5% of the ash from flue gas.

All this has had a dramatic effect on the dust emitted per unit of electricity produced. This has fallen from rather more than 4 g/k Wh in 1925 to around ¼ g for our latest plant. After dilution and dispersal in the atmosphere this corresponds to an annual average deposition from electricity production of one or two-tenths of a g/m² — about one-thousandth of the burden on London in the early part of this century and barely detectable among the dust arising from, construction, agriculture, transport and other human and natural activities.

It is fashionable these days to disparage the tall stack as a control technology. But its contribution to the clean up of urban air is undeniable. Around the year, a 200 MW power station only 20 km from a typical British city would burn perhaps ten times as much fossil fuel but would contribute less than 10% to the ground level SO_2 concentration in the city (Fig 11). In fact all the CEGB power stations put together contribute less than 20 % to urban SO_2 levels. Moreover, as was evident when flying over the London fogs, emissions from tall stacks are not trapped in urban fog (Fig 12).

The highest concentrations of SO_2 have always been found in our cities, and they still are. Nevertheless urban sulphur dioxide levels have fallen by a factor of four or five since the early 1960s as coal has been displaced from urban areas by gas and electricity (Fig 13). But the legacy of more than a century of urban combustion is still with us in the form of corroded stonework. If present SO_2 levels are indeed still harmful, then the most effective control measure will be a continuation of the trend to lower sulphur fuels in urban areas.

But sulphur dioxide in stronger doses can devastate landscapes — as it has around the Sudbury smelters — or kill trees — as it is still doing in East Germany and in Czechoslavakia and near their borders (Fig 14). There has

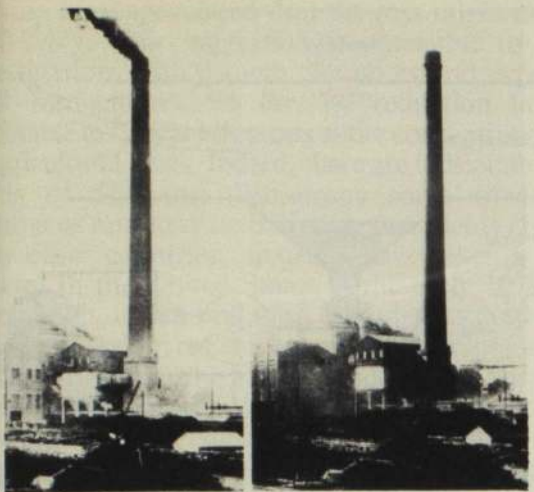


Fig 10 Nechells power station before and after fitting electrostatic precipitators, 1934

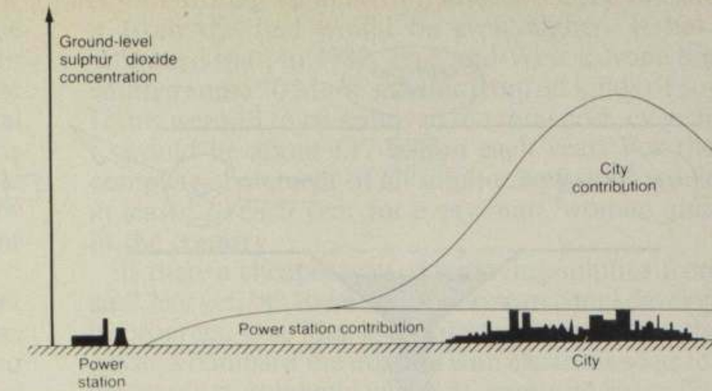


Fig 11 Contributions to urban SO_2 levels

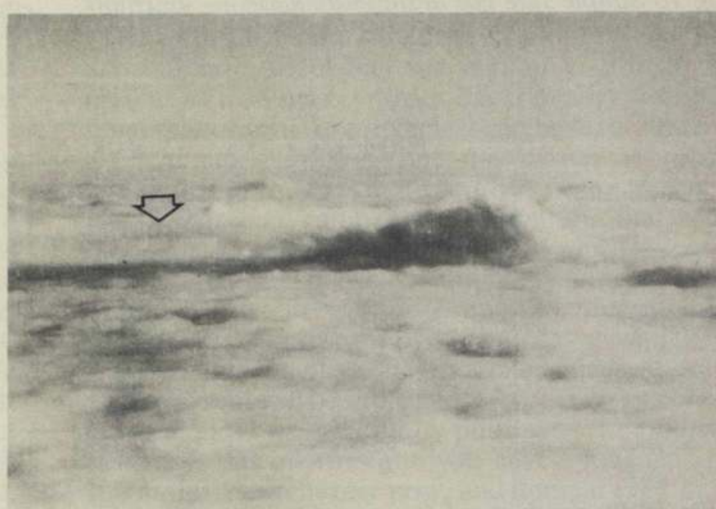


Fig 12 Plume from the 320 ft stack at Deptford East power station penetrating a 600 ft deep fog layer on 28 October 1958

Fig 14 SO_2-damaged trees in Czechoslovakia

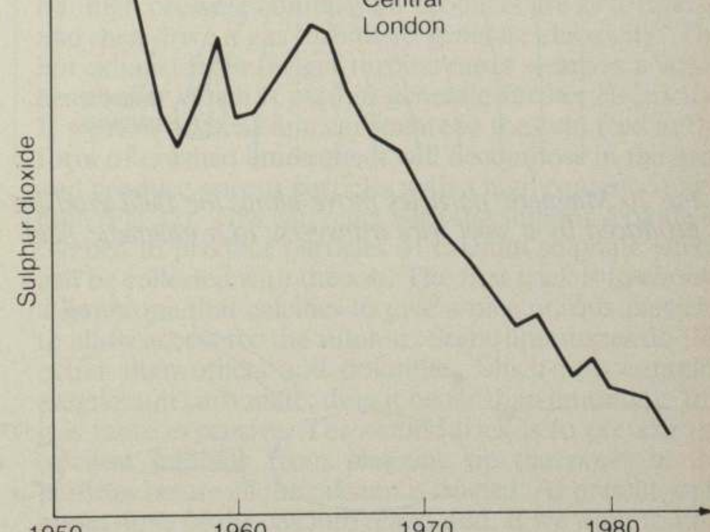


Fig 13 Trends in SO_2 concentration, Central London

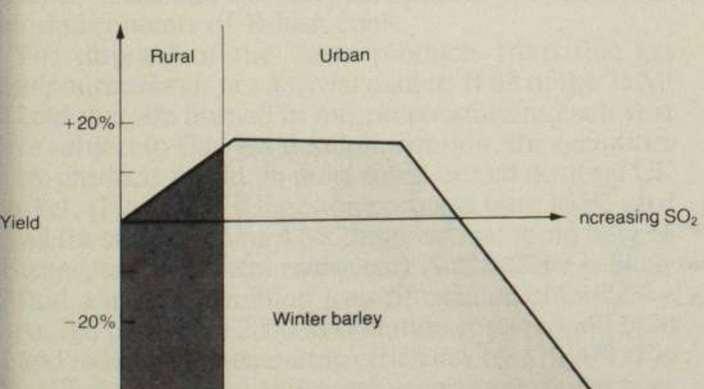


Fig 15 Effect of rural and urban levels of SO_2 on the yield of winter barley

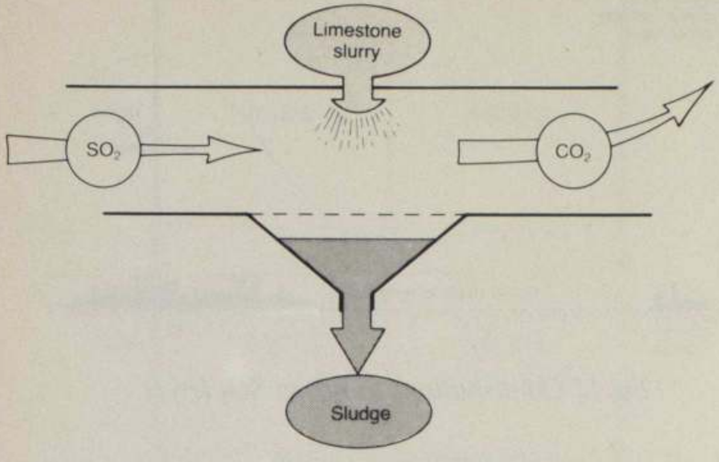


Fig 16 Simple flue gas desulphurization — schematic

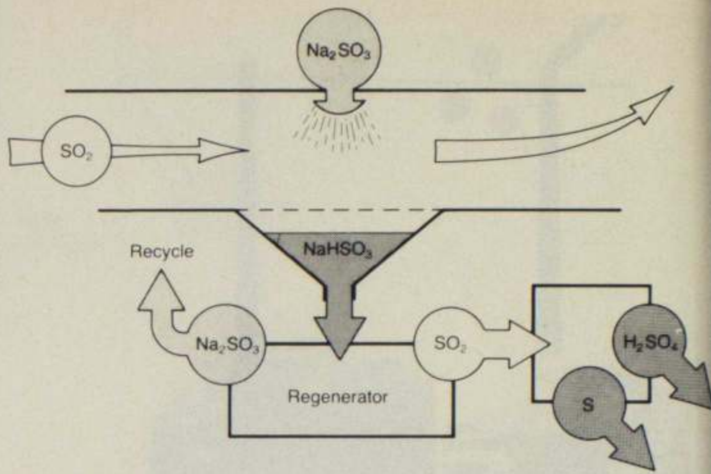


Fig 17 Regenerative flue gas desulphurization — schematic

	By-product	FGD on one 2000 MW power station, 1.6% S coal (tonne/year)	% of UK Market if FGD fitted to all coal-fired stations
	Gypsum	400,000	200
or	Sulphuric acid	185,000	100
or	Sulphur	55,000	100

Fig 18 By-products of flue gas desulphurization

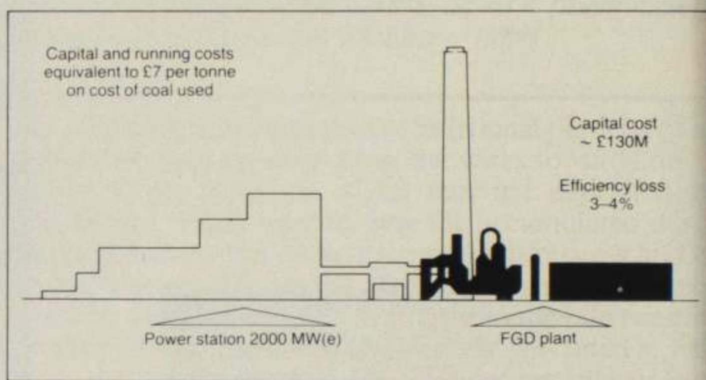


Fig 19 Cost of flue gas desulphurization

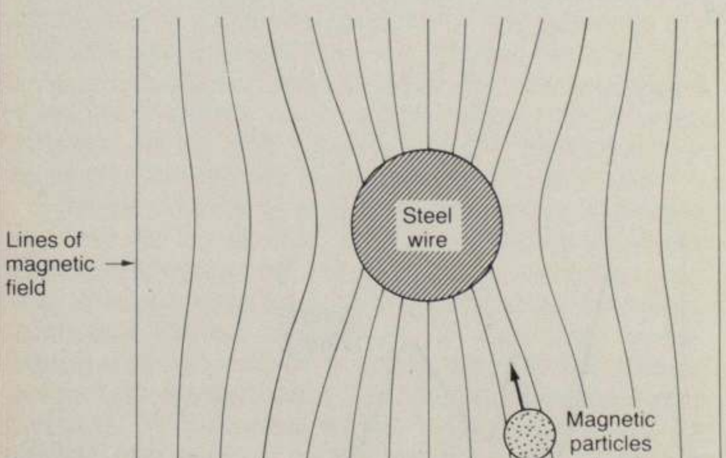


Fig 20 Magnetic particles move along the field gradient produced by a steel wire transverse to a magnetic field

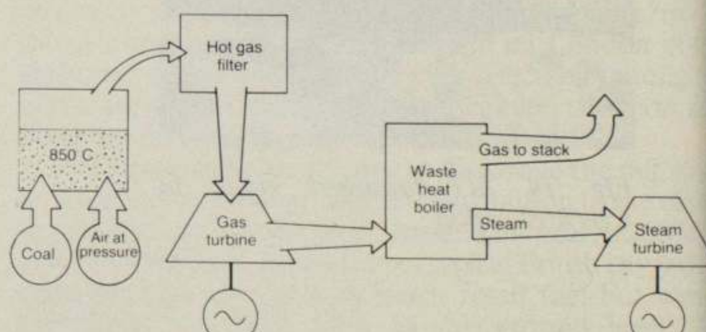


Fig 21 Combined cycle generation: hot gas from a pressurized fluid bed combustor drives a gas turbine and goes on to raise steam in a boiler

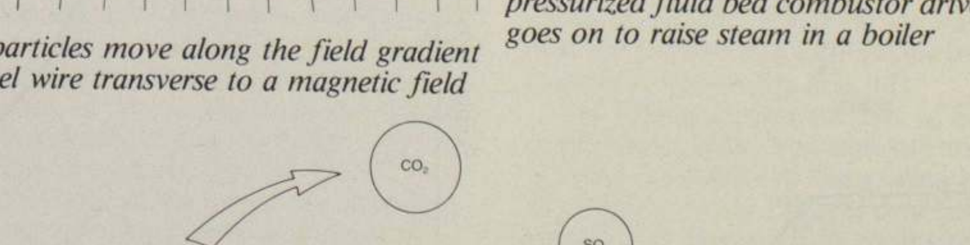


Fig 22 Capture of SO_2 by limestone in a fluid bed

en concern that it may be reducing crop yields in the UK combination with nitrogen oxides or ozone, and some ithors have speculated that the loss might amount to :50 M/y. This suggestion is amenable to scientific vestigation, with growth chambers and experimental eld fumigations. So far, no reduction in yield is etectable in typical UK crops at the concentrations found agricultural areas. Indeed, there are indications that low vels of SO_2 can discourage some of the plant ithogens and may actually increase yields (Fig 15).

In other countries, anxieties have taken a different urse. In the United States in the early 1970s, excess ortality in urban pollution episodes was attributed to lphur dioxide, or to ammonium sulphate aerosol rmed from it in the atmosphere. Before the necessary search and epidemiology had been completed, limits ere placed on the emission of sulphur dioxide from new ower station boilers. Similar measures were imposed in ipan for the same reasons. Where these could not be met / the selection of coals with a naturally low sulphur ontent, a new technology was needed — flue gas esulphurization (fgd).

The principle of the first fgd systems was simple (Fig i). The flue gas, on emerging from the precipitator, was posed to a calcium carbonate spray in the form of a nestone suspension. This absorbs up to 90% of the ilphur dioxide — releasing carbon dioxide in its place id producing a slurry of calcium sulphite and sulphate, hich has to be concentrated and disposed of. The volume sludge produced in a year by a single 2000 MW station ill cover an area of about 100 acres to a depth of 3ft. nce it has the consistency of toothpaste and dries out cceedingly slowly, the environmental benefit of this articular control technology may be questioned. evertheless some 32 000 MW of this type are already operation in the USA and they are still being onstructed.

More civilized implementations of fgd have a further action stage in which the sulphite is fully oxidized to ilcium sulphate, which may be dried and disposed of in ie same manner as pulverized fuel ash. Alternatively it ay be washed to produce market-quality gypsum. There e even more sophisticated systems which do not require ie use of limestone. In one of these (Fig 17) a solution sodium sulphite is used to strip up to 95% of the ilphur dioxide from the gas stream. In a separate vessel ie sulphur dioxide is re-generated in concentrated form, id can be further processed in additional plant to make emental sulphur or sulphuric acid for disposal or sale. he sodium sulphite solution is re-generated and re-cycled. i the more sophisticated processes it is necessary to move hydrogen chloride from the gas stream before it aches the fgd plant. This produces an additional waste oduct — calcium chloride, particularly with the higher ilorine contents of British coals.

The disposal of the waste products from flue gas esulphurization is not a trivial matter. If all of the 75 Mt coal that are burned in our power stations each year ere subject to flue gas desulphurization, the quantities by-products would, in most cases, exceed the total UK arket, (Fig 18). If a limestone process were to be used all the stations some 4 Mt of limestone would have to e transported to them each year. And no-one is likely find a use for a million tons of calcium chloride.

An fgd plant on a 2000 MW station costs around £130 l and reduces the generating efficiency by 3 or 4% (Fig). When the capital and running costs are spread over ie fuel used in the station, it works out at about £7/t on ie price of coal, or around £550 t of sulphur abated. The cost of abating sulphur from smaller boilers, or extracting it from the fuel would be even higher. It has been estimated that, in 1982, East and West Europe together emitted some 30 Mt of sulphur from all kinds of sources. If this were all to be removed the total cost, even at £550 t, would be about £17 billion each year. For the UK, complete abatement of all sulphur emissions would cost at least £20 each year for every man, woman and child in the country.

Is there a cheaper way of removing sulphur from flue gas? Not yet, but there's a lot of research and development in progress. One idea is to inject ammonia into the flue gas and bombard the mixture with electrons so as to form ammonium sulphate which is captured in a filter or precipitator. There are also systems under development which inject powdered lime into the gas stream which is then captured on a fabric filter and reacts there to capture yet more sulphur dioxide.

How much sulphur could we take out of coal before it is burned? About half the sulphur in British coal is present as iron pyrites which has a density nearly four times that of coal. In principle it can be separated out by a 'float-sink' process. But the pyrites is generally distributed in the coal in a very dispersed way and only a limited amount can be extracted without fine grinding of the coal. The froth flotation process, which is very good at separating coal particles from many minerals because of their different wetting properties, doesn't reduce sulphur much because the pyrites bubbles up with the coal. But pyrites is magnetic and in a magentic field gradient a particle of it will be subject to a force (Fig 20). The field gradient can be produced by putting a wire in a strong field. Use lots of wires and you have a magnetic filter. It is at the research stage now, and it might eventually be used after the standard coal milling process at a power station. None of these processes touch the organic sulphur in the coal. It has been suggested that bacterial attack could be used to extract this, and reductions of 40% have alreaddy been demonstrated in the laboratory; but this needs fine coal, and a lot of water; and the bacteria need a lot of time to do their work. But research continues.

For new plant, in the future, there is a radically new principle which may enable sulphur to be captured efficiently and economically during the combustion process — fluidized bed combustion (Fig 21). Here the crushed coal is burned in a bed of its own ash, kept fluidized by a stream of compressed air from below. The hot high pressure combustion products are first filtered and then drive a gas turbine to generate electricity. The hot exhaust from the gas turbine raises steam in a waste heat boiler which is used to generate further electricity. If we now add calcium carbonate to the coal feed in the form of crushed limestone it will decompose in the heat and produce porous particles with a high content of free lime (Fig 22). This can react with the sulphur dioxide in the bed to produce particles of calcium sulphate which can be collected with the ash. The first trick is to choose a limestone that calcines to give a nice porous particle, to allow access for the sulphur. Some limestones do this better than others and dolomite, which also contains magnesium carbonate, does it better than limestone. But it is more expensive. The second trick is to prevent the calcium sulphate from plugging up the pores in the particles before all the calcium is reacted. At present, only about 40% of the calcium reacts and, if we want to take out 90% of the sulphur, we have to add more than twice as much limestone as should be necessary. We may be able to improve on this with selected limestones, or with finer particle sizes, or even by re-circulating the limestone

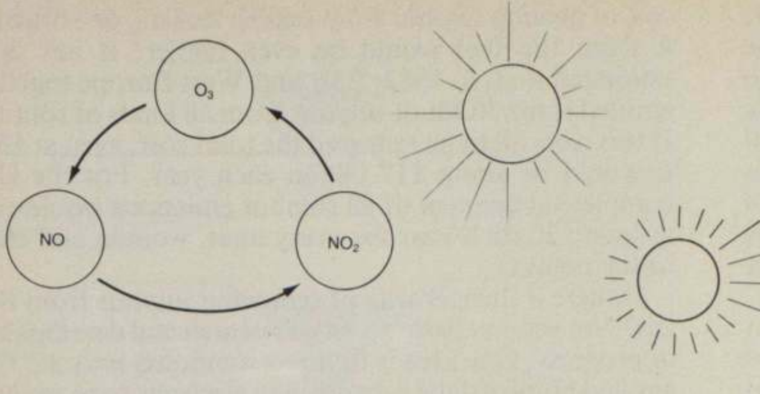


Fig 23 Equilibrium between nitric oxide, nitrogen dioxide and ozone in sunlight: no net production of ozone

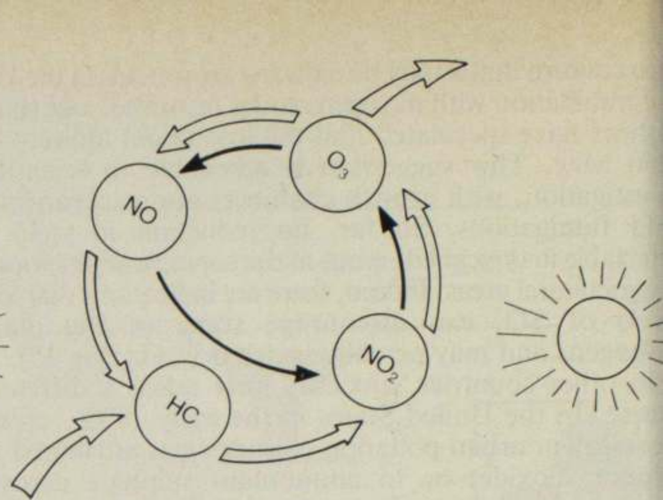
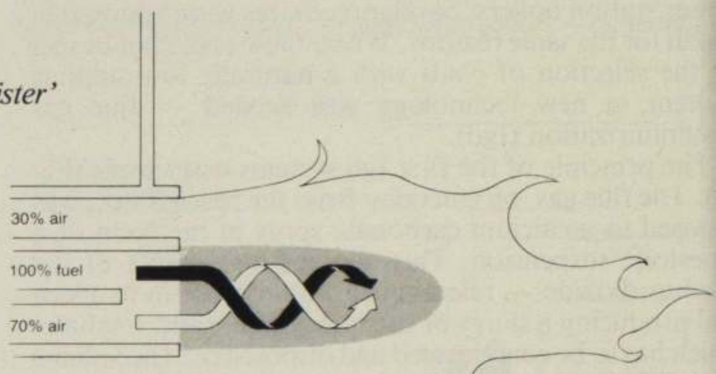


Fig 24 Equilibrium disturbed by reactive hydrocarbons in sunlight, resulting in net production of ozone

Fig 26 Delayed combustion using a coaxial 'dual-register' burner



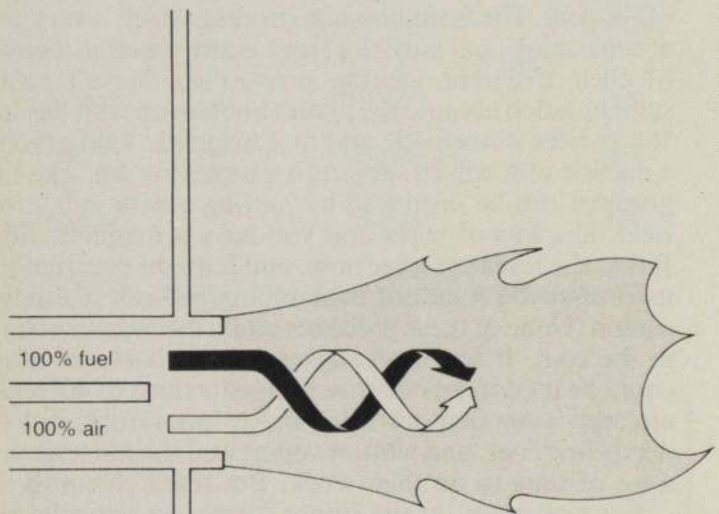


Fig 25 Well-mixed, high intensity combustion

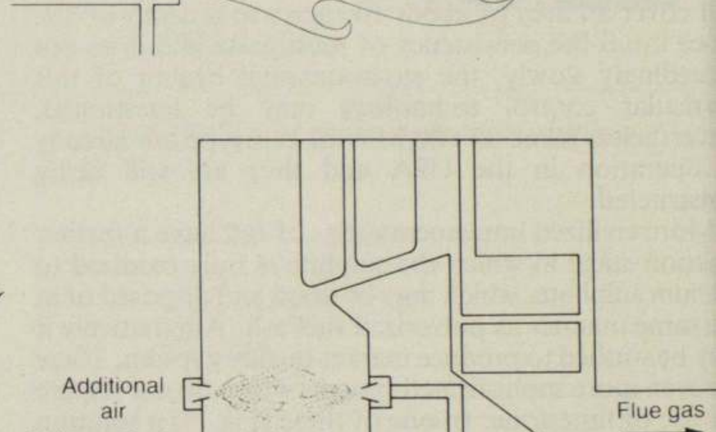
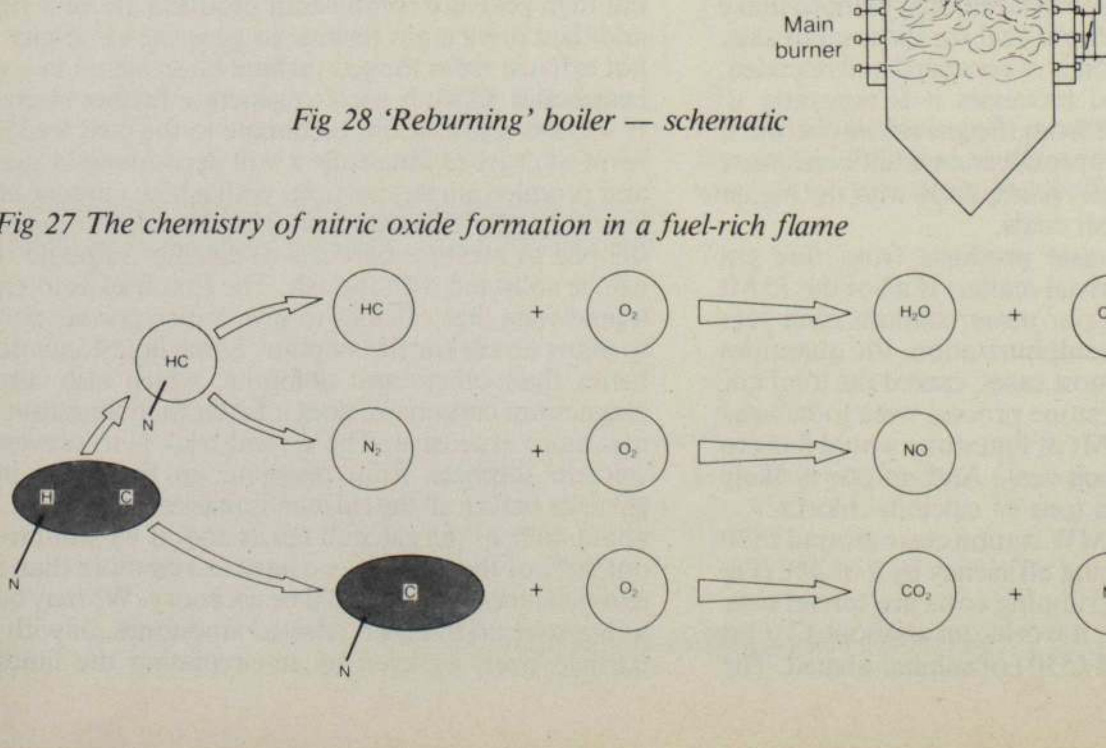


Fig 28 'Reburning' boiler — schematic

Fig 27 The chemistry of nitric oxide formation in a fuel-rich flame



ırticles through the bed again.

This problem is one of several being tackled by the NCB ıd the CEGB at Grimethorpe. We shall be spending ıme £28 M there over the next two or three years to see pressurized fluid bed combustion technology provides cheaper alternative to flue gas desulphurization. There e still a number of technical hurdles to cross — the clean- ɔ of the hot gas before it enters the turbine is one of ıem. But the cycle has the potential to generate electricity ith an efficiency of 40% compared with 37½% for a ɔnventional power station fitted with flue gas esulphurization. In America they think that the capital ɔsts will be comparable with a conventional station with ;d. So we are looking at this in more detail for the British tuation in collaboration with the Department of Energy.

In the meantime would the widespread adoption of flue ıs desulphurization in Europe cure the sickness that is resently afflicting some of the German trees — articularly silver fir and Norway spruce? This is not the amage caused by sulphur dioxide near the East German ıd Czechoslovakian borders. The symptoms are not the ıme and it occurs where sulphur dioxide concentrations re so low that lichens flourish, in the Black Forest and ı the Bavarian alps. In fact, three quite distinct symptom atterns are observed. Bright sunlight is evidently involved s the yellowing is only observed on the upper sides of ıe needles. The needles are found to be deficient in one r other of the important mineral nutrients — magnesium r manganese for instance. And they drop off much ɔoner than they should.

There is a strong suspicion that the cause of this damage s attack by ozone on the leaf tissues which allows certain ıutrients to be leached by rain or mist. It is theorized that cid mist may accelerate this process. Other theories link he action of ozone with frost or drought and involve a onsequential dieback of the fine roots, aggravating the ıutrient deficiency. It has also been suggested that a virus nay be responsible.

We have tried to reproduce the German symptoms on Norway spruce in our laboratories with exposures to ɔzone and acid mist. So far we have failed — the needles ;o brown not yellow and are not magnesium deficient. But we will continue the work with higher light intensities, ınd for longer times. It is encouraging that work at Freiburg University is showing that applications of nagnesium sulphate to affected plantations can restore he green colour. It remains to be seen if this would be ɔracticable on an extensive scale.

Would a reduction in sulphur emissions in and around Germany solve the problem? Not in the view of a leading orestry scientist giving evidence to the Select Committee ast year on behalf of the Natural Environment Research Council:

> *'if they were to remove sulphur from the atmosphere the German trees would still die';*

ınd this view is increasingly echoed in scientific circles.

In Germany, concern that ozone may be the responsible ıgent has sharpened interest in technologies for the control ɔf nitrogen oxides (Fig 23). Ozone is formed in the ıtmosphere by a complex series of reactions driven by unlight, involving reactive hydrocarbons and nitrogen ɔxides. By themselves the nitrogen oxides would simply ake the ozone on a merry-go-round: nitric oxide destroys ɔzone and forms nitrogen dioxide; sunlight converts the lioxide back to ozone and nitric oxide again. So there vould be no net production of ozone. But, in sunlight, eactive hydrocarbons also convert nitric oxide to the lioxide and the net result is that hydrocarbons are consumed and ozone is produced (Fig 24).

Now, efficient combustion of coal results in negligible emissions of hydrocarbons. But you will recall that combustion generates nitric oxide from both the nitrogen in the coal and the nitrogen in the combustion air. In our current design of boilers, the fuel and air are mixed rapidly and thoroughly to give a short, efficient, high-temperature flame (Fig 25). Because it is short the boiler can be compact. To reduce NO_x formation we must do almost the opposite.

The basic idea behind low-NO_x combustion is to get the coal hot enough to decompose before it is allowed to burn up completely. The simplest way of doing this is with a dual-register burner, in which the pulverized coal and part of the air feeds a fuel rich flame in the centre and the balance of the combustion air doesn't get mixed in until later on (Fig 26). In the fuel rich flame the coal decomposes into volatile hydrocarbon compounds which carry rather more than half the nitrogen and a carbonaceous char which carries the remainder of the nitrogen (Fig 27). Because the oxygen supply is kept low, as the volatiles decompose the nitrogen in them tends to re-combine to form harmless nitrogen gas. Now, when the balance of the air is added the volatile hydrocarbons are oxidized to water and carbon dioxide. Some of the gaseous nitrogen is oxidized to nitric oxide and the nitrogen on the char is also oxidized to nitric oxide. The amount of nitric oxide produced in this way is perhaps half of that produced in a well-mixed, high intensity flame.

But you can be even more clever. There is a little oxygen left after this process, and if you add a little more fuel it will burn to produce carbon monoxide and this in turn can react with the nitric oxide to convert it to harmless nitrogen gas. This 're-burning' technique is being developed by a number of manufacturers for new boilers — rather bigger and more complicated than conventional ones, but they will only emit about a fifth of the NO_x (Fig 28).

Meanwhile there is the stock of existing boilers. We do not know how much NO_x reduction we can get by modifying them before we run into problems — either due to flame impingement on the walls, or to incomplete combustion of the fuel, but we are starting to find out. At present there is a full scale boiler trial at Fiddlers Ferry and another will start at Eggborough in a year's time. We imagine the reduction will lie between 20 and 40%.

If you want to do very much better with existing plant, you will need to remove nitric oxide from flue gas after combustion. Several processes are under commercial development. The most advanced is that of selective catalytic reduction. This involves installing a bed of catalyst in the hot combustion gases near the back end of the boiler. Ammonia gas is injected in controlled amounts and this reacts with the nitric oxide on the catalyst surface to form molecular nitrogen and water vapour. But there are complications. Not all the ammonia is reacted and what slips by can react with sulphur dioxide to form ammonium sulphate and bi-sulphate which can clog up the air heater further downstream. On conventional coal-fired plant, the catalyst bed would have to be upstream of the electrostatic precipitator and exposed to the entire dust burden. Nothing is known of the performance and durability of catalysts exposed to the ash and hydrogen chloride from British coals. So the prospect of diesembowelling an existing power station to fit flue gas de-NO_x as well as fgd is quite off-putting for a boiler operator.

For future plant, isn't there a simpler way of achieving emission reductions? The radical answer to this question

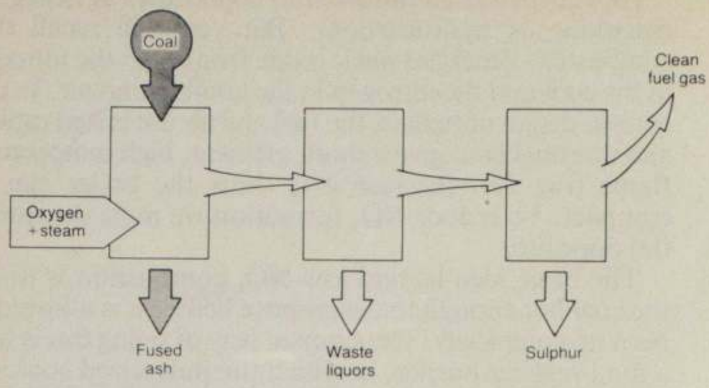


Fig 29 Coal gasification — schematic

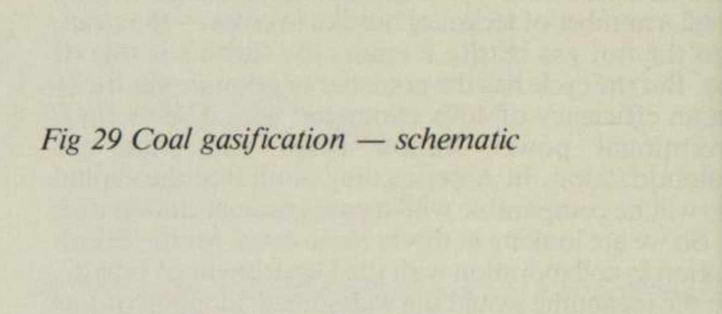


Fig 30 Combined cycle generation: clean fuel gas from a gasifier is burned to drive a gas turbine and the exhaust gases raise steam in a boiler

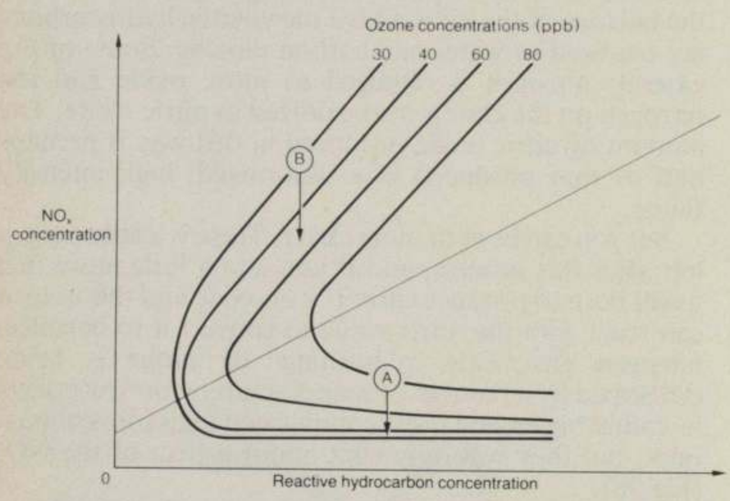


Fig 31 Expected maximum daily ozone concentrations as a function of initial NO_x and hydrocarbon levels

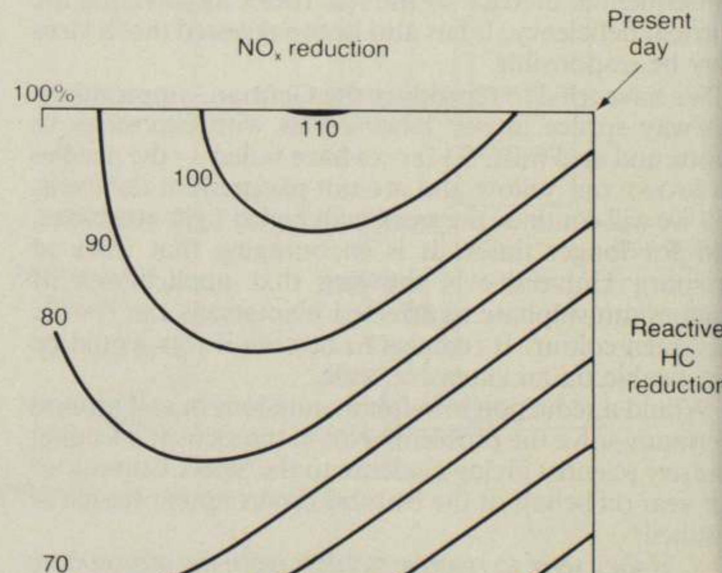


Fig 32 Relative effectiveness of NO_x reduction and hydrocarbon reduction on urban ozone levels (after Derwent and Hov, 1980)

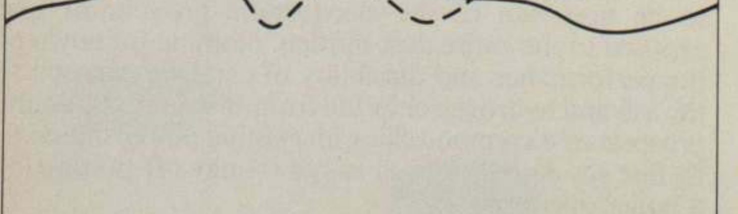


Fig 33 Seasonal variation of SO_2 in air and sulphate in rain, Bottesford, 1978-80 (after UK Review Group on Acid Rain, 1983)

to convert the coal to fuel gas, free of both sulphur and itrogen. The technology already exists. A number of ommercial designs are available, among them the British ias/Lurgi slagging gasifier at Westfield in Scotland.

The principle is to convert the carbon in coal to carbon ionoxide and to convert the hydrogen to hydrogen gas r methane. This can be done by burning coal in a arefully limited supply of oxygen and steam, which itself ipplies additional hydrogen (Fig 29). In the British Gas orporation gasifier the ash is discharged as a molten ass. The chlorine comes out as hydrogen chloride in the aste liquor and the sulphur, which emerges as hydrogen ilphide, can be converted downstream into elemental ilphur. The nitrogen in the coal appears as nitrogen gas. 1 the BGC gasifier more than 80% of the input energy ppears as calorific value in the fuel gas.

This clean, dust-free product is suitable for burning at igh temperature, say 1250°C, in a more sophisticated ower cycle, using a gas turbine (Fig 30). The exhaust om the gas turbine raises steam in a waste heat boiler nd the discharge to atmosphere consists almost entirely f carbon dioxide and water vapour with only the reducible nitric oxide produced thermally from the ombustion air. With an advanced gas turbine the overall fficiency of this arrangement could be as high as 39 or 0%. In the United States, using a different gasifier, and less advanced gas turbine, they already have a emonstration plant operating at 30% efficiency. In this ountry, the CEGB and the NCB are working with the ritish Gas Corporation on an engineering and cost sessment of their gasifier in a combined cycle.

Will all this effort pay off? Will ozone levels come own if NO_x emissions are cut? That is not at all clear. or many years now, following the Los Angeles smogs, tmospheric chemists around the world have been studying nd modelling the complex chemical reactions involving unlight, hydro carbons and NO_x which lead to the roduction of photochemical oxidants. Even a modest iodel needs dozens of equations for the chemistry alone. Vhen you try to put in all the meteorology as well, it's ifficult for even the fastest computers to keep up. But iere is already a scientific consensus on the role of NO_x 1, and around, urban areas. Fig 31 shows contours of eak ozone concentrations expected to develop during the ourse of a day for different initial concentrations of IO_x and hydrocarbons in the air. If we are in a situation orresponding to point A, then a reduction in NO_x ould be expected to reduce ozone levels. But if we are 1 a situation corresponding to point B then cutting NO_x missions would actually *increase* ozone levels and the only ay to reduce them would be to cut hydrocarbons, not IO_x. It seems likely that around industrial and urban reas we are in situation B.

The Harwell modellers have examined this situation. rom Fig 32 you can see that even a fourfold reduction 1 NO_x would be counterproductive — ozone would ctually increase. But any degree of reduction in ydrocarbons, on the other hand, would be effective from he start. You'll see that reducing NO_x and ydrocarbons together could well have no effect at all.

The modelling becomes more difficult when we try to redict ozone concentrations at longer times and distances ownwind and the situation at long distances is unclear. ut in terms of policy, and investment in technology, not o mention the price of cars, this must surely be the most nportant unresolved question in coal science for the nmediate future.

There are large uncertainties too in the processes which enerate sulphuric acid from SO_2 in our atmosphere. For example, in England, SO_2 emissions peak in January but sulphate in rain peaks in May (Fig 33). Now, photochemical oxidants, including ozone, are necessary for the production of sulphuric acid from SO_2. We do not actually know to what extent the sulphate in rain falling over Southern Scandinavia or Scotland is limited by the available supply of these photochemical oxidants. If their supply turns out to be limiting the formation of sulphuric acid at the present time, only very major cuts in SO_2 will reduce the sulphate in rain, and it might be better to go for the photochemical oxidants instead.

It is certainly very hard to find a consistent relationship between SO_2 emissions and the sulphate falling in rain or snow in Southern Scandinavia. Over the period 1963 to 1975 when European emissions increased by 40%, wet deposition of sulphate in Scandinavia actually decreased. It is not generally realized that over 60% of the non-marine sulphate falling in rain on Western Scotland arrives on winds that have been travelling over the Atlantic for several days. And existing models of European emission cannot account for 30 to 40% of the sulphur deposition in SW Norway.

There are other intriguing findings. Last year, the Institute of Terrestrial Ecology in Scotland published trends in Scottish rainfall over the period 1978 to 1983 showing an average 50% reduction in acidity — hydrogen ion concentration. This was hailed as the result of the 25% reduction in UK sulphur emissions over the same period. But sulphate levels in the Scottish rain did not change significantly at all over that period. There are many other ingredients in rain that affect its acidity and these should not be overlooked.

Over the past few years, we have been sampling the composition of aerosols and cloud water in the sky around the UK, both upwind and downwind. Our export of sulphur is clear, but evidently we export calcium as well. Now, calcium is a very important element for the survival of fish, especially in the pure waters of Southern Norway. Fig 34, which applies to 1975, shows the difference in composition between the fishless lakes there, represented by the dots and the lakes with good fish populations, represented by the crosses. You will see that even quite acid lakes can have good fish populations so long as they have adequate calcium. On the other hand, lakes with low calcium were found to be fishless even if they were not very acid. The low calcium lakes on the left of the figure are mainly at higher altitudes, in catchments with very little mineral soil, supplying very little dissolved material to the lake water. In such lakes, an important source of nutrients, such as calcium, is the rain itself.

It is interesting to speculate whether the low levels of calcium in these lakes could in any way be related to the kind of environmental improvement that is illustrated at the beginning of this paper. Throughout Europe, dust emissions from power plant, cement works, metallurgical processes and domestic fires have reduced progressively over the past few decades. For example, at Harwell, airborne dust attributed to combustion sources fell by a factor of two or three between 1957 to 1974 (Fig 35). We just do not know the contribution of manmade dust to the composition of the air passing over the UK in earlier decades, but it must have been very much greater than nowadays. But before the last war, emissions of SO_2 in the UK were little more than half their 1970s levels. So it is quite possible that 50 years ago, our production and export of neutralizing mineral dust, including calcium, equalled, or even exceeded, our production and export of sulphate. The same may be true for other countries. This may have been a factor in the acidification of lakes, over the past few decades. People are just beginning to examine this possibility more seriously. We do know that the addition of calcium to acid lake waters in Sweden is effective in maintaining healthy fish populations.

Most of this paper has discussed sulphur dioxide and nitrogen oxides because they are the focus of intense current interest, but if we look to the future it is carbon dioxide that moves to centre stage. It is not possible here to expand on the possible consequences of the accumulation of carbon dioxide in our atmosphere from the combustion of fossil fuels. It is currently estimated that a doubling in atmospheric CO_2 would lead to climatic changes greater than any experienced naturally over the last 10 000 years.

So, will flue gas de-carbonization provide the next boom in the world of emission control technology? The ideas are already flowing. It is suggested that you could scrub out the CO_2 with an organic solvent, re-generate the CO_2 and liquefy it; you would have to dispose of somewhere and one notion is that it could be piped 1(to 200 miles out to sea and put in the depths of the ocea where it would form a liquid pool insulated from tl atmosphere by 3000 m of water (Fig 36). It is estimate that to take 90% of the CO_2 from flue gas in this wa would reduce the efficiency of a power station from 38% to 14% and would treble the cost of electricity.

This Coal Science Lecture is concluded with tha sobering thought for, if the carbon dioxide threat do indeed turn out to be as ominous as some suggest, the I fear that *coal* science may have rather little to contribu to the remedy.

Acknowledgments
I am indebted to many colleagues for contributions to thi lecture and to Dr A J Crane in particular for his help i its preparation.

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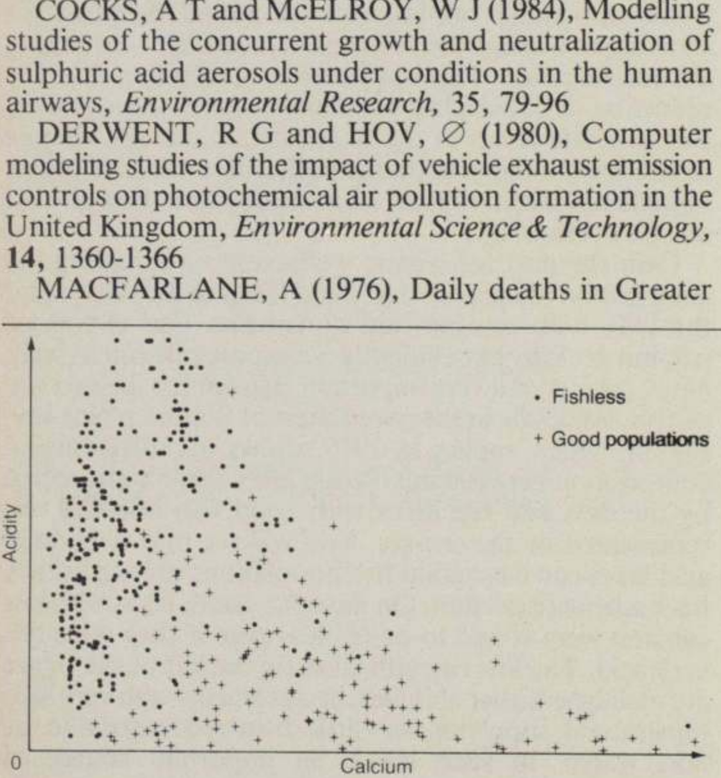


Fig 34 Distribution of fishless and well-populated lakes in southernmost Norway according to acidity and calcium level (after Chester, 1984)

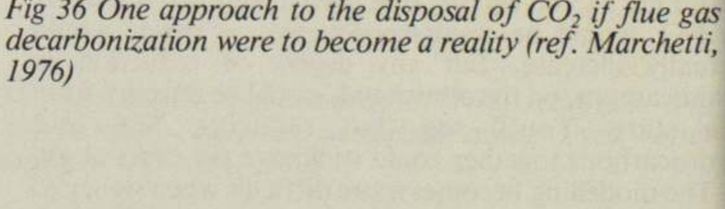


Fig 36 One approach to the disposal of CO_2 if flue gas decarbonization were to become a reality (ref. Marchetti, 1976)

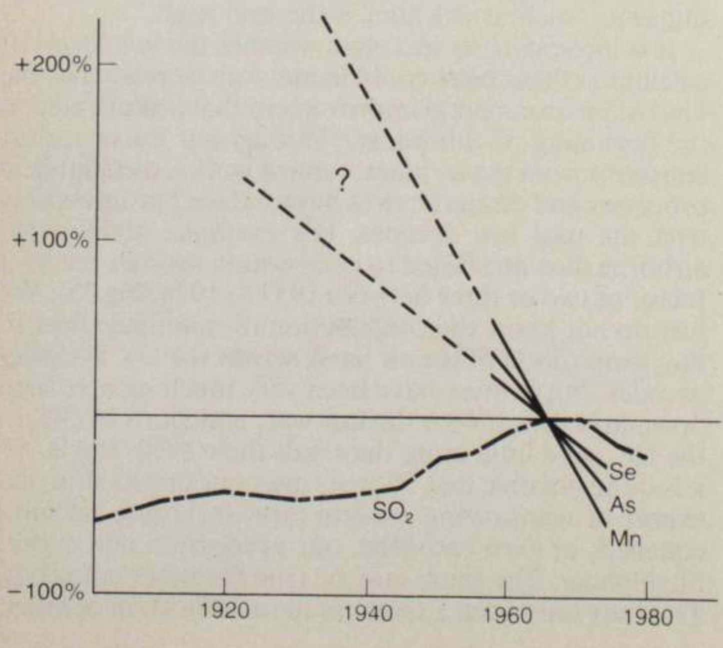


Fig 35 Trends in British atmospheric dust levels and SO_2 emissions

r J C McVeigh reviews a selection

he energy balance in /ortheast Asia

seph A Yager (with the assistance of ielley M Matsuba)
he Brookings Institution, Washington, 84
2.85

ortheast Asia is defined by the authors the non-communist countries of Japan d South Korea. They have several mmon features — their economic owth rates have been among the highest the world, they are all poor in energy sources and are major energy porters. The various changes in their tterns of energy supply, total energy nsumption and economic growth are amined for the 1960s and 1970s and mpared with three western countries — e United States, West Germany and ance. Energy security and foreign licy issues are discussed and this sets the ene for the major part of the book hich projects possible future energy quirements under different sumptions.

The final chapter reviews the principal ndings of the study and the implications f the possible energy developments that ave been projected for 1990 and beyond. lthough the authors point out that these timates are necessarily only illustrative can be seen that their projections for apan in 1990 are very unlikely to be ached, with 1984 figures falling well elow the place the estimates had ggested. Some readers may find that e authors' style is not particularly easy follow as the text contains a nsiderable number of footnotes and the nall print in notes accompanying the bles is irritating. An appendix gives etails of the technical terms and nalytical methods which could be useful r non-specialists. However, this is not book for the general reader and will be f limited interest to those who do not are the authors' view that such a study ould be useful in analysing the problems f other energy importing areas.

The demand for energy in he Soviet Union

avid Wilson
owman and Allanheld, New Jersey, 983
18.95

his book will come as a surprise to those ho are unaware of the impressive rimary energy resources and production apacity of the USSR. In the words of the uthor '...most Western analysts have failed to comprehend the scope and depth of Soviet technological advances during the last decade... and that highly efficient new models of machines with very low fuel rates are being installed by most sectors of industry...'.

The first chapter examines the forecasting of fuel supply and demand, and immediately the first table (of nearly 150 in the whole text) enables a comparison to be made of planned fuel production with actual achievement. In 1982, when the book was prepared, the 1985 plan was for 524 Mt of coal (Mtce), 900.9 Mtce of oil, 746.5 Mtce of gas and 50 Mtce of peat, shale and firewood. Actual output in 1984, quoted in the *BP statistical review of world energy* shows coal at 555 Mtce, oil 919, gas 789 and the nuclear industry, having doubled its output since 1979, at 37.5 Mtce. This is precisely what the author would have expected to see, but clearly not what other economists were forecasting in the late 1970s — a CIA report in April 1977 suggested that oil production would have declined to less than 775 Mtce by 1985.

Successive chapters look at the household and municipal sector, the demand for fuel by the electricity and thermal energy industries, iron and steel, construction materials, chemicals and oil refining industries, transport, agriculture and foreign trade. The final chapter discusses the future supply of fuel and predicts the levels of fuel consumption in each sector if a minimum growth rate in the Soviet economy is to be sustained. The author, who is a lecturer in Soviet Geography at the University of Leeds, has drawn upon some 176 books and 40 magazines were regularly monitored since 1971 as part of his source material. The result is a highly readable and fascinating account of the Soviet energy economy which deserves to be included in any serious energy library.

Energy outlook: with projections to 1995

The Washington Group
The Washington Group and Elsevier Science Publishers, Amsterdam 1985

The Energy Information Administration of the United States Department of Energy and its predecessor agencies have provided annual projections of energy production, supplies and prices since 1976. Their reports and associated data have been used as the basis for this major reference source, which has also drawn upon material provided by the Energy Statistics Division of the International Energy Agency.

It is important to appreciate that although there is a chapter on international energy markets, this is essentially a book about the United States and their government's views on energy futures. Nuclear power, for example, is considered to be about to experience a tremendous growth in other nations towards the end of the century, while their domestic market is due for a very rapid near-term expansion because of commitments to plants currently under construction. Their overview of the present trends in the world energy outlook is carefully stated and the assumptions used in their forecasting models are clearly explained. This will be a basic reference source for those who need to study the energy policies of United States in detail, but probably not particularly essential for non-specialist libraries.

Bio-energy: technology, thermodynamics and costs

David T Boyles
Ellis Horwood, Chichester, 1984

The author is a project leader with a major oil company and the book arose from an industrial evaluation of the merits and problems of bio-energy. The value of the work to a wider readership must therefore be judged with this caveat as a significant proportion of the text material has been covered by many other authors in a more digestible form. The book is divided into nine fairly brief chapters, commencing with an outline of the need for abundant and cheap energy. This is followed by a chapter on the various factors influencing the use of biomass — solar insulation, land use, crop yields, costs of collection and conversion routes. The next two chapters examine the technology of biofuel processes and a more detailed approach to costing, while the fifth chapter looks at the energy cost of bio-energy.

The next chapter contains a discussion of risk assessment, social impact and pollution. Markets for biofuels are dealt with in the seventh chapter and it is in the eighth chapter, called 'What can research do?', that the author's own area of expertise can be seen to make an original contribution. The book ends with a rather short and pessimistic conclusion, summarized in the sentence 'Biomass is unlikely to contribute anything but a small percentage to total energy consumption!' The very wide range of potential readership envisaged by the publishers is unlikely to be achieved, as the author's somewhat technical text is not always easy to follow. A glossary would have been helpful.

(Books continued on following page)

(Books continued)

Western european energy policies — a comparative study

Nigel Lucas
Oxford University Press, 1985

Prof Nigel Lucas is visiting Professor of Energy Planning at the Asian Institute of Technology where he is on secondment from Imperial College. This book, which was completed some years before he took up his present appointment, examines how countries choose their energy policies. The organizational structures and policies of five European oil-importing countries — France, Germany, Denmark, Italy and Sweden — are compared with particular emphasis on the allocation of responsibilities for energy procurement, conversion and distribution. The author feels that to a large extent the opportunities for the use of technology on which to base an energy policy are equally available to most industrialized countries depending on imported oil, but a detailed analysis reveals considerable variations in approach. In the five countries studied, for example, Prof Lucas concludes that political factors have had a greater influence than technical factors in the development of energy policy.

The author has the gift of making a subject which is often treated in an unimaginative, quantitative manner become alive and full of interest with his perceptive comments — a few examples chosen at random will illustrate this: '...the referendum can be seen as a clever political manoeuvre; it was a means by which the (government), broadly favourable to nuclear power... could get a population broadly opposed to tha[t] power to accept a nuclear programm[e] which is *per capita* one of the largest in th[e] world whilst simultaneously appearing t[o] close it down...'

'Generally, one would not expec[t] conservation by legislation to have muc[h] future in (the country)... the lack o[f] legitimacy in the State finds expression i[n] a range of activities from terrorism to ta[x] evasion...'

'It is astounding to an outsider to se[e] the extent to which utilities accept thei[r] diverse interests being represented by on[e] body, and that the arrangement works s[o] smoothly...'

Whether or not you can work ou[t] which country or countries, should b[e] attached to these comments, this boo[k] can be thoroughly recommended as [a] course text in all the wide variety o[f] energy related courses available a[t] graduate level.

LETTERS

Medallion standards: objectives achieved

I must reject Owen Dumpleton's assertion in the November issue of *Energy World,* that Medallion Houses are not energy saving.

The Medallion Scheme launched in 1977 throughout England, Wales and Scotland clearly demonstrates the importance of energy saving. The many thousands of homes built to Medallion standards are a visible proof of achieving very high standards of living, comfort and convenience, cleanliness and reliability. Such homes have a competitive selling edge over conventional homes. As far as Scotland is concerned, private builders have been attracted by all electric developments. In 1984/85, 4790 homes were constructed, 12% higher than the previous year, 20% of the total UK figures.

Sales of storage radiators during 1984/85 in the Scottish Boards totalled 46 800 units confirming the confidence of consumers in space heating. The Medallion specification demands strict standards in thermal insulation in particular, but obviously must be balanced in economic terms. One needs to establish the relative merits of various methods of thermal insulation for roof and cavity wall insulation, floor insulation, double glazing etc, to obtain the correct 'U' values.

Taken that Medallion requirements are met, electric heating and hot water systems designed to ensure 50% of the total electricity for the two systems can be used on Economy 7, or White Meter tariff; economics and energy saving will result.

Mr Dumpleton suggests it is wrong to have separate and competing authorities for different forms of energy. I take issue with him on this. The customer has the right at all times to make the final choice. This assures builders and energy suppliers must remain conscious of the customer's needs which will be 'finance dominated'. It adds the vital ingredient of securing improvements in performance in the area of marketing modern dwellings. I am not sure what Mr Dumpleton has in mind when he speaks of power station efficiency and transmission losses. Is he suggesting there is a superior form of energy transportation waiting to be commercially utilized?

Last year saw the Golden Jubilee of the National Grid, and it is worthwhile reflecting upon the enormous benefits to 20 million consumers of an extremely efficient electrical integrated network. The 400 kV system is supported by an increase in overall thermal efficiency of its supplying power stations from 27% to 34% since the 400 kV system was designed 20 years ago. The top 10 conventional power stations in England and Wales already exceed 35%, three exceeding 38%.

These facts represent an enormous saving in fossil fuel and the financial rewards are similarly immense.

F JOHN L BINDON *(Member)*
Bangor, N Wales

Single energy supply authority: no thanks!

'Heaven forfend' that we should have a single energy supply authority with the role proposed by Owen Dumpleton.

It is setting energy saving *per se* as the goal that leads us along false paths. There is no merit in singling out energy as the resource above all others whose consumption should be minimized. The objective function to be minimized is total economic resources — which, perforce, have to be measured in money terms.

Horror stories about power stations 'wasting' two-thirds of the input energy cut no ice if the cheapest way to make good the heat losses from a small well-insulated dwelling turns out to be sending 'nutty slack' or uranium (very inconvenient fuels for individual householders) by wire and converting the received electrical energy into heat by the use of low cost household appliances. The higher the standards of home insulation the more likely is this solution to be the one that consumes least economic resources in bringing about the desired end of maintaining the temperature of the dwelling at the comfort level. It goes without saying of course that the cost of the insulation has to be included in the sums for each option if the right choice is to be made.

L G BROOKES PhD *(Fellow)*
Bournemouth

Industrial implications of the new UK educational initiatives

by David Browning*

In secondary education in recent years there have been a number of major developments designed with the eventual aim of providing students with a general education but achieved through a broad vocational or technological framework. The hope is that there will be an increasing move towards student-centred learning, with more emphasis on relating education to the outside world, in particular the world of work. These moves are designed to enhance, rather than displace, the broad aims of education

In England and Wales a major new approach has been initiated by MSC in the Training and Vocational Education Initiative (TVEI) which will eventually encompass the whole of education from 14 to 18 years. For the first time this involves joint teaching (as opposed to link courses) in schools and colleges of further education. TVEI is not a new course or set of courses. It provides an integrating control (or umbrella) for a wide range of courses including existing GCSE and 'A' level courses. In addition a number of courses, from bodies such as the City and Guilds of London Institute (CGLI), the Royal Society of Arts (RSA) and the Business and Technician Education Council (B/TEC), of a vocational or pre-vocational nature are included. These are normally considered to be further education courses. TVEI consortia of schools and colleges are also encouraged to develop their own syllabuses for individual modules to be assessed by one or more of the recognized awarding bodies (eg WJEC).

Although the co-ordinating influence of TVEI is predominant it is not haphazard and very definite criteria concerning structure have been laid down. These are mirrored in many of the courses incorporated within TVEI. These criteria are outlined below:

1 There will be a common core of skills/competences to be learned by all students in whatever they study to prepare them for employment and adult life, and under the following headings:

Personal and career development.
Industrial, social and environmental studies.
Communication.
Social skills.
Numeracy.
Science and technology.
Information technology.
Creative development.
Practical skills.
Problem solving.

The skills/competences need not, indeed preferably should not, be taught separately but within the framework of academic and vocational subjects. The level of attainment will be different for each student depending both on his or her age and level of ability.

2 There must be a balance between academic and vocational elements that will depend, to some extent, on student choice and on that made by educational establishments involved. It is important that students are effectively exposed to both by the age of 14 years or, as an interim measure, 16 years.

3 Combinations should be such that they will lead to further study and aid employment prospects.

4 Emphasis is being placed on the role of experiential learning, and work experience, as an integral part of secondary education. There are likely to be difficulties in arranging this, in part because of local difficulties in providing the right kind of experience in sufficient amount and in part because of possible union antagonism at a time of high unemployment.

5 An important aspect of this and other initiatives is the significance being given to problem-solving as an integral part of the learning process. It provides an excellent stimulus for training for adult life providing the level of problem is retained within the student's purview and ability.

6 The dual needs of literacy and numeracy are highlighted by TVEI and, indeed, by all major developments in education at present.

7 There is an inbuilt requirement to provide career guidance and exploration, a vital area of study in today's very difficult employment situation.

8 It is also mandatory to avoid sex stereotyping, a difficult criterion apparently to achieve completely when students are allowed a large measure of choice.

These broad criteria are representative of most of the vocational and prevocational courses provided at present. They afford no conflict of interests between the various awarding bodies. They do, however, provide a serious challenge as far as assessment is concerned. It is no longer feasible to examine students only on the basis of a final written paper. Many of the skills and competences to be learned need to be asessed on a regular, or continuous basis. This will normally require routine assessment of progress combined with some form of final examination.

It is not the aim here to discuss individual initiatives as such, but two require special, if brief mention. Many of the criteria to be met in TVEI at aged 14 may not be possible for some students, in particular those who develop later, or those who have missed the opportunity to participate at 14. The Certificate of Pre Vocational Education, run jointly by B/TEC and CGLI, provides many of the skills for 16+ students outlined within TVEI and is available in schools and colleges of further education.

In Scotland the needs of education are being met by the 14 to 16, and Plan for Action (16 to 18) initiatives developed by the Scottish Education Department in conjunction with the Scottish Vocational Education Council (SCOTVEC). Although related to the Scottish educational culture and ethos they have much in common with the initiatives in England and Wales.

References are given at the end of the paper to some of the recent initiatives in UK education but most of the criteria are embodied in the earlier discussion which was designed to explore the essence of the changes rather than give a detailed synopsis of curriculum change. Clearly the changes are in attitudes and approaches rather than in

*Consultant

syallabus content, although there will be modifications in the latter reflecting changing outlooks.

The changes have led to the introduction, or extension, of a number of areas of study. This is particularly noticeable in the increasing emphasis on craft, design and technology courses, and on courses biassed in the direction of high technology (eg electronics, information technology, control and modular technology, microprocessor control, robotics, CAD/CAM) and the 'service' industries (business studies, retail and distribution, food and catering, community care).

This, coupled with the mandatory study of science in early secondary education has serious implications for industry. What are these implications?

Two of the major learning strategies which are being encouraged are those of learning for life and employment and a flexibility of attitudes. This, coupled with an insistence on the attainment of basic levels of literacy and numeracy, shows a definite intention to meet many of the needs expressed by industry over many years. It is now up to industry as a body, and as individual companies, to play their part in ensuring the success of these initiatives. Some of the ways by which this can be achieved are given below.

Firms must become involved with schools and colleges in a much more intimate way than is often true at present.

(a) They should become involved in working parties designing new syllabuses or modules of study, particularly those with a vocational element.

(b) They must be prepared to help in the preparation of teaching material to ensure that it is relevant and up-to-date.

(c) They must be prepared to provide industrial placements, where at all possible, to ensure that students get some idea of what the world of work is like and where feasible to relate that work to their academic and vocational studies. There are serious difficulties in providing the right kind of placements and enough of them and, in the past, too often the reaction of companies has been to refuse to help on grounds of lack of expertise, money or time. I do not believe this is any longer acceptable if industry, as it claims, wants students to be educated to be employable. If direct industrial experience is not possible (d) can be an alternative.

(d) Simulated industrial experience is a second best alternative to direct placement. It does not allow students to encounter the personal problems they will meet in an adult, and sometimes hostile environment. However they can be placed in a situation which resembles the work place in other respects. For example, a laboratory may be set up in college where the students are laboratory personnel dealing with a specific problem devised by one of the local firms. The teacher, or a student, as laboratory manager sets up a team to solve the problem. Stress can be imposed, eg by the continuous kind of 'phone calls from industry which would frequently occur when a solution is required urgently. Students could be expected to work firms' hours even with enforced 'overtime' on one or two occasions. This will necessitate provision of expertise, time, materials and possible finance from industry.

(e) If a problem-solving approach is to be adopted firms should be involved in the provision of such problems in conjunction with school and college staff.

These, and other initiatives, can increase the impact of industry on education, but demand a greater responsibility for education — not only at secondary level but above and below this. This will clearly pose problems not only financially, but in their relations with education locally and nationally.

If industry does not participate in this venture wholeheartedly the vocational and training aspects will become school, or college-based, and will not have the validity which has been demanded by industry in recent years.

Firms at a local level may not have been approached by colleges — either because the colleges are not involved in the initiatives available or, unfortunately, in many cases because there is insufficient liaison between industry and the education sector. There are a number of agencies who can help, but the first approach should be made to the Manpower Services Commission, who certainly will be able to advise.

Having considered the implications for industry, it is important to look at the benefits. The first major advantage will be a greater knowledge of the role and significance — and, indeed, the challenge — of industry which should encourage students to look at an industrial career, on graduation, as a first choice, rather than as at present when it is still looked upon by able students too frequently as a last resort. Employment realities are ensuring such people are entering industry — but not always with the right outlook. They are also more likely to opt for the kind of qualifications being offered by universities and polytechnics in subjects like Engineering, Food Technology and Business Studies. This must increase the potential for sound management and technology skills. To achieve this, industry in partnership with education must excite the imagination of youngsters at an early age.

However, only a fraction of youngsters go on to higher education, the majority comprising clerks and technicians. I often hear the complaint from industry that they have to employ graduates because of the lack of supply of youngsters with lower level (but important) skills, and less demanding aspirations. With the right kind of education *and* training, as proposed by the new initiatives, we will be developing a technologically more literate and numerate society than before. Many of these students will be able to play a more realistic part in the growth of both manufacturing and service industry as employees, and possibly just as importantly as customers and purchasers of industrial products and expertise.

There are benefits to all, but the effort required is substantial. The push must come from both sides but if properly done the result will be a more employable population on a growing industrial base. This has to be worthwhile trying to achieve.

What is the role of energy in this new equation? It is probably the most important applied science and technology topic that the student is likely to meet, since it is significant in many ways and at many levels, and is related to many subject areas. It has connotations in design in, for example, the siting, construction and comfort of house and home. The chemistry of fuels and, more broadly, the energetics of chemical reactions is fundamental in both chemistry and physics. Food technology is based upon the energetics of body functions.

In the industrial situation the ethos and economics of manufacturing processes are essentially energy-controlled. Indeed, our national economy is dependent to a large extent on the finance from North Sea oil and gas.

Many of the most significant implications for society can be related to the use, actual or recommended, or abuse of the energy sources at our disposal.

It is clear from the manifold links energy has with areas f study that it can act as an integrating feature in ducation. Such links are sorely needed if we are to rovide students of all ages with the kind of education nd training that is envisaged earlier in this paper.

It is to be hoped that the Institute of Energy, and ssociated societies overseas will take the lead in ensuring hat the teaching of energy acts as a unifying influence 1 the future.

Relevant bodies and courses

Training and Vocational Education Initiative (TVEI)
Manpower Services Commission
Selkirk House
166 High Holborn
London, WC1V 6PF

Certificate of Pre Vocational Education (CPVE)
Organized jointly by the City and Guilds of London Institute and the
Business and Technician Education Council
National and Higher National Certificates and Diplomas
Business and Technician Education Council
Central House
Upper Woburn Place
London, WC1H 0HH

The City and Guilds of London Institute provide a range of pre vocational, foundation and vocational courses:
The City and Guilds of London Institute
46 Britannia Street
London, WC1X 9RG

The Scottish Ordinary Grade courses and the Plan for Action
Scottish Education Department
New St Andrews House
St James Centre
Edinburgh, EH1 3TD

Vocational courses in Scotland: run by the *Scottish Vocational Education Council (SCOTVEC) and CGLI.*
SCOTVEC
22 Great King Street
Edinburgh, EH3 6QH

□

Third World
Communications — letting the people know

The spectre of drought and famine has been brought very powerfully into the living rooms of the industrialized world in recent months through the medium of television, radio and newspapers. Because of our easy access to the latest in technologies, many of the problems facing poor people in developing countries have become clear to us.

However, communication is a two-way process, and the difficulties begin when we seek to communicate not only our desire to help the Third World, but also the options and possibilities at our disposal. Many different technologies are available, any one of which could theoretically benefit poor people in rural areas.

One reason for the lack of progress in applying appropriate technologies is the difficulty in informing and consulting the rural people who stand to benefit from their introduction. They may have a good idea of what might help them, but effective means for informing them are lacking.

The three main means of communication at present are:

- *Printed matter with text and pictures.* However, literacy among the rural poor cannot be guaranteed, and, anyway, it is difficult to accommodate the great diversity of languages and dialects, many of which are not written.
- *Extension workers.* They are usually trained on a formal basis by technical staff, supplemented by printed matter, models and audiovisual aids. The communication to this point is generally adequate, depending on the teaching staff and the available software. The problems begin when the extension worker goes out into the field and, despite his knowledge of the local language, finds there are no adequate words to describe some of the alternatives. Pictures are used in a few cases, and also models, but these are usually too cumbersome or delicate to transport.
- *Radio,* a very useful medium, but being limited to an audio channel, it is difficult to convey effectively concepts and possibilities of a more technical nature. Also, the reception of radio broadcasts needs a receiver with a power source to operate it. This is sometimes beyond the means of rural communities.

The ideal solution would be to present technical choices to rural people through colour television, with appropriate commentary. This is obviously impossible, so an intermediate stage is necessary. Many organizations offering technical assistance or technical choice have libraries of colour slides, which can be used in an urban environment where mains electricity and other relevant equipment is available. If these same slides could be combined with commentary in local languages and taken to the villages, there would be an improvement in understanding of the technologies on offer.

An even more effective method would be portable video machines, which can operate from an easily rechargeable energy source, such as car batteries. At present, there is a lack of suitable equipment of this type, and also the software is not widely available to the organizations offering technology choice.

A fundamental consideration is the power consumption of these machines. Commercially-available video viewers, linked to television sets, use about 300 W, and even conventional slide projectors consume some 100 W. This is obviously too high for an easily-portable power supply. However, the technology is readily available to operate video machines at less than 100 W. The problem remains to design a unit which can be effective in situaions remote from mains supply or even home generators.

The equipment for communicating with people in the Third World also needs to be portable, light and robust, and have an easily renewable power source. It is easy to write up the ideal specification but very difficult to persuade a manufacturer to consider making such equipment.

The Institution of Mechanical Engineers has been seeking suitable devices on the world market for over a year without success. If *Energy World* readers know of a potential supplier, a note to the editor would be very greatly appreciated.

JOHN C FROST *(Project manager)*
Intermediate Technology Development Group

Identifying energy losses
Aerial thermography

Over 50 Cardiff businesses have been studying a new aerial thermographic survey which shows energy wastage and heat loss in the city.

The results of the survey,* which were revealed at a seminar sponsored by the Energy Technology Support Unit last year, were used to show how infra red surveys can be used to improve energy efficiency at low cost.

Infra-red thermography works by measuring energy which passes from a hotter to a colder object by radiation. All objects emit some radiation at temperatures greater than −273°C. The technique is very useful as it shows quite graphically where energy is being wasted.

'Measured energy emission can only be related to temperature if the emissivity of the surface is known' said Alan Williams (Fellow)†, energy consultant, who advised caution in the interpretation of infra-red thermograms.

'A layman can interpret the photograph but would not attempt to analyse a computer print out of photon levels at a particular infra-red wavelength An infra-red thermogram is just such a print out but looks like a photograph. Hence the danger,' he said.

Details of another airborne thermographic infra-red survey, carried out in 1984 for Surrey County Council at a cost of £11 700, were used to identify energy wastage.

Energy conservation officer, P Davies from Surrey County Council showed how selected parts of the county participated in aerial thermographic surveys and how 75% of the aerial thermographic costs were recovered from owners of the buildings and other premises studied.

The Cardiff infra-red survey has already helped identify insulation problems, energy wastage and leaks from underground pipes, leakage from inaccessible areas such as glazed or asbestos roofs, and insulation defects.

Source: Cardiff Energy Action

Energy Efficiency
More councils are saving

Earlier this year we reported that the south Birmingham Area Health Authority are expecting to save £1M on their energy bill in the coming year. Now, Lancashire County Council have announced almost a £7½M saving in energy costs between 1978/79 and 1984/85.

The savings, which come as a result of good housekeeping, energy conservation investment and changes in use of fuel, amount to £7.39M or 8.2% of the fuel bill of almost £90M for that period. These figures are nearly £3M ahead of the target set by the County Council when it accepted a policy document *Fuel, Buildings and the Future* in November 1981. Such savings reflect the hard work of the Energy Conservation Unit of the Property Services Department, one of the first of its kind to be set up in the country and the continued co-operation of staff and building users in taking good housekeeping measures. These include turning off lights when rooms are not in use, closing doors and windows to minimize heat loss and the adjustment of heating controls to avoid overheating.

The County Council have also set up a special energy sub-committee and an energy steering group of officers to constantly look into energy conservation matters.

Lancashire County Council has made a £2.5M capital investment in energy conservation measures during the six years, including, for example, roof insulation, cavity wall insulation and draught proofing of Council buildings and the savings from these measures for last year were just over £½M, or a return of 20% on the money invested. Over the whole of the review period the savings on this investment amount to £1.47M with the remaining balance of £5.92M coming from good housekeeping and conversion to low cost fuels, for example, oil to gas, and other conservation measures.

The Conservation Unit is keeping records on some 1800 major County Council buildings and for each building energy consumption and costs are analysed over a five year period. Each building is given a target figure for energy consumption (which allows for weather variations) and those buildings not reaching their target figure are constantly monitored and measures taken to achieve further savings. The system obviously requires a great deal of data collection from many sources and necessary analysis is supported by two computer based systems.

Some 2300 NORWEB electricity accounts are regularly reviewed by the Energy Conservation Unit to ensure the County Council obtains the most economical tariff.

Source: Lancashire County Council

Industry year
Engineers urged to join in

Britain's engineers are being urged to participate in Industry Year by getting involved in local affairs, promoting their companies and demonstrating the contribution of engineering to the community as a whole reported the *Financial Times* in January.

Guidelines to the profession issued in January by the Engineering Council emphasize the need to get the message over to the public that engineering is exciting and creative, and contributes to the quality of life. Engineering employers are asked to hold open days for staff and their families, schools and the local community.

Most of the £500 000 budget for Industry Year provided by the Department of Trade and Industry has already been allocated or spent on promotional literature. The contribution from industry has been mainly in the form of people seconded to the project by companies such as IBM, ICI and Barclays Bank.

These people are working from the offices of the Royal Society for the Encouragement of Arts, Manufactures and Commerce in London and in regional units created to spreading the Industry Year message with the support of the CBI, TUC and institutions such as the Engineering Council.

Another guide — *School/Industry Links: a directory of organizations* — produced by the Department of Education and Science, has been sent to every secondary school in England and Wales.

Sir Keith Joseph, Education Secretary, told the North of England Education Conference 'Let 1986 be the year which saw the end, once and for all, of the damaging estrangement between education at all levels on the one hand and industry and commerce on the other.'

Source: Financial Times

USA/natural gas
Horizontal wells

The US Department of Energy has awarded** a $1.2 M contract to test and evaluate a directionally drilled horizontal well as a novel concept for more effective draining of a natural gas reservoir from one well in Devonian shale rock. Conventional production methods use explosives in vertically drilled wells. Scientists at the Morgantown (WV) Energy Technology Centre believe that this horizontal well technique has the potential of improving the amount of gas that is recovered per well by 100%, which will make Devonian shale rock competitive as a source of natural gas. Typically, conventional natural gas wells are drilled vertically but they produce only 25% of the available gas.

In the last 70 years, some 12 000 vertical wells have produced only 3 trillion cu ft of natural gas from production fields in southwestern West Virginia and Kentucky. With this novel production technique, multiple stimulations in a long, horizontal borehole that is drilled across the natural fracture system in the rock could be the key to unlocking more of the gas available for production, according to computer modelling studies.

Such computer applications enable the

*Clyde Surveys
†Chairman of the Institute's Education Committee
**BDM Corporation

valuation of various engineering options vithout actual experimentation in the aboratory or field. The computer imulation integrates different scientific nd engineering disciplines into predictive nodels, data needs are identified, and hen research strategies, such as this irectionally drilled horizontal well, can e evaluated.

The major objectives of this research re to verify current computer model redictions that indicate improved atural gas recovery efficiency is possible, nd to test the concept that multiple ydraulic fractures from a horizontal vellbore are the key for such success. In he process, well cores and logs, reservoir ests, and diagnostic surveys will be used o evaluate recovery efficiency.

If successful, this new concept for ecovering natural gas from the eologically complex Devonian shale rock reas warranting development can ecome an accepted practice in an ndustry where vertical wells have been raditional. The research payoff could be nore gas from a resource for which the as gathering infrastructure already is stablished. It is like finding a new eservoir within an old reservoir.

Morgantown Energy Technology Centre researchers have been studying Devonian gas shale rock as an nconventional source of natural gas for he past nine years. These earlier efforts haracterized the resource and mapped its xtent so that industry would know the ize of the resource and the location of the reas for development. The extent of the Devonian shale gas resource now is stimated to contain 500 to 1100 trillion u ft of gas.

Current field research efforts are neasuring reservoir properties in areas of known production potential so that ssessment of gas recovery potential can e made for new areas. For production, esearch has been done on the behaviour nd prediction of natural gas reservoir roduction performance through earlier ntense testing and evaluation of timulated vertical wells in known roduction areas. Now, this complimentary research will expand this nowledge base by measuring the roduction potential from a stimulated as well that is horizontal.

Source: US DoE

Petrol from coal
Work started on new plant

Construction work began in January on Britain's £35 M petrol-from-coal plant longside Point of Ayr Colliery, Clwyd, North Wales.

Using a liquid solvent extraction rocess developed by the National Coal Board's Coal Research Establishment, he pilot plant to be built at Point of Ayr vill process 2.5 t of coal a day into a wide ange of transport fuels, including petrol, liesel and jet fuels for aircraft.

The pilot plant will develop laboratory processes and could eventually lead to the engineering design for construction of a full-scale commercial conversion plant — virtually a coal refinery processing thousands of tonnes of coal a day. Commercial exploitation could be feasible in the 1990s.

Commenting on this new stage of the development, NCB chairman Ian MacGregor said 'This pilot plant will scale-up our laboratory processes for converting coal to high premium fuels, so that eventually coal will again be a major source of energy to the transport market.

'This process has the potential of being substantially more efficient than the South African SASOL process. With lower cost coal available in the UK we can ensure that we will remain wholly or partially independent of imports when our North Sea oil and gas production starts to decline.

'In the longer term, I believe oil prices will increase relative to coal, and we need to be ready with a proven process to take advantage of this potential market opportunity.'

Source: NCB

Fuel cells
Military applications

The ability of the fuel cell to supply electricity and heat at a military base located in a harsh environment is now being tested near Anchorage, Alaska, at Elmendorf Air Force Base. The military is evaluating the potential of fuel cells for supplying a portion of its energy needs in applications that can be uniquely different from those in the private sector. Of special interest here is the fuel cell operation in very low temperatures and severe weather conditions and its reliability in a location that needs low-maintenance power systems.

The Alaskan test is using a 40 kW phosphoric acid fuel cell power plant as part of a research programme that is sponsored by the Departments of Energy and Defence, the Gas Research Institute, and more than 37 gas/electric utilities. The research is technically managed by the National Aeronautics and Space Administration (NASA) for the Department of Energy's Morgantown (WV) Energy Technology Centre. It is one of some 46 40 kW power plants that are either in operation, have completed field testing, or are in final installation or start-up.

At Elmendorf Air Force Base, the test fuel cell is installed next to a 21MW steam turbine power generating plant where it provides power for some of the lighting in the power plant. This arrangement serves a dual purpose. First, it ensures continuous lighting in the plant because it is independent of the main power source. Then, second, the lights act as a visual indication that the fuel cell is operating properly. The fuel cell is in an unheated building that protects maintenance personnel from the −20 to −30 temperatures and wind chill when working on the test unit. A one year test period will evaluate how well the fuel cell works and how reliable it is in these severe temperatures.

The Elmendorf unit ran continuously for 1674 hours from initial start-up on July 23, 1985 until October 1, 1985, when it was shut down for scheduled maintenance. That was the longest continuous run from initial start-up in the entire 40 kW fuel cell programme.

Other military field tests of this phosphoric acid fuel cell as an advanced energy system are at the Wright-Patterson Air Force Base, Ohio, where it supplied 5% of the electricity needs of the Air Force Museum; and for supplying a portion of electricity and heat to a dormitory and dining hall at two other army bases.

A fuel cell is a noiseless, almost non-polluting power system when operating on natural gas. It produces energy by an electrochemical reaction rather than by combustion. This particular fuel cell uses phosphoric acid as its electrolyte, corresponding to the acid in a car battery. The system uses natural gas as a fuel; the fuel is electrochemically combined with air in a reaction that directly produces electricity and releases 'waste' heat to a coolant. As no direct combustion occurs, the fuel cell plant avoids inefficiencies that occur from other heat-driven power systems. The relatively small amount of waste heat, compared to conventional power cycles can be used to make the total system even more efficient. At Elmendorf, this waste heat preheats water to generate steam in the main power plant.

Fuel cells are termed 'on-site' because, unlike large centally located power stations, these small power systems (each of the 1000 lb systems is about the size of a garden tool shed) can be installed where the energy is used. Since there are few moving parts, only fans and coolant pumps and no emissions, fuel cells are easily located to use the waste heat. When this is done, about 80% (40% is the electricity portion) of the fuel energy can be efficiently used. Most conventional power plants convert only 30 to 50% of the energy in their fuel to electricity and the excess heat is lost or vented.

The 40 kW phosphoric acid fuel cell is development of smaller fuel cells that were developed and used by NASA in their Gemini, Apollo, and space shuttle missions.

Source: US Dept of Energy

Gasification
US investigates pollution

The US Department of Energy has awarded a $540 000 contract to the Institute of Gas Technology (IGT), Chicago, to study how oxygen, sulphur, and nitrogen elements in coal form environmental pollutants during coal gasification. Novel use of a method called radioisotopic tagging will help IGT researchers find out what chemical reactions cause the formation of pollutants.

The study is for two years, and the University of Chicago will perform some of the research under subcontract to IGT.

Coal gasification produces solids, liquids, and gases as end products. Environmental contaminants such as sulphur appear in all forms of the end product. It is preferred if the sulphur ends up in the gas, because it is relatively easy to capture simple sulphur compounds from gas. Cleaning of complex liquid and solid products to eliminate the sulphur is much more difficult.

It is important to study the fragments that are released as the bonds break because these fragments eventually determine the make up of the desired products and unwanted pollutants. But, this information and other key features of basic coal structure is difficult to get from experiments on coal itself.

To overcome this problem, IGT researchers will use a new application of selective chemical changes to the coal to tag some parts of the coal structure with radioactive atoms. With very sensitive instruments to detect and trace these radioactive atoms, the scientists will 'tag' specific blocks of molecules to locate them in the original coal structure for tracking when they are freed by the breaking of the bonds.

Once the chemical paths involved in the coal fragmentation are better understood, then it will be possible to adjust coal gasification process conditions to get end products that are more easily removed from the gasification products or controlled during the gasification process. With this information, major improvements in designing and operating coal gasification reactors for more useful end products will be possible.

Source: US Dept of Energy

Australia
New combustion research plant

A new $2.1 M plant to test the combustion qualities of Australian coal will help overseas and Australian buyers determine the characteristics of coal to be burnt in furnaces.

The plant, built at Ipswich, Queensland, was opened by the Australian Minister for Resources and Energy, Senator Gareth Evans, on November 8.

Senator Evans said the coal combustion test plant would provide, for the first time in Australia, research into and determination of the combustion characteristics of a wide range of steaming coals from Australia's eastern coalfields. This would enable their potential performance in large coal-fired power stations to be assessed.

In particular, the plant would assess such characteristics as ash fouling, emissions and fly ash. It would be operated by Australian Coal Industry Research Laboratories.

Up until now it had been necessary for producers to obtain combustion performance data on their coals by contract testing overseas.

'It will provide direct access to coal expertise and hence technical assistance to coal producers for the domestic and international marketing of Australian steam coals,' Senator Evans said. 'We are now probably ahead of overseas competitors because of our access to this modern facility.'

He said Australia was now the largest coal exporter in the world, but to remain so it needed to stay at the forefront of coal technology. The new combustion test plant would enhance the Australian coal producers' ability to compete in the market place.

Source: Australian Information Service

Sewage disposal
Pyrolysis or incineration

Two study projects relating to sewage sludge were recently undertaken by an Epsom-based multi-discipline consultancy*, on behalf of the Water Research Centre. Both concerned processes for sewage sludge disposal, one by low temperature pyrolysis and the other by incineration, and the overall economics involved will be the subject of careful comparison by the centre.

The report produced by the Water Research Centre last year entitled *Oil from sewage sludge* concluded that indications were very favourable for the successful development of low temperature pyrolysis of either raw or digested sewage sludge, especially as regards the evolution of energy in hydrocarbon form, and that the process may be less costly than incineration. The most cost-effective route, however, was likely to depend on site-specific factors.

The effects of design and site features would be assessed rapidly on a sizing and costing computer model. But whilst the centre has considerable in-house experience of normal sewage treatment, it needed information on the plant and equipment necessary for the completed process, including the pyrolysing reactor itself. A full technical and economic appraisal of the pyrolysis process and all relevant associated technologies was commissioned.

The heart of the study was an appraisal of the alternative equipment available for each operation. The equipment must cater for feed rates of raw or digested sludge of 3000, 30 000 and 180 000 t of dry solids. The technologies concerned included materials handling, thermal drying of sewage cake, odour control, the pyrolytic reactor, char cooling, processing pyrolytic products, effluent disposal, combustion systems and in-process energy conservation.

As part of a long term strategy into alternative methods of sewage sludge disposal, complementary to the pyrolysis study, the Water Research Centre commissioned a technical and economic study into sludge incineration.

The aspects covered by this study included:

- ☐ Incineration practice over the past 20 years.
- ☐ Operating costs of 14 sludge incineration plants in the UK, with case histories and overseas experience.
- ☐ Detailed appraisal of multi-hearth, fluid bed, rotary hearth and rotary kiln incinerators.
- ☐ Capital and operating costs of plant to handle raw and digested sludge over a range of throughputs and sludge cake moistures.
- ☐ Potential reductions in these costs.
- ☐ Energy recovery.
- ☐ Appraisal of novel sludge incineration processes.
- ☐ Co-incineration of municipal refuse and sewage sludge, with case histories from UK and overseas installations.

Some findings of the study indicate that, whilst all but five sludge incineration plants in the UK had closed down, in none was the viability of the process in question. A review of existing installations showed that this form of disposal can be economic, but the cost per tonne of dry solids incinerated is sensitive to the design capacity of the plant. For a 30 000 t plant the cost would be approximately £10 t, while for one incinerating only 3000 t it would be about four times as great.

Obviously, selecting the right design of plant for the particular application is highly important. Due mainly to the relatively large amount of internal refractory employed, multi-hearth incinerators are best suited to continuous operation. Fluid bed plants, on the other hand, are less susceptible to refractory damage through thermal cycling and are therefore better suited to intermittent operation — should this be required. As regards operating economies, significant cost savings can be achieved by recovering energy from the incineration process for use in the process itself or to generate steam and/or electricity.

Source: W S Atkins

Gas fires
Health and safety warning

The Health and Safety Executive has warned that every year construction site workers needlessly die from the fumes of gas fires operated in site huts and caravans without proper ventilation.

Even with proper ventilation there is always the temptation to block up holes through which draughts blow, and ventilation grills can become clogged with dust or debris. For this reason the Health and Safety Executive recommends permanent installations with fixed flues, which must be installed by competent persons. Flueless LPG heaters may be

*W S Atkins

sed safely, however, provided the entilation is adequate and the burner is tted with an atmosphere sensitive cut-ff device, which is designed to shut off ne main supply before hazardous onditions occur. The minimum entilation area can be calculated from ne formula given in BS 5482: Part 2: 977.

Cut-off devices have been a British tandard requirement on new flueless .PG space heaters for domestic use since 980, other than for catalytic combustion eaters. They are therefore, readily vailable and there is little excuse for hem not being fitted to site hut heaters f this type. Information on cut-off evices should be available from both ppliance and LPG suppliers.

Guidance on the precautions to be aken with the storage and use of LPG on onstruction sites can be found in GNCS6 *he storage and use of LPG on contruction sites,* price £1.50 ISBN 0 11 83391 X available from HMSO or ooksellers.

ource: Health and Safety Executive

Crack invisibility
Offshore industry's new programme

The offshore industry's inspection R and D club at Harwell has launched a new programme to investigate the problem of 'crack invisibility' in offshore structures.

Non-destructive testing (NDT) echniques may fail to detect or may undersize fatigue cracks, particularly where the cracks are tight and their sides are in contact, or where a crack is bridged by corrosion products or calcareous deposits.

The programme will investigate the mechanisms associated with transparency and assess the scale of the problem. It will involve the preparation of special seawater fatigued specimens and NDT measurements at all stages of the fatiguing process. The results will be compared with a full destructive analysis of the samples. All the principal NDT techniques — ultrasonic (pulse echo and 'Time of Flight') eddy current, magnetic particle inspection, and alternating current potential drop systems — will be evaluated. Theoretical modelling techniques wil be used to help understand the response of the various NDT systems. With this information, it should be possible to recommend the inspection procedures or combinations of techniques which minimize the uncertainty in crack detection and sizing.

The Offshore Inspection R and D Service was set up at Harwell in 1982. It has recently expanded its membership to 14. The club's programmes include the development of ultrasonic time of flight techniques for the underwater sizing of fatigue cracks. This will culminate shortly with the demonstration of a prototype system offshore. A further programme to develop a reliable and simple eddy current inspection system for offshore use is also well advanced.

The annual club membership fee is £12 000 pa, with new members paying a joining fee for access to the results of established programmes.

Source: Harwell

BNF
China contract

BNF Metals Technology Centre has been commissioned by the Overseas Development Agency (ODA) to assist the Chinese metals industry in the design of improved open flame furnaces used for producing refined copper. The work involves improving energy efficiency and environmental standards and training local staff in efficient operating production.

The contract (worth nearly £100 000), will be met by the British Aid Programme to China and carried out over 18 months. The end result, it is intended, will be a modernized high efficiency furnace, equipped with the latest control instrumentation, which will serve as a demonstration unit for the rest of the country.

The BNF team will make on the spot examinations of existing installations in Beijing and Zhuzhuo and initially review current practice and furnace design. They will investigate the quality and variability of feedstock and environmental standards for flue gas and other polluting emissions.

BNF will be required to identify ways of enhancing productivity and thermal efficiency, assist in the selection of equipment supplied, and formulate a training programme for Chinese personnel operating the test bed furnace.

Source: British Nuclear Fuels

Cavity wall insulation
Meeting Buildings Regulations

Injected cavity wall insulation (cwi) is claimed to be the easiest way to comfortably achieve the 0.6 U-value required for external walls within the amended Buildings Regulations which came into force in November.

This claim is made by the National Cavity Insulation Association, because U-values down to 0.45 W/m^2°C are achieved in traditional masonry constructions, incorporating standard size (100 mm) insulating block (105 mm brick, 50 mm cavity width with injected fill, 100 mm insulating block and 16 mm lightweight plaster). However, because the regulations are so comfortably met, this gives design freedom, particularly as regards flexibility over window areas.

Alternative methods would call for use of wider (150 mm) insulating blocks or those used in association with insulating board. These, to meet the 0.6 standard, require an additional 50 mm of width for the construction of each external wall, when compared to standard masonry construction. Such additional use of wall material and, in consequence, foundation work, increased roofing etc, is expensive.

Provided good outer wall construction is achieved, the Association believes injected cwi is far more cost effective and satisfactory to builders. Not only does it achieve lower U-values, it obviates on-site storage problems (where insulating batts or boards are used), and the installation is carried out by a specialist contractor who provides a longterm guarantee, also the builder with an independent check on the construction. By achieving a U-value that more than meets the regulations builders can also save by installing slightly smaller heating appliances as original equipment.

Source: National Cavity Insulation Association

Band Aid
Welsh solar power for Eritrea

A team of technicians from the Centre for Alternative Technology (Wales) have flown to Eritrea to install solar and wind-powered vaccine refrigerators.

The project funded by the *Band Aid Appeal,* will provide electricity for hospitals. This is the first attempt to introduce small-scale alternative technology into Eritrea, where relief work is made doubly difficult by the Eritrea-Ethiopia civil war.

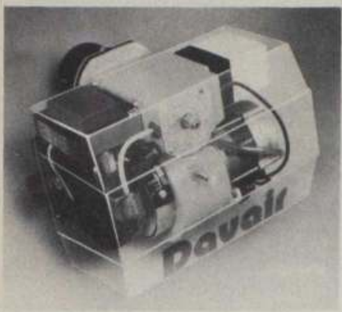
The system comprises a 50W Rutland WG910 wind generator, four BP B1233 photovoltaic cells, a 12V Norfrost refrigerator and battery storage. At the heart of the system lies a special 250V battery controller designed and built in Wales.

Source: Centre for Alternative Technology

outh Wales and West of England branch
Vednesday 19 March 1986

Young People's Papers Evening

niversity of Bath, Room 3E2.2 at 17.30 h



Daviar modulating oil-fired burner

Fully modulating oil burners

Davair have introduced a new form of air atomizing, oil-fired burner, fully modulating on outputs from 20 000 Btu to 200 000 Btu/h with stable CO_2 and smoke contents throughout its modulating range. The flame modulation allows a compact modern design. Another advantage claimed is that as fuel pumps, restrictive filters and pressure jet nozzles are not used, a wide range of oil densities and viscosities can be accepted with minimal alteration to burner settings. Combustion is unaffected by fuels of lower quality.

The burner is automatic and fully fail safe incorporating standard control devices. A small, quiet, air compressor provides both fuel delivery and atomization through a float-controlled oil reservoir tank incorporated within the burner. A specially designed speed controller sensing boiler flow and return temperatures modulates burner output in conjunction with the system demand.

Reader enquiry no 2/1

Low-line modular boiler

Hamworthy Engineering have introduced a range of low line modular boilers to supplement their standard UR series modular range. The new UR series low line modules have integral low profile draught diverters and are intended for use in commercial and industrial heating and hot water applications with restricted headroom.

The new low line range is built up from two basic modules: the UR 265LL output 59.4 kW and the UR 384LL output 86.2 kW, giving variable modular outputs from 118 kW to 1034 kW. Both modules are identical in construction to the standard UR series with the exception of an integral draught diverter which gives an overall height of 1048 mm for the UR 265LL and 1068 mm for the UR 384LL.

Both low line modules can be installed in the traditional modular formation using the Hamworthy single, double or triple unified casing system and, as with the standard UR series, low line modules are suitable for firing all gases and can be supplied for fully automatic operation.

Reader enquiry no 2/2

Gas drier for North Sea operation

The **Peabody Holmes** Process Division have received an order to supply an adsorption gas drier to Occidental Petroleum (Caledonia). The drier will be supplied as a complete packaged unit for the drying of 'lift gas' for use on the Scapa subsea development, due for production in late 1986. The unit will form part of the process facilities being installed on the nearby Clavmore 'A' Platform to handle Scapa oil.

Lift gas is injected into the oil well to improve the rate of recovery. It is essential to dry the gas to prevent the formation of solid hydrates, with subsequent blocking of the pipelines, or corrosion in the three mile subsea gas line from Claymore 'A' Platform to the Scapa subsea template. The unit will have a throughput of 26 million scfd at a pressure of 1835 psia and is microprocessor controlled.

Reader enquiry no 2/3

High-performance ground flare

A high-performance ground flare, designed and manufactured by **Airoil Flaregas**, is now fully operational on a new semi-commercial scale pilot plant at the Coal Research Establishment, Stoke Orchard.

This plant, with a nominal coal throughput of 0.5 t/h, is being developed under an EEC grant to provide an economical coal-derived fuel gas as an alternative source of energy for a wide range of industrial applications requiring high furnace temperatures including brick making, line calcinine, glass melting and steel reheating.

Information is also being analysed on the combustion properties of the gas by burning a small stream of the product gas in a test furnace. The bulk of the gas however is burned off safely in the Airoil Flaregas ground flare. This eliminates all radiation within the body of the unit which is essential in a residential area where a sterile environment must be safely maintained at all times. The Airoil Flaregas system provides automatic flaring on demand from a remotely mounted control panel.

Reader enquiry no 2/4

Infra-red thermography

Thermoscan use the technique of infra-red thermography to provide a service which both identifies and quantifies heat losses. Where appropriate, remedial action is suggested and pay-back times are calculated. The equipment can be used to view a small or a large area, searching for temperature differences as low as 0.2 Celsius. These differences in temperature frequently reveal hidden problems that otherwise would have remained undiscovered. An advantage is that Thermoscan can provide both aerial and ground-based inspections.

The main applications of infra-red thermography fall into four areas:

Industrial heat losses

This covers the identification and quantification of heat loss (or gain), from buildings, plant, storage tanks, pipelines and heating or ventilating systems. These surveys can be either ground-based, aerial based or a combination of both.

Shutdown time prevented

Thermoscan regularly carry out inspections of electrical installations including power lines, sub-stations, switchgear, and electrical components. These components can be inspected while under load and problem areas can be identified for later repair during routine shutdown.

Quality control

Thermoscan carry out regular inspections of new cold stores before their handover to their new owners. This ensures that all insulation is of the correct standard.

Flat roof inspections

Thermography, as used by Thermoscan, can accurately identify water-logged areas of flat roofing. This enables precise instructions to be given to roofing contractors and allows for accurate costing of repair work.

Clients are provided with a written report illustrated by thermograms (infra-red views) and photographs. The report provides a sophisticated analysis of the major problem areas and, where requested, quantifies the problem and estimates the cost and related payback period of remedial action.

Reader enquiry no 2/5

Grinding and air classification equipment

NEI International Combustion have recently completed the successful commissioning of a new 6058 pendulum roller milling plant for Singleton Birch at their Melton Ross quarry.

The milling plant, which was selected following extensive test work at the NEI International Combustion commercial scale test facility at Derby, is designed to take burned lime from a new kiln installation and produce a variety of grades of materials from -3 mm to 99% passing 76 microns.

NEI International Combustion have also recently received an order for a 5057 pendulum mill from ECC Ball Clays. The mill plant for this application incorporates a hot air furnace for simultaneous drying of the material in the mill during grinding.

The NEI International Combustion range of grinding and air classification equipment also includes Lopulco table and roller mills, Hardinge ball and pebble mills, Impax pulverizers and Delta-sizer classifiers, all used extensively for producing fine powders from a wide range of industrial minerals.

Reader enquiry no 2/6

Crack detection and monitoring system

A new acoustic emission monitoring system for the detection, location and remote monitoring of structural defects in steel structures has been developed by **AVT Engineering Services** for the manufacturing, process and construction industries. Vulcan 8-SM is based on a system designed originally for the detection of cracks in offshore steel structures, and monitors cracks induced by repeated loading, and inadequacies of design, material quality or fabrication methods, in addition to defects resulting from corrosion, hydrogen-induced cracking and other degradation processes. Pressurized components can also be monitored, drawing attention to areas requiring additional testing.

The system comprises a series of purpose-designed, high performance sensors, which can be attached, by means of silicon rubber or epoxy adhesive, or by magnetic clamps, around either a localized area or covering larger areas for simple applications such as leak detection. Housed in a sealed enclosure for use in virtually any industrial environment, the sensors respond to signals emitted from growing defects, feeding the signals to a purpose-built data acquisition and processing computer on site.

From this information, a clear picture of all relevant emissions can be produced, using advanced data sorting and pattern recognition facilities. Confusion due to background noise is eliminated, as the computer is able to identify clearly those specific sounds emitted by a crack in the structure.

Reader enquiry no 2/7

Test gauges

New test gauges from **Budenberg Gauge Co** can measure pressure to a guaranteed accuracy of $\pm 0.2\%$ throughout their range.

Features of the master test gauge include a mirror-finish band on the dial to eliminate parallax errors and a zero-adjustment screw which rotates the dial to compensate for temperature and head effects. Each gauge comes with a test certificate covering readings taken at multiple points under both rising and falling pressure, so that the users can improve on the nominal accuracy if they wish.

Reader enquiry no 2/8

ENERGY WORLD — COMMERCIAL
(Photocopy acceptable)

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

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

Name ....

Address ....

....

Organization ....

Council

A meeting of Council was held at the Institute of Energy on 14 November 1985. A summary of salient points that may be of interest to members follows.

Presentation of cheque

Dr P J Mullinger, chairman of the Midland branch, presented the president, *P C Warner,* with a cheque for £8187. This was the financial surplus on the branch conference entitled *Modern practice in reheating and heat treatment furnaces,* held on 21 March 1985 at the University of Aston in Birmingham. The president thanked the branch warmly and congratulated the organizers on their successful conference.

Overseas affairs

The first meeting of the International Committee was to be held at Sheffield on 2 December 1985 with *Prof J Swithenbank* (president-elect) as chairman.

Elections/nominations for Council

C E Pugh, managing director of the National Nuclear Corporation, was elected a *vice-president* to take office from the conclusion of the AGM to be held in May 1986. *Prof A Williams* and *Dr W A Simmonds* were re-elected respectively *honorary secretary* and *honorary treasurer* to serve for a further year from the conclusion of the AGM.

The following retiring *members of Council* were nominated for re-election to Council, to serve from the conclusion of the AGM.

C R Coleman
B Lubert
W Tipler

The following *Corporate Members* were nominated by Council for election to take office from the conclusion of the AGM, subject to their willingness to serve.

B G Gills
The Revd Dr J H Harker
C R E Hillyer

Technician Engineer representation on Council

A paper on *Technician engineer representatives on Council — electoral procedure* had previously been circulated. It was approved and adopted as rules of Council. In accordance with this procedure *S M Taulbut* and *P Jenner* were nominated to serve as Technician Engineer representatives from the conclusion of the AGM.

The president, P C Warner, (right) receives a cheque from the Midland branch from Dr P J Mullinger, Midland branch chairman (left)

Honorary Fellows/Companion

Dr J H Chesters, chairman of the Watt Committee on Energy, outgoing chairman of the British Flame Research Committee and a past president of the Institute, was elected an Honorary Fellow with immediate effect. *Sir John Hill,* a former chairman of the United Kingdom Atomic Energy Authority and a past president of the Institute, was elected an Honorary Fellow with effect from 1 January 1986. *Prof Richard Eden* of the Cavendish Laboratory, Cambridge, who had

(continued on p 24)

Honorary Fellows/Companion

At the Council meeting held on 14 November 1985 the following awards were announced:
Hon Fellows: Dr J H Chesters OBE FRS FEng; Sir John Hill FRS FEng
Companion: Prof Richard Eden OBE

Dr J H Chesters OBE FRS FEng

Dr J H Chesters, a consultant, is chairman of the Watt Committee on Energy and outgoing chairman of the British Flame Research Committee. He is well known for his research work in steelmaking, which extended over a period of more than forty years, and for his many publications and awards in this field. Dr Chesters was president of the Institute of Fuel (now Energy) in 1972-73. He is also a past president of the British Ceramic Society, the Institute of Ceramics and the Iron and Steel Institute.

Sir John Hill FRS FEng

Sir John Hill joined the nuclear industry in 1950 and was appointed to the Board of the United Kingdom Atomic Energy Authority in 1964 as member for production. He succeeded Lord Penney as chairman in 1967 and held this position until his retirement in 1981. He was also chairman of British Nuclear Fuels from 1971 to 1983. Sir John has been chairman of Amersham International since 1975. He was president of the Institute of Energy in 1981-82. Sir John was created Knight Bachelor in 1969.

Prof Richard Eden OBE

Prof R J Eden, a physicist, is professor of energy studies and head of the Energy Research Group, Cavendish Laboratory, University of Cambridge. He has been a Fellow of Clare Hall, Cambridge since 1966. Prof Eden is also currently syndic, Cambridge University Press, chairman of Cambridge Energy Research and a Member of the Eastern Electricity Board. Prof Eden has advised the Government on energy matters and published widely both on energy matters and in the field of physics.

contributed to energy thinking on a national scale, was elected a Companion of the Institute with immediate effect. *(See p 23).*

Melchett Medal and Lecture

Council approved the award of the Melchett Medal to *Prof N L Franklin*, formerly chief executive of the National Nuclear Corporation and now at Imperial College. Prof Franklin was to be invited to deliver the Melchett Lecture at the Royal Institution, London on 6 March 1986 following the March meeting of Council.

Financial issues

Council next discussed a number of financial issues:

1. *Membership subscriptions*
   It was agreed formally to minute approval of the membership subscription increases from 1 January 1986 as contained in a circulated paper and previously approved by Council by post.
2. *Benevolent Fund*
   Council discussed ways of encouraging members to make use of the Institute Benevolent Fund. The honorary treasurer, Dr Simmonds, agreed to write a suitable article for publication in *Energy World*. *(See this page).*
3. *Funding of branches*
   A paper, prepared by the president and the honorary treasurer, on a proposed new policy for funding of UK branches had been previously circulated and was now discussed. The principles of the paper were approved, subject to amendments to reflect the points made during discussion. It was also agreed that the new policy should be implemented for the 1986 financial year.

Financial Review Sub-committee

Dr Simmonds reported on the two meetings of the newly formed Financial Review Sub-committee: one a general financial briefing and the other a review of the Institute's investment policy. The long-term maintenance requirements at 18 Devonshire Street were under review.

Industry Year 1986

1986 had been designated both Industry Year and Energy Efficiency Year and, from reports from UK branches, it appeared that branches were emphasizing both aspects in 1986. Staff from the Energy Efficiency Office would be contacting the Institute and the Secretary of State for Energy had accepted the president's invitation to be the Principal Guest and Speaker at the Institute's annual luncheon.

Energy managers

C R E Hillyer suggested that the programmes of energy managers' groups and Institute branches should be co-ordinated to maximize attendance at meetings and their effectiveness. Another suggestion, from *J P MacCarthy*, was for branches to maintain close contact with the Regional Energy Efficiency Officers in their branch areas.

Aid to developing countries

Council endorsed the principles of the draft policy statement on aid to developing countries sent by *W Tipler* to the president. It was agreed that this should now be passed to the newly formed International Committee for publication in due course as a definitive statement from the Institute. A further paper on *Technical literature for developing countries*, prepared by Mr Tipler, was also referred to the International Committee.

Reports from Standing Committees

1. *Membership*
   Membership Committee chairman, *J P MacCarthy*, reported that a response from Membership Committee to the Engineering Council document 'SARTOR' was being prepared. Membership Committee was considering the Engineering Council consultative document on trade union membership for chartered engineers and the potential conflict of interest with professional practices. The committee was also reviewing the grade of collective or group membership. It was agreed that the committee should examine grades of membership which might be especially attractive for energy managers, including collective or group membership.
   Council approved the recommendation of Membership Committee that in 1985 the Special Award of the Institute should be made to the following members:

J B Haigh	London & Home Counties branch
Dr C Davies	South Wales & West of England branch
J Limb	East Midlands branch

2. *Education and training*
   The education secretary confirmed that material was being collected for a student's information pack that would be available for distribution before the start of the next academic year. Students' packs would also be available for use in the branches of the Institute.

The Benevolent Fund and cases of hardship

The Institute has, as members know, a Benevolent Fund, which is well supported by members and branches. The purpose of the Fund is to help members in need; but what is the procedure for using the Fund?

Applications for assistance are referred to the hon chairman (or hon secretary) of the appropriate branch, who will vet the application and pass on a recommendation to me as hon treasurer, and I authorize the Institute's accountant to make the payment.

There are limitations on what the Fund can achieve. It could not, of course, replace a member's salary for very long; (the State and the employer in these days fill many needs). However, there are things that the Fund can do — for example by paying the subscription to the Institute for members in difficulties, or again giving rapid help to get over initial problems in a sudden crisis. Our procedures are purposely kept simple so that we can respond rapidly.

The president and I have been surprised that even in the present economic difficulties, there are still relatively few applications for assistance. I have therefore written this to remind all members of the Fund's existence and purpose, and the procedures for using it. Obviously the Fund operates in a very sensitive area and you realize that the procedures deliberately involve very few people.

If you become aware of cases of hardship where the Fund might be able to help, please pass the information on confidentially to your branch hon secretary.

W A SIMMONDS
Honorary treasurer

3. *Publications and Conferences*
   Publications & Conferences Committee chairman, *N G Worley*, reported that new committee members had been recruited.
   It was hoped that the 1986 *Energy World Reference Book and Buyers Guide* and *List of Members* would be in members' hands in January 1986.
   The role of *Energy World* and its objectives was discussed, and it was suggested that a more vigorous level of debate in *Energy World* might have a stimulating effect.
   Mr Worley advocated holding occasional afternoon meetings at Devonshire Street to discuss published papers.

Gummer Exhibition

Council approved the nomination of Imperial College, London that the R H Gummer Exhibition should be awarded to *Dr J Wilhelmi,* who had worked on axi-symmetric swirl stabilized combustion.

Data Protection Act

The Institute secretary confirmed that appropriate action was being taken for the Institute to register under the Data Protection Act 1984.

Engineering Council

Engineering 'is fundamental to our industrial success'

Britain's engineers will be asked to back Industry Year 1986 by increasing public awareness of the vital role of engineering and technology in society.

Dr Kenneth Miller, director general of the Engineering Council and chairman of the engineering working group supporting *Industry Year 1986,* said: 'This campaign is an ideal platform for all of us to highlight the fact that engineering is fundamental to the industrial success of Britain.'

The engineering working group represents the Engineering Council, professional engineering institutions, the Engineering Employers' Federation, the Engineering Industry Training Board, and the Women's Engineering Society. In January the group issued a brochure *Take action for engineering* which gives suggestions on action that can be taken by employers of engineers, the institutions and individual engineers.

Messages that the engineering profession is being asked to put across to the public include:

- □ That engineering helps create wealth for the community.
- □ That company performance can be improved by better engineering design and manufacture.
- □ That engineering helps, for example, to improve health care, travel, communications and housing.
- □ That engineering is exciting and creative.
- □ That engineering contributes to the quality of life in both developed and developing countries.

Twelve main points aimed at employers of engineers range from advice on telling the media about their organizations' engineering successes to tips on holding open days for staff and their families, schools and local communities.

Engineering institutions are asked, among other things, to highlight the contribution they and their engineering disciplines make to the overall success of British industry and to strengthen links with schools.

In its guidelines to individul engineers, the group stresses the importance of getting involved in local community affairs, giving talks to organizations ranging from parent/teacher bodies to business clubs, promoting their own companies, attracting youngsters into the profession and generally demonstrating the valuable contribution of engineering to the community as a whole.

New members

Fellow

John Stanley Danks, Energy & Safety Management Services, W Midlands *(transfer)*
Peter Frederick Gill, Babcock Power, London *(transfer)*
Dale Greenwood Horne, University College, London
Stephen Anthony Lloyd, Bechtel Great Britain, London *(transfer)*
Anthony Rex Burgess, University College London

Member

Mohammad M Ali Al-Faruq, Kuwait Oil Company, Kuwait *(transfer)*
Trevor Harvie Andrew, NCB, Harrow, Middlesex *(transfer)*
David Joseph Carr, Coal Research Estab, Cheltenham
Brian Charles Birtles, South Wales Electricity, Cardiff
Peter John Hammond, YRM Engineers, London
Nicos Ladommatos, Brunel University, Middlesex *(transfer)*
John McCabe Martin, Hulley & Kirkwood, Glasgow
Raymond John Standley, Hoare Lea & Partners, Birmingham *(transfer)*
Todar Mal Verma, Babcock Power, London

Associate

Shui Yee Wong, Pan Am World Services, California, USA

Graduate

Pin Lin Louis Chan, J Roger Preston & Partners, Hong Kong
Paul Bernard Chamberlain, Airoil Flaregas, West Drayton
Chak Yin Mak, Air Pollution Control Division, Hong Kong

Student

Arthur Ibiduni Burney-Nicol, Leeds University
Allen Williamson, Polytechnic of the South Bank, London

Personal

M D Gray has been appointed director of the National Coal Board's liquefaction project. Mr Gray, a chemical engineer, was formerly director of coal processing with NCB (Coal Products) and before that, managing director of Coal Processing Consultants. He joined the NCB in 1971 at the Coal Research Establishment, from the British Coal Utilisation Research Association. Before working in the coal industry, Mr Gray was employed by the UK Atomic Energy Authority at Harwell.

Mr Gray was chairman of the organizing committee of the Institute of Energy's third international fluidised conference held in the Hilton International, London in October 1984: *Fluidised combustion: is it achieving its promise?**

B. Kelly has agreed to remain a Technician Engineer representative on Council until the conclusion of the AGM on 27 May 1986. He is now with the Clyde Project Commissioning Group in Aberdeen.

C G Manders (Member) has been appointed as business associate for the South East region of the National Industrial Fuel Efficiency Service. He is based at their new regional office in Bishop's Stortford. Mr Manders has worked for more than 25 years in the energy and building services fields. He was in contracting for 15 years as a project engineer and then worked as a consultant, eventually becoming a joint partner in an energy consultancy.

C G Poole (Fellow) has been appointed to the post of distribution engineer operations (North) at the South West Gas Regional Headquarters.

Obituary

M I Hanley (Member), who died last year, had been a member of the Institute since 1954.

G R Nellist (Fellow) died on 23 November 1985. He joined the Institute in 1944.

He formerly worked for ICI and the National Coal Board, retiring as divisional chief chemist, Durham Division in 1967. Following this early retirement, he was for three years a senior research associate in the Public Health Section of the Civil Engineering Department, University of Newcastle upon Tyne. Subsequently he spent three months as a visiting lecturer in public health at the University of Kumasi, Ghana. He also participated in a study tour in India, visiting various industrial centres, under the auspices of the British Council.

In addition to the activities of the Institute of Energy, he was greatly interested in the activities of various scientific societies, in particular the Society of Chemical Industry. During his career he had several papers published and also edited the translation of a work on the treatments of various effluents. He continued to take an interest in scientific publications during his retirement.

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*Conference proceedings available from the Institute of Energy. Price: £50.00

New Year Honours

We congratulate the following whose names appeared in the New Year Honours List:

Baron (Life Peer)
Sir Frederick Sydney Dainton, chancellor, Sheffield University.

CBE
H V Keating (Companion), chairman West Midlands Region, British Gas.

OBE
L G Hadley (Fellow), senior partner, Donald Smith, Seymour and Rooley.
H L Mathews (Fellow), director of production, Midlands region, CEGB.

MBE
D F Pearce (Member), energy efficiency engineer, Nottingham City Council.

Members who receive awards in Honours Lists are reminded that they should let staff at the Institute know as soon as possible so that records can be altered.

London and Home Counties: The president speaks at April meeting

The president of the Institute of Energy, *P C Warner* (director for corporate engineering, NEI), will speak on *Investing for energy* at the April meeting of the London and Home Counties branch. The 1985-86 programme of the branch gives particular emphasis to energy's role in relation to *Industry and wealth creation.* All are welcome at the meeting which will be held on **Tuesday 15 April 1986** in the Bernard Sunley Theatre of the Royal Institution, 21 Albemarle Street, London W1.

The lecture will start at 1730 h, but tea and biscuits will be served in the Long Library from 1710 h onwards. The meeting will also be followed by a buffet supper (by application only).

Imperial College: March combustion research colloquium

Dr Peter Lindstedt of Imperial College will speak at the combustion research colloquium to be held on Tuesday 11 March 1986 in the Department of Chemical Engineering, Imperial College. The subject is: *Deflagration to detonation transitions and high-speed deflagrations in mixtures containing LNG/LPG constituents.*

The colloquium will start at 1545 h (tea from 1530 h). Visitors are welcome. A synopsis will be available a week beforehand and will be sent on request. Further information from Prof F J Weinberg FRS, Imperial College, Dept of Chemical Engineering and Chemical Technology, Prince Consort Road, London SW7 2BY (tel 01-589 5111 ext 4360).

Industry: caring for the environment

As part of the *Industry Year 1986* campaign, the RSA's Committee for the Environment is inviting British firms to submit case studies on how their work is enhancing the environment. Case studies of good practice are being sought in all facets of the environment, eg planning, transport, land use, pollution, energy and waste disposal. The Committee will especially be looking for examples of environmental responsibility which can save or make money. Many case studies will be publicly highlighted at an RSA national conference in April 1986, and in a subsequent booklet.

The Committee for the Environment, which was formed i 1971 at the instigation of HRH The Duke of Edinburgh, seek to identify and anticipate major environmental problems an provides a forum for discussion by a wide range of interests

Further information ffrom Timothy Cantell, RSA, 8 Joh Adam Street, London WC2N 6EZ (tel 01-930 5115).

I Mech E ballot

The result of the ballot on the proposal for a merger of th Institution of Production Engineers with the Institution o Mechanical Engineers was announced in December, a follows:

37.3% voted in favour of a merger, 62.7% voted against

Carbon one chemical technology: symposium, London, 19 and 20 March 1986

There is an ample supply of oil for the world's needs in th foreseeable future and the price is correspondingly weak However, one does not need to assume catastrophic scenario in order to forecast that this will change sometime in the 21s century. Furthermore, the availabilty of plentiful and low-cos natural gas or coal, the shortage of foreign currency o strategic considerations have created regions where it is now sensible to produce transport fuels or chemicals starting from raw materials other than oil.

The efforts to develop processes for fuels and chemical from coal and natural gas, which were given a sharp boost i 1973 with the sudden large increase in the price of crude oil therefore continue. The aim of this symposium is to report an record, as far as possible, the stage reached in thes developments. Prof Ian Fells (Newcastle University), a pas president of the Institute of Energy, will give the introductor paper: *Review of world fossil fuel reserves and consumptio — price forecasts.*

The symposium will be held at the Forum Hotel, Cromwel Road, London. Further information from Mrs Juli Tayler/Miss Anne Hughes, Conference Section, Institution o Chemical Engineers, 165-171 Railway Terrace, Rugby, Wark CV21 3HQ (tel (0788) 78214; tlx 311780).

Parliamentary Group for Energy Studies: March visit to Culham

There will be a joint visit to the JET fusion experiment a Culham on *Thursday 20 March 1986.* The other participant will be the Committee on Science & Technology of th Parliamentary Assembly of the Council of Europe.

Further information from Melanie Mullarkey, PGES, Eagl House, 109 Jermyn Street, London SW1Y 6HB (tel 01-83 4887).

Call for papers:

1. Large scale applications of heat pumps

The third international symposium will be held at *Oxford* from 25-27 March **1987.**

Papers are invited on the following topics:

- *Heat pump applications on:*
  space heating of industrial and commercial buildings
  distillation processes
  drying processes
  steam raising
  heat recovery and waste heat sources
  solvent recovery

(continued on p 2

REGISTER OF ENERGY COURSES

lembers are invited to make use of the istitute of Energy's national register of nergy courses, through which we can ipply salient details of forthcoming ourses of all types. As well as the ember's name and address, we need to now (a) the specific subject in which he interested; (b) his present level of chnical qualification; and (c) the referred geographical location. Only etails of suitable courses will be sent in ply.

We take this opportunity of listing a lection of courses due to start in the ear future, and details of each can be btained by quoting the reference number nown against the entry. Please enclose a amped addressed envelope.

Course No 18-348

Title: Coal technology and utilization.
Duration: 4½ days.
Location: Sheffield University.
Starting: 6 April 1986.
Content: Fundamental aspects of modern coal technology such as the nature and classification of coal, its preparation for the market place, its role in power generation and other major technologies such as fluidized bed combustion, gasification and liquefaction. The industrial use of coal, including coal-water slurries. Coal handling. Coal economics.

Course No 00-342

Title: Combustion engineering.
Duration: 4½ days.
Location: British Gas School of Fuel Management, Solihull.
Starting: 7 April 1986.
Content: Chemistry of combustion. Properties of natural gas and other fuels. Combustion product analysis. Interpretation of its results. Flame types produced by gas and oil burners. The burners to produce the various flames. Flame retention techniques. Mechanisms of heat transfer. Parameters affecting rates of heat transfer in furnaces and boilers. Descriptions of the common types of boilers, their applications and expected efficiencies. On-site boiler efficiency determination. Low-temperature processes including boilers. High-temperature process including metal melting and heat treatment. An overview of the types of equipment available for heat recovery from buildings, boilers and furnaces. Efficiency tests and heat balances on boilers, furnaces and vats and tanks.

Course No 00-338

Title: Basic heating plant controls.
Duration: 4½ days.
Location: British Gas School of Fuel Management, Solihull.
Starting: 14 April 1986.
Content: The operation and application of the different types of valves used in gas control systems. Flame detection systems, thermoelectric valves, flame rectification and UV detection. Requirements for semi-automatic and fully automatic control systems. Non-return valves and pressure switches. Burner and process requirements for controls.

□

ecial announcements (continued)

concentration processes
agricultural use
System studies
Component studies and unit processes
Thermodynamics
A limited number of papers on novel cycles would also be of interest but emphasis will be on practical applications
District heating and cooling
Research areas including
heat exchanger design
system design integration
ground water effects etc
heat pumps/storage combined programmes
low-grade heat sources including geothermal and solar heat
Fluids
stability and corrosion of fluids-chemical aspects
non-azeotropic mixtures as working fluids
Novel types of heat pumps
problem areas and solutions
overcoming temperature limitations
Economics
projected economics as related to inflation
changes necessary to reduce capital costs

Authors are invited to submit titles and synopses of papers reach the organizers as soon as possible and not later than *April 1986.* Further information from conference organizer, d *Heat pumps* symposium, BHRA, Fluid Engineering entre, Cranfield, Bedford MK43 0AJ (tel (0234) 750422; tlx 5059 BHRA G).

Energy options — the role of alternatives in the orld energy scene

e fifth international conference will be held at the *University of Reading,* from 7-9 April **1987.** The conference will consider the future role and progress in the development of energy conservation and alternative and renewable sources.

An international overview paper on each technology will summarize progress and present the background against which the viability of that technology can be judged and compared with other options. An important aspect of the conference will be discussion of alternatives in the light of the experience that is now being gained in full-scale trials, demonstration projects or commercial developments, the sensible size of the resource for each alternative, the associated environmental impacts and the resulting overall costs. *The Institute of Energy is associated with this conference.*

Papers are invited on the following topics:

- □ Policy and economics, including electricity demand management
- □ Energy efficiency and conservation
- □ Combined heat and power
- □ Advanced fossil fuel systems
- □ Wind
- □ Tidal
- □ Hydro, including low head
- □ Wave
- □ OTEC
- □ Solar thermal
- □ Solar photovoltaic
- □ Geothermal
- □ Biomass

Synopsis

Authors are invited to submit a synopsis of not more than 500 words plus diagram by no later than *20 June 1986* to the organizers, Conference Services, Institution of Electrical Engineers, Savoy Place, London WC2R 0BL (tel 01-240 1871).

CONFERENCES

The following conferences, courses and meetings are organized by bodies other than the Institute of Energ[y]. For Institute conferences please see page 1

March 1986

Mecca 86

Energy efficiency exhibition and conference, Trentham Gardens (Stoke on Trent), 5 and 6 March 1986.
Details from Lesley Brookes, Energy Systems Trade Association, PO Box 16, Stroud, Glos GL5 5EB (tel (045 387) 3568).

Recycling energy from waste

One-day seminar, London (South Bank), 12 March 1986.
Details from Tomlinson, London Centre, IWM, c/o Cleanaway Limited, 557-563 Rayleigh Road, Eastwood, Leigh-on-Sea, Essex SS9 5HT (tel (0268) 775599; tlx 99291) *or* Philip Evemy, director, The Warmer Campaign, 83 Mount Ephraim, Tunbridge Wells, Kent TN4 8BS (tel (0892) 24626).

The JET project & the prospect for controlled nuclear fusion

Discussion meeting, London (Royal Society), 12 and 13 March 1986.
Details from Miss C A Johnson, Royal Society, 6 Carlton House Terrace, London SW1Y 5AG (tel 01-839 5561 ext 278/277; tlx 917876). *Registration required.*

Flowmeter selection, calibration and application

Seminar, London (Portman Hotel), 17 and 18 March 1986.
Details from Miss Louise Marriott, Oyez Scientific & Technical Services, 3rd floor, Bath House, 56 Holborn Viaduct, London EC1A 2EX (tel 01-236 4080).

Asbestos — policies for the future

NSCA workshop, Newcastle University, 26 and 27 March 1986.
Details from the National Society for Clean Air, 136 North Street, Brighton BN1 1RG (tel (0273) 26313).

April 1986

Hazards in the process industries

Meeting, Manchester, 2-4 April 1986.
Details from D V Greenwood (tel (0606) 888238).

Combustion problems in spark ingnition engines

Combustion Institute (British Section) meeting, Leeds University, 9 April 1986.
Details from Dr C G W Sheppard, Dept of Mech Eng, Leeds University, Leeds LST 9JT (tel (0532) 431751).

Energy 86

An exhibition sector of *Hannover Fair 86*, Hannover Fairgrounds (FRG), 9-16 April 1986.

April 1986 (continued)

Details from Hannover Fairs USA Inc, PO Box 7066, 103 Carnegie Centre, Princeton, NJ 08540 (tel 609/987-1202).

Energy, finance and taxation

SPE symposium, Washington (USA), 14 and 15 April 1986.
Details from Society of Petroleum Engineers, PO Box 833836, Richardson, Texas 75083-3836 (tel (214) 669-3377; tlx 730989 SPEDAL).

Eurocon 86

Seventh European conference on *Electrotechnics*, Paris (France), 21-23 April 1986.
Details from *Eurocon 86*, General Secretariat, 11 rue Hamelin, F-75783, Paris Cedex 16, France.

June 1986

ENC 86

Nuclear: energy of today and tomorrow

Fourth international ENS/ANS conference and ninth Foratom congress with ENC 86 trade fair. Palexpo, Geneva (Switzerland), 1-6 June 1986.
Details from Harry Cartwright, Tabbits Hill House, Corfe Castle, Wareham, Dorset BH20 5HZ *or* Jack Scarborough, JCS, 6936 Race Hill Lane, Rockville, Md 20852, USA.

Eurochem 86

International chemical and process engineering show and conference, Birmingham (NEC), 3-6 June 1986.
Details from Mike O'Connor, *Eurochem 86*, Chatsworth House, 59 London Road, Twickenham, Middx TW1 1BR (tel 01-891 5051; tlx 936028).

Gas Turbine Users Association

Thirty-first annual meeting, Dublin, 3-6 June 1986.
Details from GTUA, PO Box 1682, Dublin 1, Republic of Ireland (tel (01) 300777; tlx 25695).

Enhanced oil recovery

Conference, Heathrow Penta Hotel, 9-10 June 1986. *Please note change in date.*
Details from Offshore Conferences & Exhibitions, Spearhead Group, Rowe House, 55/59 Fife Road, Kingston upon Thames, Surrey KT1 1TA (tel 01-549 5831; tlx 928042 SPEARS G).

Petroleum industry application of microcomputers

Symposium, Silver Creek (Colo, USA), 18-20 June 1986.
Details from Society of Petroleum Engineers (see address above).

July 1986

An introduction to petroleum economics

Conference, London, 7-9 July 1986.
Details from Caroline Little, Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR (tel 01-636 1004; tlx 264380).

Management development for scientists and technologists

Conference, Manchester Business School, 9-11 July 1986.
Details from Russell Cialis, external relations manager, Manchester Business School, Booth Street West, Manchester M15 6PB (tel 061-273 8228 ext 273).

August 1986

Nuclear physics

International conference, Harrogate, 25-30 August 1986.
Details from the meetings officer, Institute of Physics, 47 Belgrave Square, London SW1X 8QX (tel 01-235 6111; tlx 918453).

September 1986

Renewable energy potential in South Africa

Conference, Cape Town (SA), 8-10 September 1986.
Details from conference secretary, Energy Research Institute, University of Cape Town, Private Bag, Rondebosch 7700, South Africa (tel (021) 69 8531 ext 128 or 66 4500; tlx 5-21439 SA).

Environmental effects of mining and restoration

One-day meeting, UMIST (Manchester), 23 September 1986.
Details from Institution of Mining and Metallurgy, 44 Portland Place, London W1N 4BR (tel 01-580 3802; tlx 261410 IMM G).

Heating and processing 1 to 3000 MHz

Conference, University of Cambridge, 23-26 September 1986.
Details from the British National Committee for Electroheat, 30 Millbank, London SW1P 4RD (tel 01-834 2333).

October 1986

Intelec

International Telecommunications Energy Conference, Toronto (Canada), 19-22 October 1986.
Details from N N Siomra, C & D Power Systems, 9 Bradwick Drive, Concord, Ontario L4K 2T4, Canada (tel 416/669-4400).
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