uly 1986: No. 138

ENERGY WORLD

Published monthly by the Institute of Energy
18 Devonshire Street, London W1N 2AU
Telephones: *Editorial:* 01-580 0008. *Administration:* 01-580 7124.

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The Institute of Energy is in association with:
The American Society of Mechanical Engineers
The Canadian Institute of Energy
L'Institut Français de l'Energie (Paris)
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Verein Deutscher Ingenieure (VDI-Gesellschaft Energietechnik)
The Australian Institute of Energy

Advertisement representation
P Cottle Advertising Services Leatherhead 376884

Typeset by Trafford Typesetters and Printed by Trafford Print (Colour) Ltd,
Holly St, Doncaster Tel: (0302) 67509 and
108 Temple Chambers, Temple Avenue, London EC4.

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he Engineering Council has worried many professionals by the quantity of paper which it issues and the nplications of the contents for professional institutes. In general the documents which the Council issues confirm rocedures and describe the best intentions of those institutes; so far so good. The documents do, however, tend to e long, describe ideal procedures and require an advanced degree in acronymics. The practical and financial nplications for institutes with a limited reservoir of available voluntary professional time and of subscription inance have hitherto not been addressed. All institutes are in the same situation.

Now there comes a change. The Engineering Council (EC for acronymics graduates) has issued a succinct and ermane document entitled *A call to action.* This relates to continuing education and training (CET!) for engineers nd technicians. The emphasis on action is appropriate and the subject is important.

The Institute of Energy has recognised the significance to its profession of the twin supports of education and aining, as is demonstrated by its committee structure. There are those who are less convinced and if they have not een put off by previous EC documents, let's hope they read *A call to action.* It states in seven pages which, God less them, include an executive summary, and the conclusions of research and of a much discussed document. The ole of and a description of good practice by the participants in CET are tabulated. These participants are mployers, individuals, professional institutions, the providers of CET, government and the EC itself. The research nd background are described in Appendices and Annexes clearly distinguishable from the seven pages of distilled visdom. Acronyms there are, but all are mercifully translated.

The wisdom that is distilled is sometimes inevitably self evident but it is wisdom and deserves to be widely roadcast among the primary role players.

Employers for example are encouraged to include CET in business plans with the significant rider that this will harpen their competitive edge. To that end employers at the highest level should be committed to CET as a strategic veapon.

Individuals are exhorted to update and extend their professional competence. Do you declare and define your aining needs at every performance appraisal? Having seized opportunities do you log them? The document includes specimen personal record card so you, and I, have no excuse.

Professional institutions should develop a commitment to CET throughout engineer and technician career patterns. he four elements of good practice which are described sit easily on the terms of reference of the Training ccreditation Panel chaired in the Institute by J R Willetts. The development, registration, updating and publication f CET activities are required. The resource implications of these activities on limited reservoirs of time and money o still need to be assessed.

Providers need to be more aware of the market they serve and how it can be better served (and stimulated). This mphasis on marketing, publicity and selling is one to be welcomed.

Government has an active role to play in encouraging employers and individuals to make a greater commitment to ET. Some of the admirable suggestions may get longer shrift and more chance of acceptance if the EC were to mplify and cast their recommended practices. The Engineering Council itself 'should take sustained action', it says, n order to stimulate a radical change of attitudes amongst employers and individuals'. I would only request that it kes action which is not administratively inoperable, that it recognises that change need not be too radical in the ore up-to-date institutes and that it uses *A call to action* as a model for future documents.

There are, in my view, three stages to any profession; deciding to join it, being educated for it and being ducated/trained in it. The decision and what affects it is not yet properly attacked by the Council. At what age does happen? Why don't more people make it in favour of an exciting career with good employment prospects? The econd phase was dealt with by Standards and Routes to Registration (SARTOR if you must), which is good but ong and off-putting. The final stage is dealt with by *A call to action* and I commend it to your attention. More specially I commend it to your inclination to act.

J Williams *Chairman, Education and Training Committee*

Investing for energy

P C Warner MA CEng FIMechE FInstE*

The subject of this paper is the investment decisions at the core of all energy policies. The one possible policy that does not involve investment is to exhort people not to waste energy — the *Save It* campaign a few years ago. This does not give lasting results, and I shall not refer to it again. Fig 1 shows the three investing groups: consumers, energy suppliers, and the manufacturing and construction industry — the manufacturers, for short. They form a chain with a flow of causation from left to right — suppliers respond to consumer decisions, and manufacturers respond to both consumers and suppliers. My questions are: how does all that work and what are the implications for overall policy?

Investment by the consumer

Let us consider the three groups of decision takers in turn, starting with the consumer. He may range from a private person to a large organisation. He sees investment mainly as a way of reducing his fuel bill but may have secondary objectives, such as cleanliness or convenience. His improvements may be a better boiler, heat insulation, a monitoring system, new machines with higher efficiency, and many others. He asks himself whether 'the investment will pay for itself' after a given number of years.

It is not easy to work out, so he errs on the side of not spending the money. It adds to his hesitation that an improvement usually means a fixed commitment. For instance, if he insulates his loft he cannot later change his mind and rip out the insulation: he would lose his money. If he buys a new boiler, for higher efficiency or to switch fuels, he is committed to it for some years: in fact until it becomes an old boiler.

In the larger, more sophisticated organisations, assessments are more systematic. But the Energy Efficiency Office and the energy managers movement have said that even so it falls short of what is desirable, which means that consumers fail to invest where they should. Hence the Monergy campaign. That is not true of those industrial firms who are large consumers of energy, such as producers of materials. For them, energy assessments are an inherent part of production planning and they perform them with due professionalism.

Investment by the energy producer

The demarcation between the consumer and supplier groups is not all that sharp, and those who might install solar panels or private generators logically belong to the latter; however the pressures on them are similar to those on the consumer which I have just discussed.

Large suppliers are run as businesses and compete with one another. Their objectives are those of any producer: speed and efficiency of production, and perhaps also greater volume, for which they invest in power stations, mines, gas systems, oil rigs, tidal barrages, combined heat and power schemes, transmission lines, distribution pipework, etc.

Investment by the manufacturer

The manufacturing and construction industry is made up of a great many companies, mostly in engineering and with non-energy interests as well. They are conventional companies, subject to the pressures of the market place, and they have to keep their products up to date and tuned to customer need. Their aim is to compete effectively and to maintain, or increase profitably, their share of busines They are regular investors of capital in renewing the production facilities.

We have established so far that for all three group investment is the key. Whatever their method in makir policy, whether they use deep thought, or follow fashior or merely guess, they are arriving at that moment c decision: what to invest in — what to buy, what to build

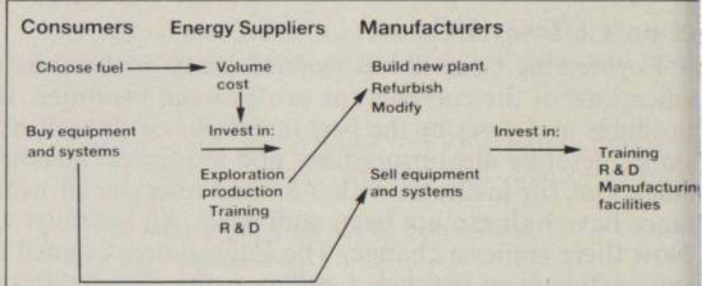

Fig 1 The energy investment chain

The pure market school

Some say 'let the market decide', and demand tha everything that interferes with market forces should b removed. This Pure Market School regards that as th right way of achieving what the nation requires. To b more precise, it is saying that if all the individuals are le to contemplate their problems and take their ow decisions, then the aggregate result is the right on nationally. This thesis has an advantage, which some c its critics might, unfairly I think, regard as cheating: says in effect that the way to discover what the natio needs is also to leave it to the market, because no singl individual can know; so the aggregate of all thos investment decisions is not only the result of the polic (it is what happens), but also its objective (what ought t happen). You might say that it is impossible to get wrong. It is also impossible to check whether the polic is right.

I must tell you that I consider the arguments of the Pu Market School to have a lot of validity. If you think abo it, they are those we employ in other walks of life. W say the customer should decide, through his purchase what will be available and that the suppliers will respon and make it available — and they do — and long ma it continue. There is a basic plausibility about th argument, and that is why some people think it qui reasonable that it should extend also to energy. How it then that some of us do not agree?

The counter-argument that is popular among those wh debate these matters is that in practice things are not le entirely to the market — not in energy. The list c Government interventions runs from the excise tax o hydrocarbons via the ever changing fiscal regime for th North Sea to the 1983 Energy Act. This is not to condem

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*Immediate past-president. The paper was given as his Presidential Address at a London and Home Counties branch meeting at the Royal Institution on 15 April 1986 ıtervention, just to say that it cannot be avoided. It is sound counter-argument, but I am more interested in ne based on the interaction of the three investing groups ı Fig 1. A simpler version of Fig 1 is shown in Fig 2, hich presents it as a control loop; and as in all such ystems behaviour is governed by the time delays.

The energy suppliers respond to consumer decisions ther by increasing volume or reducing unit costs, ormally by investment. Time delays for modifications nd refurbishment may be just a few years, the full cycle) a new production plant rather longer. For instance, ith the Channel Link it was four to five years, and with orness seven to eight years (each had two stages). If you emember your control theory, a condition for stability that response time should be short relative to intervals etween signals (in this case the consumer action). But our esponse times here are of the order of several years, much oo long for consumer behaviour to remain consistent. o the system is not stable, and is liable to hunt. It would e informative if our energy academics could say if they ave analysed the dynamic system on Fig 2; my surmise that the Pure Market School has not, and may not even now of its existence.

That is one of three ways in which the time dimension ffects our problem. Another is in the prediction of future vents: that is needed, even if the system is stable, because enters into the way investments are assessed.

ssessing the investment proposal

Conceptually, the question is whether lower fuel and aintenance will cover the cost of the improvement, given aybe some hidden advantages. There are broadly two ays of expressing that analytically.

On an annual basis:

$$z = (f_1 - f_2) + (m_1 - m_2) + b - aP \quad ....(1)$$

where: z is the annual gain
- f is the annual fuel cost
- m is the annual maintenance cost
- suffix 1 refers to conditions before the improvement
- suffix 2 to conditions after the improvement
- b is any other benefit, as yet unspecified
- P is the net capital cost
- a factor converting to annual charge

The units throughout are those of money pa.

Or in the integral form, which the consumer is more likely o take:

$$Z = (F_1 - F_2) + (M_1 - M_2) + B - P \quad ....(2)$$

where: Z is the overall gain
- F is the aggregate fuel cost
- M is the aggregate maintenance cost
- B is the benefit, as yet unspecified
- Suffix 1 refers to conditions before the improvement
- Suffix 2 to conditions after the improvement

The units throughout are those of money.

Equation 2 is ambiguous, because the number of years over which the gain is to be measured is not stated. It vould be logical to take it over the life of the improvement say 10 years for a central heating boiler) but consumers lo not look that far: they tend to ask 'whether it pays for tself in a year or two', and assume that they will be on he right side, and in marginal cases they throw in a benefit B such as comfort or cleanliness.

From equation 1, we can see that if the future fuel cost, f_2, rises enough, z can become negative. For instance, if ou switched to oil heating tomorrow, in April 1986, rusting that current low oil prices would be there a long time, you might write off your new boiler in two years, but you are locked in to a fuel whose price could rocket and you will not want to change your boiler system again. So the consumer ought to be appraising his investment over its whole life, which would involve taking a view about future movements in fuel price. Few consumers do that, and the industrial and commercial consumers are often just as short sighted as the domestic.

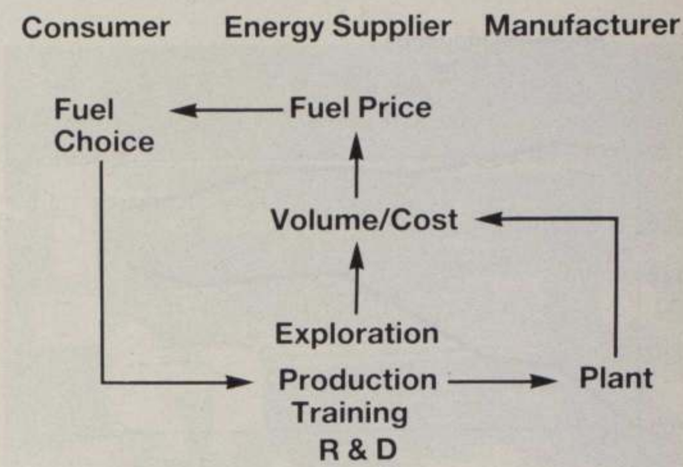


Fig 2 The energy investment control loop

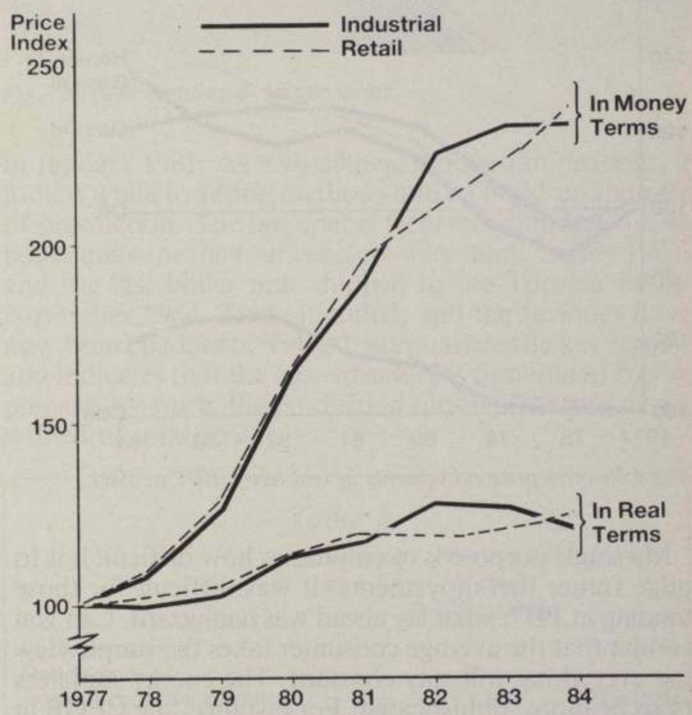


Fig 3 Movements in coal prices 1977 to 1984

The next question is how to cater for inflation: should future fuel prices be in real terms or in money terms? The former argues that the consumer's income rises to compensate, and is usually thought more correct. Considering that most people simply ignore future fuel price anyway, it is automatic that they ignore inflation also. However, inflation can help, because the capital diminishes in real terms. If you take it into account, you favour those alternatives with higher capital cost and greater savings in operation. This helps those who borrowed money at a fixed interest rate, as home mortgagees know very well. So ideally both future inflation and future fuel prices should be predicted over the life. It is not easy.

Fig 3 shows price movements for coal in the years 1977 to 1984 for both real and money values; the difference between the two curves is inflation, as represented by the Retail Price Index. How could the movements in Fig 3 be forecast? Admittedly these were years of high inflation, but in general it is not surprising that the average consumer just gives up and is content to assume that fuel prices are constant. Fig 4 shows movements in real terms for a range of fuels and you can see how scattered they are. May I stress that this is not a beauty contest. We are not looking at these in order to choose the best fuel, and could not do it from those plots because the presentation brings all fuel prices, which differ widely, back to 100 in 1977, and displays only movements relative to that.

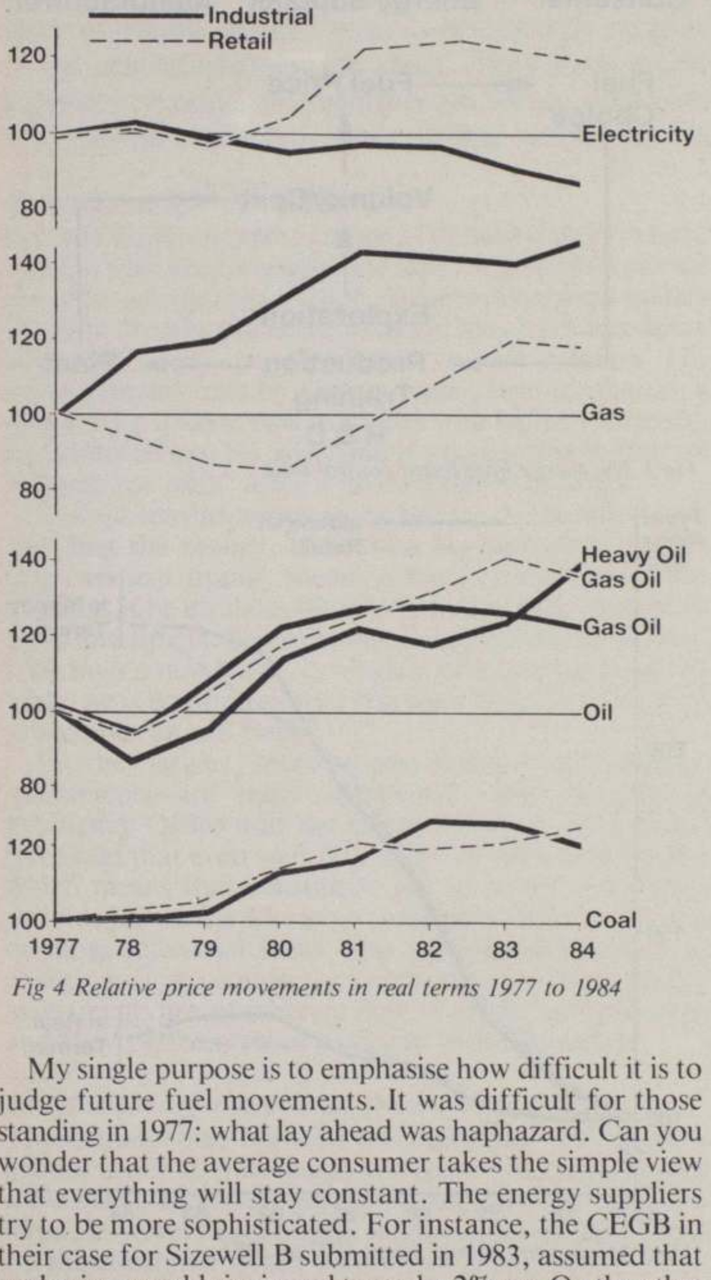


Fig 4 Relative price movements in real terms 1977 to 1984

My single purpose is to emphasise how difficult it is to judge future fuel movements. It was difficult for those standing in 1977: what lay ahead was haphazard. Can you wonder that the average consumer takes the simple view that everything will stay constant. The energy suppliers try to be more sophisticated. For instance, the CEGB in their case for Sizewell B submitted in 1983, assumed that coal prices would rise in real terms by 2% pa. On the other hand, nothing was allowed for future inflation: more of that later.

Consumers then should make decisions that will stay valid for the life of the equipment over which they are pondering. The Pure Market School reckons that they can cope with the degree of scatter shown in Figs 3 and 4. The plots show no consistency from one fuel to another, very little between retail and industrial prices, and none from year to year: and those are the movements in real terms. The effect of inflation was brought out by the earlier graph for coal only, without plotting a full array in money terms for every fuel. What I am saying is that the predictions which are essential to adequate investment appraisals are beyond the reach of the average consumer and ought not to be expected of him, either by the Pure Market School or by anyone else.

We do not need to look ahead 50 years. The periods that matter are those for the investment under consideration. I do not suggest that energy specialists necessarily get it right, on the contrary. They make many mistakes, which allows the Pure Market School to claim that their method is superior. It does seem strange to argue that the imperfections of specialists show that one can dispense with them or that because a job is difficult it is better to get it done by people who are incapable of it. I am afraid the Pure Market School is guilty of a false analogy with ordinary consumer products where the time dimension is hardly significant and where matters of personal taste rightly predominate.

Let us look briefly at the other terms in equation 1. We have just been discussing $(f_1 - f_2)$, the fuel saving: it is logically simple, but the values are difficult to predict. The next term in brackets $(m_1 - m_2)$, the saving in maintenance, has a bearing on the rather wider and separate question of quality costs. I had not wanted to complicate my main argument by bringing in availability and load factors, just two of the things that make the appraisal of investment much more complex than is suggested by equation 1, which covers only the principles I wanted to discuss. The maintenance term includes loss of production through outages; and there is a relationship between that and the capital investment P: you spend capital not only to get fuel savings, but also for improved availability and lower maintenance charges. But that is a subject in itself. The parameter b is there to remind us that not all benefits of investment can be strictly quantified. For instance, reasons for switching out of coal may be to avoid dirt and difficulties of handling. Benefits of that kind are not easy to quantify but should not be forgotten: and one could give other examples. There are always some such benefits which is why in the end the investment decision must involve judgement.

Perhaps the most controversial item in this expression is a, which turns the capital cost into an annual charge. This is not a lecture on economics or financing methods, and we need not go into the alternative treatments. At one end of the scale is the process of dividing the capital cost by the number of years assumed to be relevant, what I called earlier the pay-back period, to give a constant annual charge. This is a long way from being satisfactory for an energy supplier, who would use a discounting technique, and leaving aside engineering questions about life and load factor, the argument is about which discounting factor to use. That is something I want to talk about presently, but before that we need to consider the value of P, the capital cost, normally taken at the date of commissioning, and to include interest during construction. It mainly comes from the third group on Fig 1 because most of the investment by consumers or suppliers is in the products and services they buy from the manufacturers, which brings me on to home ground. To

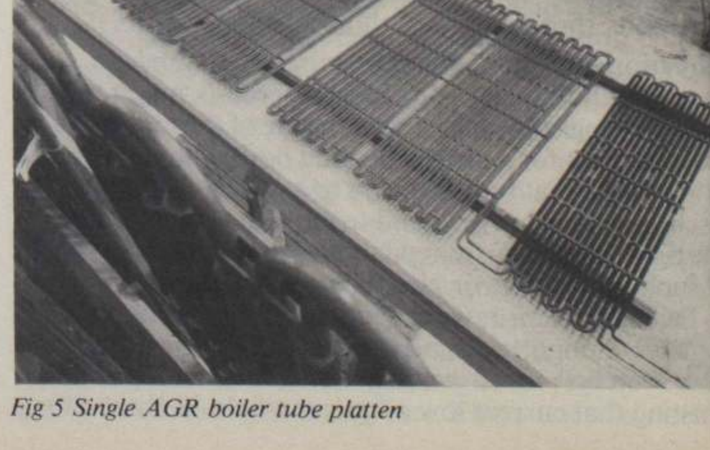
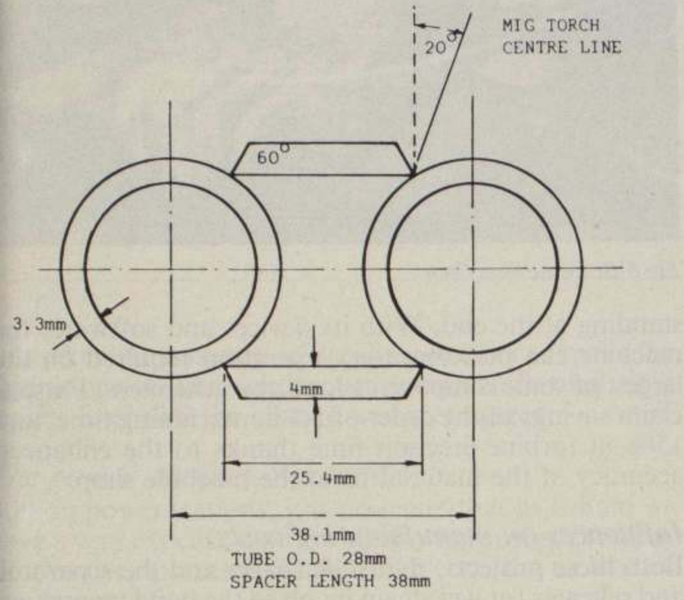


Fig 5 Single AGR boiler tube platten

e how the costs of that work, we need to look at the natomy of a manufacturing project, and I have chosen vo for illustration. The background is that anufacturing costs contain overheads covering among her things speculative development, selling effort and nsuccessful tenders, depreciation of premises and quipment, and the upkeep and operation of the factory nd offices.



ig 6 New spacer configuration

AGR spacer welds

he first illustrative project is the manufacture of the pacer welds for AGR boilers by NEI Nuclear Systems. he policy to build two further AGRs was endorsed by he Labour Government in January 1978 and confirmed y the new Conservative Government in December 1979. he boiler tubes (in Hinkley B and Hunterston B, and herefore in Heysham II and Torness) form a structure hat will stand up in the high density CO_2 flow without ibration or fatigue. Fig 5 shows a complete platten, water nters at the bottom, to the right, and emerges as steam t the top. In the reactor, the elements stand vertically side y side, to make up a tube bank. The gas flows ownwards, on the outside. They have spacers (Fig 6) in he form of small metal plates spanning from one tube o the next and welded at the two ends; there were ltogether about 8 M spacers, all factory welded. On the irst two stations, manufactured over the period 1968/72, hey were welded manually and although performance in ervice was first class, it was decided that for the next two tations they should be machine made, to give better speed nd uniformity, and to underwrite the reliability even more. Robotic welding was chosen for its flexibility, and y 1977 the designers were ready to evaluate the world-vide capability for suitable robots; and they produced a hort-list of three. Each submitted a scheme for the roblem as defined, and were assessed in detail. The uccessful proposal involved putting the tube platten on fixed table and suspending two robots from a gantry hat would run over them.

Fig 7 shows the embodiment as eventually developed. n 1978, the company purchased a standard robot for valuation in their own works, and from then on work roceeded in parallel. ESAB dealt with the gantry system vith its suspended robots, while NSL developed the velding process and the control software.

Typical of the associated technical development was the atigue work, with specimens taken from the welding trials traight to the fatigue testing machine. Some 200 endurance demonstrations were completed using full scale element samples. The tube bay at NSL's Gateshead works was refurbished with new equipment, reflecting developments in manufacturing technology since Hunterston B and Hinkley B 12 years earlier, including the robotic gantries for the spacer welds. Delivery and installation of the equipment in the tube bay started in March 1980, and the first production spacers were welded

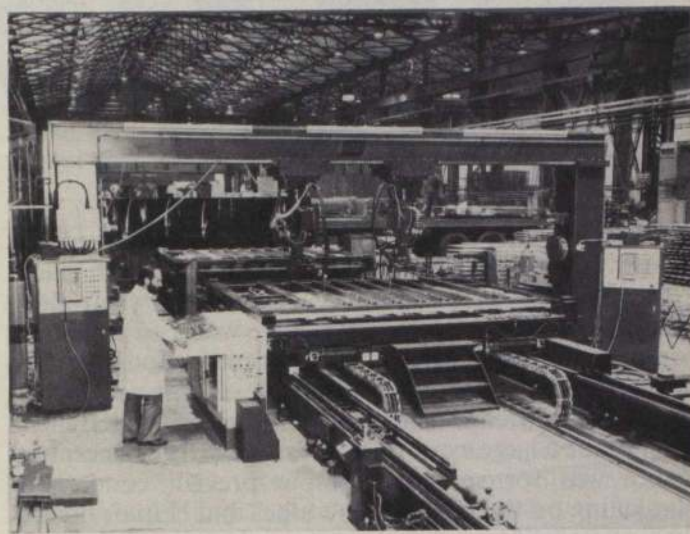


Fig 7 Robotic welding of spacer welds

in January 1981. As with all new production facilities, it took a while to refine methods and to build up the rate of production. The last spacer welds to complete the 48 boiler units for the four reactors were made in July 1984, and the last boiler unit shipped to the Torness site in November 1984. There it ended, and the facilities have now been cocooned. Table 1 summarises the key stages, and indicates that the cost structure is dominated by the preparatory work, the production runs representing about a third of total cost.

Table 1

	Relative cost %	Number of direct NSL people	Period
Early studies			1976-1979
Design and production development	13	10	1979-1980
Procure equipment)	52	2	1979-1980
Install and work up)		6	1980-1981
Production run	35	10	1981-1984

Separators and reheaters for wet steam

My second illustrative project is the development, by NEI Parsons, of components for wet steam turbines (for nuclear reactors that supply steam at relatively low pressure and temperature and without superheat). The lesson here is the critical importance of steady progress: where a manufacturer with a reputation is getting a good share of the market, as with this company in supplying turbo generators for CANDU since 1965, he can plan his improvements, and the benefit is translated into solid behaviour in service. Table 2 shows that in September 1985 their wet steam units occupied six of the first 10 places in terms of world lifetime load factor for nuclear units over 500MW. One of the reasons is the combined separator and reheater system, a peculiar need of these large wet steam sets.

There are three possible types of separators: cyclone,

Table 2 Lifetime load factors for nuclear units 500MW and above to September 1985

1	Bruce 3*	87.6
2	Bruce 4*	85.0
3	Bruce 1*	83.8
4	Grafenheinfeld	82.8
5	Lepreau*	82.1
6	Stade 1	81.9
7	Genkai 2	81.9
8	Unterweser	81.2
9	Pickering 4*	81.1
10	Pickering 3*	81.1

* NEI Parsons set

(Source: Nuclear Engineering International, March 1986)

corrugated plate, and wire mesh. The last two need low steam velocities, well ordered entry, and a lot of space. Parsons entered this market very early when little information was available on water extraction performance, and decided to develop a cyclone type in-house. The reheaters have to handle a large volumetric flow of dried steam with a low heat transfer coefficient and require a large external steam surface. The conceptual choice was for vertical tubes to prevent condensate blanketing on the inside of the tubes and help drainage; that also facilitates separate tube bundles for quick individual replacement.

Another feature that contributes to high availability is good access for maintenance to reduce expensive shut-down times. With relatively small and highly reliable cyclone separators and separate vertically tubed reheaters, the turbine floor is kept clear for access, as shown in Fig 8. The inlet and outlet branches are at low level, so it is easier to reach turbine cylinders for maintenance, and there is ample lay down area. All those are obvious advantages, quickly recognised in the early 1960s, but to achieve them required a sustained development effort.

The experimental set-up for the separator (Fig 9) was refined in stages. It is fundamental in water separator work that the mixture of steam and water in the rig should have a droplet size distribution close to that of steam in the full scale turbine. Early experiments obtained their mixture from a water spray, progressing to the exhaust of an experimental turbine with a small pressure ratio, and the final tests used a converted multi-stage turbine with representative extraction and separator inlet manifold. Development concentrated on the geometry of the louvred liner around the whirl chamber, and of the axial gaps into the annulus from which the water is drained. A separation efficiency exceeding 95% was eventually achieved. The main work was on a quarter scale model, and scaling effects were separately investigated to enable a full size design to be specified. Here again the important factor is the length of the sustained development process. The first Pickering machine was synchronised in April 1971 and achieved full load some eight weeks later. There are now in service over 8500MW of wet steam turbines incorporating these separator and reheater systems.

When orders are being obtained regularly, production improvements can be progressive. There have been major strides in production technology recently, and they translate into machine reliability as well as into lower costs. A new generation of CNC machine tools and robots for a whole range of processes have transformed turbo generator works, as Fig 10 will serve to illustrate. It shows a giant CNC machining complex, 60m long with a travelling gantry and associated bedplate at each end and a central rotary table. The scale is given by the people

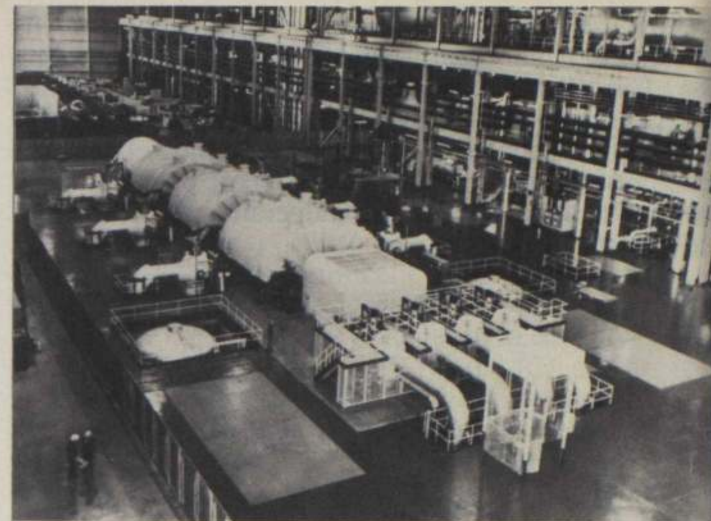


Fig 8 Bruce turbine floor

standing at the end. With its devices and software, the machine can perform every operation required on the largest of static components for turbo generators. Parsons claim savings of the order of 5:1 in machining time, and 15% in turbine erection time thanks to the enhanced accuracy of the material from the machine shop.

Influences on manufacturing costs

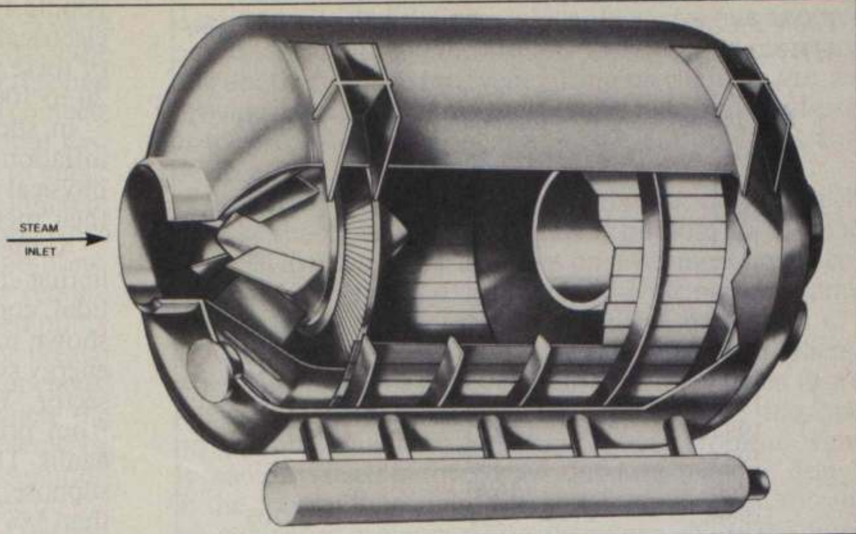
Both these projects, the AGR spacer and the separator and reheater for wet steam involved the build up and use of specialist resources over long periods. A major effort went on development and on buying capital facilities, and a relatively long time was spent on preparation and proving. In the second project, the market was sufficiently steady over many years to allow regular progress. On the other hand, if volume is low, as in the first, development and depreciation become high components of cost.

The effect of postponements is that the resources once established are held unproductively. If the extent of the delay is known, it may not be difficult to plan for least disruption and damage. Teams can be held together if there is worthwhile alternative work, and it is better than redundancy. You can increase effort on design studies or development or on proposals to other customers, so as to create alternative capability for the future. None of those corresponds to cash coming in to the enterprise in the short term unless it leads to a contract, and if so, the people can no longer be switched back to the original project. High grade technical people are primarily dedicated to what they regard as 'real work', and they have a limited interest in paper studies. Sooner or later they may look for other employment, taking their know-how of the manufacturer's products with them. When the project reawakens the manufacturer himself is less well equipped technically than he was. Recruitment and retraining also cost money.

A less quantifiable difficulty is that the lost experience will include indefinable elements of know-how whose main contribution was to quality and the avoidance of difficulties in production. As you saw, much time is devoted to trial production runs. The know-how is vested in the people, who build up acquaintance with the production process and can clear odd problems quickly and guard against mistakes. It is called the learning curve, and obviously if the people have gone so has the learning.

Any hold-up in placing a project entails higher cost, but when the delay is indefinite, they are particularly high; energy suppliers would do well to select policies that avoid public enquiries and other sources of uncertainty. Changes in project requirements are also damaging: work may have to be aborted or written off, equipment and know-how may no longer be applicable. That ought to be estimated

Fig 9 Water separator



and taken into account in deciding whether to make the change or not. They are frequently underestimated, with regrets later that the change was ever agreed.

The power station programme

Still on power stations, it is no secret that in Britain we have a very expensive way of approving energy projects. We waste resources and incur high cost. Let us look at the record.

In the 1960s we had a high ordering rate, too high because it overestimated the growth; so much so that it is often quoted as an example of bad work by planners. From the 1970s that was followed by a very erratic decade and a half, through a variety of factors that disturbed both Government and utilities, among which I shall mention at random the two jumps in oil price, the miners' strike and the *Plan for coal,* temporary disenchantment with the AGR, a fitful desire to collaborate with other countries, and a major investigation into the power plant industry by the Central Policy Review Staff.

Already the 1960s had seen great irregularity from one year to the next, even though the average was high. But since 1971 a total of just seven power stations have been started, with a combined output of 10.6GW, an average 0.7GW pa for the last 15 years. Compared with an average of 4.3GW pa for the previous decade, this is a drop by a factor of six. When the power plant industry deprecates such policies, it is often suspected of wanting to boost its business. I am saying that if the authorities want to operate on that basis, they are free to do so, but should have in mind that they are putting up the costs very considerably: the resource costs as illustrated by my two projects.

Two attempts were made to avoid the high cost of irregularity. The first was in 1972/73 when the CEGB announced that 18 PWR reactors of 1200MW should be ordered from 1974 to 1979; and some firms outlined plans accordingly. The second was in 1977 when the Government accepted the CPRS' recommendation for a smooth ordering programme of 2GW pa. Both attempts came to nothing, largely because the principle of smooth ordering was associated with a programme much greater than was needed. The scale was wrong and it killed the principle. But it can be done, for instance by commercial deals in which, for a programme pitched at a reasonable level, a run of plants would be ordered, with cancellation charges according to the amount of notice if that had to be given. That would bring discipline into the planning process, and ensure that true costs were reflected in it. But we are told that these things are not possible because 'in a democracy' investment programmes of nationalised industries have to be reviewed every year by Parliament, and again because 'in a democracy' no Government can commit its successors.

But is that true? Two of our sister nations have exhibited consistency and regularity at home in order to bring costs down and have an effective export business. Table 3 shows the Canadian achievement with a total of 21.5 GW total; and Table 4 the French 900MW units; one could show a similar table for their 1300MW units, totalling 30.5GW. Those who envy our French neighbours their low electricity costs do not have to look further than a record like this for the explanation. Both Canada and France are democracies, so there must be something wrong with the excuses that we are offered.

Contrast that, if you will, with our recent nuclear record. The two new AGRs were placed in 1980, with a controlled spacing, for commissioning in 1986/87; and Sizewell B, announced first in 1978, now two designs and a huge enquiry later, is still undecided, and there is even less firmness about the sequel. Please understand that I am not complaining about the enquiry process; but its cost and delay implications should be assessed when policy alternatives are being considered. And if they are unknown or unknowable, perhaps you choose an option that is better protected against delays and surprises. In short, the cost of unevenness should be a recognised factor in deciding policy.

The financial criteria

I now move on to the inconsistency between the financial criteria applied to different energy investments. The classical inconsistency is the one between supply-side and demand-side, or conservation, investment. That has been

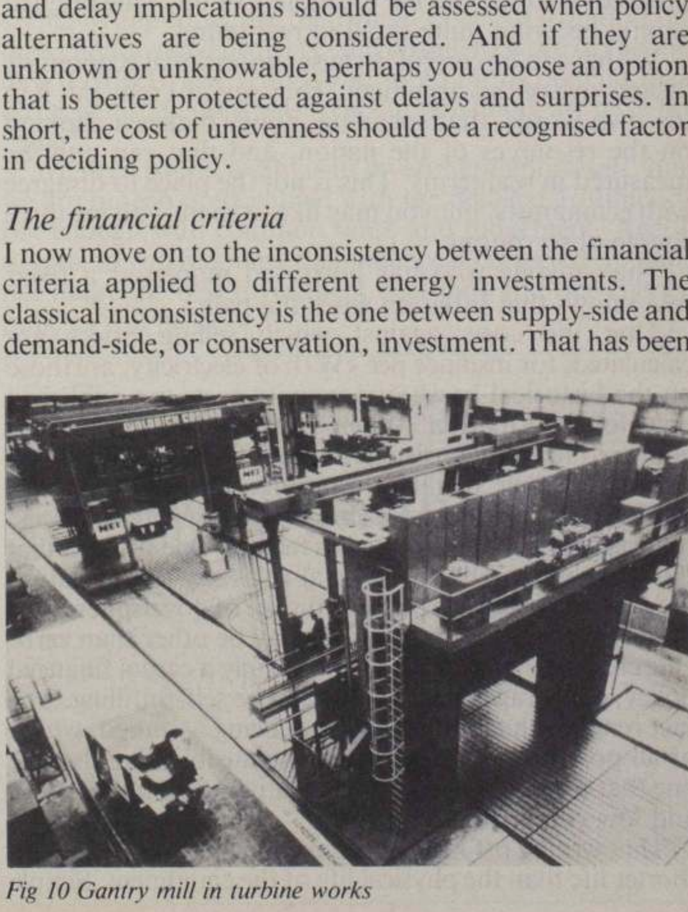


Fig 10 Gantry mill in turbine works

Table 3 Candu reactors operating/under construction MW — gross

Year of first power	*Canada*	*Export*
1962	25	
1971	1084	357
1972	542	
1973	542	
1977	1652	
1978	826	
1979	826	
1980		220
1982	1905	679
1983	540	650
1984	2230	
1985	540	
1986	1690	
1988	935	705
1989	935	705
1990		705
1991	935	
1992	935	705
1993		705
Total	16142	5431

commented upon often enough, notably by the Science Policy Research Unit at Sussex, and I should not try to give you a lesser presentation on the same point. One may quote the Select Committee on Energy in 1981:

'We were dismayed to find that, seven years after the first major oil price increases, the Department of Energy has no clear idea of whether investing around £1300 M in a single nuclear plant (or a smaller but still important amount in a fossil fuel station) is as cost effective as spending a similar sum to promote energy conservation'.

So I shall not talk about that, but about two others. The first is the use of a constant discount rate, currently set at 5%, to test public sector investment proposals. Actually we know that having borrowed money for a project, in the first year or two the interest and repayment charges are much higher than 5%, but as inflation proceeds over the full life the money value of the original capital becomes quite small in real terms.

We have to be careful because professional economists disapprove of this argument. They say, if I may put it in my own words, that spending money makes a demand on the resources of the nation, and that can only be measured in real terms. This is not the place to disagree with economists, but you may like to share with me three simple observations.

☐ That anyone who has borrowed money at a fixed rate knows that inflation eases the pain.

☐ That the costs against which selling prices are calculated, for instance per kW/h of electricity, are those on the historical basis; opportunity costs are published only for information. When I said earlier that CEGB appeared to be inconsistent about inflation, this is what I was referring to. In appraising future investment, inflation is taken as zero; in computing selling prices, historical inflation is accepted as factual. One suspects that the real reason why the official rules say that inflation must be ignored is the political dislike of governments for predicting that future inflation may be other than zero. One can understand that: it could imply a casual financial policy, encourage wage claims, and be self-fulfilling. The fact remains that zero inflation is being assumed, which of all possible figures is the least plausible and also the one that most penalises the alternatives with high capital and low running costs.

☐ That writing off investment exponentially gives a much shorter life than the physical life of the equipment. Simple people find it hard to accept that a tidal barrage, a[n] electrical or gas transmission grid, a power station, an[d] of these with a physical life remaining of anything fro[m] 20 to 100 years, has no value.

In short, they allow us to take account neither o[f] inflation, which reduces the money liability; nor o[f] physical survival, which recognises an asset. Somewher[e] their method does not seem to match the reality.

At the present time, we have an additional confusion in that energy processes that are not yet established, lik[e] tidal, combined heat and power, and others, have to b[e] shown to be viable in the private sector, but tradition[al] energy systems like electricity and gas only in the publi[c] sector. Yet there are paradoxes when interest switche[s] from private sector financeability to public and bac[k] again. The important criterion is not, as we sometime[s] suppose, the real rate of return that is acceptable: not les[s] than 5% for the public sector and perhaps 12 to 15% fo[r] the private. The very character of the question is differen[t] especially with current economic orthodoxies.

Private sector resources are not limited: cash will b[e] found if the numbers are right. In contrast, the publi[c] sector has a direct resource limitation in the Public Secto[r] Borrowing Requirement, and what matters is competitio[n] with other projects that may claim a priority within PSBR. Those giving less than 5% will be ruled out, but thos[e] above 5% must be as cost effective or better than rivals. Any otherwise sound energy project that requires som[e] participation from a public sector organisation could b[e] ruled out by that test.

Take for example a combined heat and power scheme. Those who are working in this field have been aske[d]

Table 4 French PWR programme — 900MW series

Commitment years	Location	Cooling system	Net output (MW)	Start up
1970	Fessenheim 1	River	880	04/77
1971	Bugey 2	River	920	05/78
1972	Fessenheim 1	River	880	10/77
	Bugey	River	920	09/78
1973	Bugey 4	Tower	900	03/79
1974	Tricastin 1	River	915	05/80
	Bugey 5	Tower	900	05/79
	Gravelines B1	Sea	910	03/80
	Dampierre 1	Tower	890	03/80
	Tricastin 2	River	915	08/80
	Gravelines B2	Sea	910	08/80
1975	Dampierre 2	Tower	890	12/80
	Tricastin 3	River	915	02/81
	Gravelines B3	Sea	910	12/80
	Dampierre 3	Tower	890	01/81
	Tricastin 4	River	915	06/81
	Blayais 1	Estuary	910	06/81
1976	St-Laurent B1	Tower	880	01/81
	Gravelines B4	Sea	910	06/81
	Dampierre 4	Tower	890	08/81
	St-Laurent B2	Tower	880	06/81
	Chinon B1	Tower	870	11/82
1977	Blayais 2	Estuary	910	07/82
	Chinon B2	Tower	870	11/83
	Blayais 3	Estuary	910	08/83
	Blayais 4	Estuary	910	05/83
1978	Cruas 1	Tower	880	04/83
	Cruas 2	Tower	880	09/84
1979	Cruas 3	Tower	880	05/84
	Cruas 4	Tower	880	10/84
1980	Gravelines C5	Sea	910	08/84
	Gravelines C6	Sea	910	(85) NB
1981	Chinon B3	Tower	870	(86)
1982	Chinon B4	Tower	870	(87)

NB: connected to the grid in 08.85

vhether it can be financed in the private sector. As you now, CHP produces hot water and electricity from the ame plant: the hot water has to be distributed through ipes and sold in the market and therefore has to compete vith other forms of heating such as electricity and gas, vhose capital requirements are funded according to public riteria. It will say a good deal for the inherent ttractiveness of such a system if it can still compete while aving to raise its capital under adverse conditions. nother problem is that such schemes usually require ome complementary work by the publicly owned utility r local authority, which could be ruled out for breach f PSBR (not speculation — it has actually happened).

The same paradox applies to tidal power, where the lentical question has been posed: can the scheme be inanced in the private sector? Here again, the common actor is the production of electricity whose value on the ublic supply system reflects, among other things, the cost f servicing capital. If it is to operate in the private sector, tidal scheme must service its capital under quite different ules. It does appear to be an inconsistency, which works gainst these new systems, and it would be a good thing they could be judged on a common footing.

Conclusion

he time has come to draw these scattered observations ogether. That energy requires attention at national level, took that as common ground. It is after all why we have Department of Energy and a Secretary of State. It ollows that there are policies to be decided. Should we ave more or less coal? More or less nuclear power? More r less of other energy forms? What levels and types of onservation do we aim at? How much of energy fficiency should come from more efficient usage, and ow much from more efficient production? Do we nfluence energy demand or supply? How do we balance nergy efficiency with environmental factors? — and so orth.

My theme, neglecting the trivial case of appeals all ound to be less wasteful, has been that any of those nplies investment. Nationally, there are three choices:

a) hope that enlightened self-interest will guide people into he right decisions (ie the Pure Market School).

b) use devices like grants and taxes to manipulate the ramework within which judgements are made.

c) promote investment from the centre.

I told you that I did not believe in *(a)* — partly because o government central or local can avoid manipulating onditions, as in *(b)*, but more fundamentally because onsumers at large have short horizons and we cannot rely n them whether they act singly or in aggregate to work ut in the long term interest (national or individual). There is no evidence that their errors would cancel one another out: on the contrary, they follow fashions and reinforce one another. So we intervene, using mechanism *(b)*: we provide incentives, or maybe set minimum standards, so as to discourage investment in inefficient processes and devices.

Both *(b)* and *(c)* involve policies from the centre, which must be chosen with wisdom, and my purpose this evening has been to discuss how decisions on investment are taken, whoever takes them, so as to help provide perhaps some understanding to the exercise of that wisdom.

In talking about investment by the energy suppliers, where Government policy and influences are even more relevant, I emphasised the time dimension, the one perhaps above all that administrators have problems with. It manifests itself in three ways. First the reaction delays in the control loop, reinforcing the warning not to rely on consumer preferences on their own. Next the long periods over which the conditions of a project have to be predicted in order to assess its viability. The two hardest are fuel prices and inflation, and all we really know about them is that they are likely to go up. Sensible policies are those where our ignorance matters as little as possible: those whose running costs (which are subject to long term inflation) are low, and whose capital (which is spent early on) may be high.

Lastly, time manifests itself in the cost of irregularity and surprise, which can be very high. It is not so much that manufacturers object to those; they do, of course, but are always ready to grant the customer his prerogatives. The worry is that major policies are embarked upon without this factor being evaluated. It is difficult, especially if public enquiries are involved, nearly as difficult as predicting fuel prices. But those concerned should try to allow for it, and avoid if they can policies with a high risk of outside interference.

Lastly I talked about appraisal techniques and suggested that economic orthodoxy gave strange answers. It seems wrong to use a different basis for traditional and new systems: to judge the first by mild public sector criteria and the second by harsh private sector ones. It seems wrong to ignore the benign effect of inflation on high capital value projects, and wrong to write off assets in a relatively few years , and to go on to pretend that physical installations with years of remaining life have no value.

We need sound analysis in investment appraisals, but we are far too preoccupied with the detailed arithmetic, not enough with common sense and judgement. And I suggest to you that until that balance is corrected we shall not make the best investment decisions and our energy policies will be poor.

Industrial and PhD research: time for adjustment?*

Olinga Ta'eed†

Prince Charles' recent 'fourth-class nation' speech provoked vexed expressions from those industrialists who he accused of being less imaginative, less innovative, less creative, and less enterprising than their American counterparts. He presented a tripartite diagnosis: British marketable products and ideas are falling, (indicated by the poor UK performance in international patent registrations), those that we do have are being exploited abroad, and the remainder are being suffocated by industrial inertia. While the government and the private sector have concentrated on rectifying the two latter maladies, very little attention and resources are being drawn to tackling the more central, albeit difficult, issues of the quality and appropriateness of research

The most popular model is that falling sales imply decreasing research budgets, resulting in declining standards of research, which expresses itself in reduced demand — an asymptotically spiralling but stable path. The reality is far more complex, with at least four other factors involved. In short, it has become increasingly evident that financial constraints cannot account for everything, creativity is also highly dependent on the training of the researcher.

Mistaken and ingrained concepts of research methodology can have repercussions in the actual rates of ideation. Research findings often present inherent difficulties in translation to marketable products. Foreign competitors seem to judge more accurately the delicate balance required to optimise performance and economics. What is technologically best is not always commercially best. Even potentially successful products may be terminated as a consequence of seemingly unrelated external factors; foresight and flexibility of design are invaluable for these situations. Entrepreneurs, for instance, marketing *multi-fuel* (gas, oil, coal) combustion equipment found the recent miners' strike a bonus rather than a catastrophe. It is also common knowledge that behavioural psychology has demonstrated a definite link between performance, motivation and reinforcement. That being the case, the quality of any research cannot be taken in isolation.

The notion of creative and appropriate research, of course, raises more fundamental questions underlying the whole fabric of our culture. To a large extent, the effort to seek corrective adjustments for an updated, more evolved, more valid and improved scientific research system implies a reform in the entire rubric of the education system. Companies cannot view a graduate researcher as raw material ready to be trained in tackling 'real live' issues. Sixteen to twenty years of schooling have conditioned the patterns of thought of our engineers and scientists. Tests reveal that creativity has already plummeted 90% between the ages of five and seven, and that a 40 year old is only 2% as creative as when he was five.

If we accept that we are unlikely to witness macro-structural changes in our education system in the near future, then we must look towards some more immediate solutions to enhance and sharpen our industrial research capabilities. Many of those chiefly responsible for progres at the cutting edge of industry, the standard bearers o British research, were formerly PhD students homegrow in our universities for that very purpose. I propose tha one obvious step would be to modify the training of ou PhDs to be more vocationally relevant.

Industrial researchers see their work achieve fruition..

Within industry, engineering progress and researc consists of a string of integrated processes — marke research, engineering science, feasibility studies, prototyp development, production and finally sales. Thus th industrial researcher will identify himself as only part o a collaborative team. He follows a definite teleologica path, knowing his objectives (as set by market research) the purpose of his research and the importance of it i relation to customers and the company plans. His self esteem and sense of fulfilment will grow as he applies hi skills to the optimal use of resources to define and validat his role within society. Furthermore, he has a good chanc of seeing his creativity achieve fruition within th foreseeable future and will therefore relate closely to hi work. In both financial and non-monetary terms, hi rewards are considerable.

...students assume that their work will not be implemented

In sharp contrast, the typical PhD student appears to be insular, his research being conducted in complete isolation to related disciplines. He is rarely encouraged to examine the wider issues for fear of attaining insufficient depth in his research. Unlike his industrial colleagues, he is rarely aware of the policy context and the environment in which the research is carried out. During the miners' strike of 1984-85, there were probably a large number of disillusioned coal/combustion PhD students wondering how powerless they were to control an unaccounted independent parameter, called Arthur Scargill, whose effect was to make sure that their theses might never see the light of day. The student assumes that his work will never be implemented (unless involving industrial collaboration), and that the primary purpose of the PhD is just that, to get a PhD; progress is a secondary matter. The absence of a 'carrot' other than a superfluous title is hardly an incentive for good research.

Much attention is being focused on both the fall in original academic work (represented by a 10% drop in the paper publication rate since 1973), and the statistics which represent one of the traditional measures of research performance — PhD completion rates.

*The article appeard first under the title *Research and the real world* in *The Times Higher Education Supplement* (7 March 1986, No 696)

†Leeds University. The author is to take up the post of visiting lecturer in the department of thermoscience engineering, Zhjiang University, China.

ubmission rates became a bone of contention after riticism in the *Swinnerton-Dryer report* on postgraduate ducation (1982). The report highlighted the major easons as being a loss of motivation and interest, topic hoice, supervision, ability, and the attraction of an utside career. It is interesting to note that according to ERC figures for 1974-84, engineers have consistently igher drop out rates and significantly longer cómpletion mes than other sciences. The SERC responded in 1983 ith a useful booklet on *Good supervisory practice*, but fails to properly address the relevant issues:'first and ore important, is the ability to select problems, to imulate and enthuse students, and to provide a steady ream of scientific ideas and guidance,... there is no way f giving guidance on the first matter'. Instead, it gives structions on the more minor matter of the desired echanism for expedience in PhDs.

election, motivation and structure

ike their industrial counterparts, academic research must ocus on three basic criteria. Firstly, one must ensure that e appropriate problems are selected; secondly, that the esearcher is end motivated; and thirdly, that the research subsequently structured. Surely, the key to this issue not another set of impersonalised 'techniques', but ather a new 'methodology', necessarily heuristic by ature, and laying the emphasis on the individual.

Scientific research is not merely a rigid adherence to eductive reasoning by analysing premises. It is an active terest which stretches beyond gratifying achievements, nd energises in economic and social change. The new terpretation must give full recognition and awareness f an important high level property of the human mind – creativity, which involves a direct break from the long stablished patterns of logical and behaviouristic thinking at both industrial and academic researchers have abitually taken for granted. A three to four year degree ourse in engineering, for instance, contains nothing at ll about the methodology of effective problem solving. or a methodology to fully qualify and function it must lso allow for the researcher's 'world view' and ppreciative system. Whilst some require their research be only a cerebral activity, vaguely relevant to their nvironment, others may require more utopian goals and ek meaningful results as a service to society.

The issues of selection, motivation and structure cannot e considered in isolation to each other, but rather in the ght of their intricate interrelationships — purpose, reativity, and approach. The accepted definition of reativity (historical evidence suggests a process of nifying diverse concepts) shifts emphasis from specialised ducation to a more general one. Creativity can thus be stilled in our industrial researchers and PhD students y exposing them to different disciplines.

Within this cognitive realm, the researcher has at is/her disposal the intellectual tools needed for novelty, y becoming familiar with recent developing modes of inking and procedures of inquiry remote from his ubject. Given the intellectual breadth, one has to appeal a form of eclectic epistemology to provide pragmatic olutions. An alternative line of thought expresses itself the classical paradigms of scholarship which project a ery single-disciplined, piecemeal approach to problem olving. Such an approach encourages a belief in eductionism; a concept pervasive in all scientific systems fear of losing their unique absolute status as the one easure of all things. There is no merit in producing inds infected by eager generality, but rather those apable of imaginative, lucid, and successful scientific easoning.

The emphasis must be on long-range goals not short-range results

The *Finniston report* found much evidence of the misguided but prevalent belief that particular disciplines have ontological priority over others (a belief which also underlies much of the arts versus science debate). The inquiry 'received a substantial volume of evidence both from educationalists and employers concerning the generally poor communicative skill ... of many engineers and engineering students, and their narrowness of outlook. Effectiveness for an engineer demands a high level of skill in communication, plus a basic understanding of social affairs and the exercise of judgement and discrimination in non-technical matters'. Technological progress, economic growth and social change are so closely webbed together that problems must be approached holistically. Researchers must comprehend at least the rudiments of organisational systems and associated investment decisions, if they wish to see their work successfully travail the perilous journey through development, implementation and operation. It may be, of course, that many researchers do share these views but without sufficient intensity. It is not a question of viewpoint, but one of priority. To foster creativity, one must emphasise long-range goals rather than short-range results. Conflicts for limited time, money and resources, compel concentration on short-range goals. 'Ours is the NOW generation'.

Creativity consultants

Industry can rarely afford to be intransigent when faced with a bleak economic future and, characteristically, the more prosperous companies have been swift to explore new methodologies. Perhaps the most controversial propositions are those expounded by 'creativity consultants', who claim that creativity can be taught. Twenty thousand enrolments a year prove their case, and at a cost of $60 000 per course, it is not the fringe lunatics who get baited but a veritable who's who of leading multinationals: IBM, NASA, AT & T, Procter & Gamble, Exxon, Shell Oil, Arco Petroleum, General Electric, Polaroid, Apple, etc.

An increasing number also invest in intensified personalised training for their (research) manager, encouraging less stifling supervision rather than more structured guidance. Matchett Training (UK) and the Centre for Creative Leadership (USA) are leading exponents of this. To digress slightly, a recent article in the *British Psychological Bulletin* (November 1985) even correlates research creativity with certain personality traits. Effective researchers, it seems, are those who are ambitious, enduring, seeking definiteness, dominant, show leadership and intelligence, whilst poor researchers are meek, supportive, aesthetically sensitive, sociable, objective, and extroverted!

Probably the most popular methodology, employed by all major companies, and one aptly suited to academic research, is the systematic approach. The role of the systems engineer is to coordinate resources and perspectives from a variety of company departments, within a conceptual framework. In addition, wider and more pervasive influences from senior systems are accounted for, and a solution obtained by optimising (in)compatible objectives. All these methodologies are inherently multidisciplinary and lay greater emphasis on the individual. Several professional engineering institutions are encouraging broader 'Special Interest Groups' (SIG) so that remote topics may be studied in relation to engineering. A case in point may be found in the Institute of Energy's curiously named SIG, 'Nonlinear

Studies', which instigated Babcock Power to examine industrial furnace slagging problems with some novel and abstract modelling.

The Government, for their part, have not been slow to enact measures to research capability with their *Design for profit* and *1986 Industry Year* themes. Sir Keith Joseph recently gave an interview on the Green Paper (*Edinburgh University Bulletin, September 1985*), in which he advocates the broadening of education with a wider range of subjects taken to a later stage, and some cross-fertilization between the arts and sciences. Earlier in the winter of 1984, he wrote a foreword to launch a new and promising quarterly magazine called *Engineering Tomorrow*, from the Engineering Reform Group. The first issue expressed frank criticism of the present education system and industry. Sadly, financial backing in the form of advertisements was withdrawn before the second issue, making the first probably the last.

Within the education system some exemplary moves have been initiated by the Associated Examining Board in the structuring of their engineering science A level, and also from the Society of Education Officers in a new curriculum plan, — *Education for enterprise*. The response of tertiary institutions is less encouraging. The recent 'knife at the throat' technique devised to provide incentives to improve PhD submission rates at blacklisted universities appears to show little understanding and insight of the complexities of the issues involved, though the goal is universally desired. It is usually the younger universities who provide the pockets of activity that disrupt the stagnant pools of academic routine. Lancaster has both the department of independent studies and the prestigious department of systems with its MA programme, during five months of which the student is directly involved in the study of a real client's problem.

Some suggest that the more successful US entrepreneurial capability is part due to their less 'scholarly' but broader education system. Other establishments have concentrated on broadening undergraduate courses so that scientific methods are not studied in isolation from the practicalities of work. The mechanical engineering department at Leeds has an industrial psychology final year option; and since 1983, engineering at Cambridge has integrated economics, finance, and such like into their courses, much aided by a multidisciplinary management studies group resident within the department. It is perhaps more than coincidental that evolving universities, like Lancaster, Keele and Cambridge, also have praiseworthy Ph completion rates. It seems tragically ironic that colleg like Keele are bearing the brunt of necessary Governme cut-backs, despite their unique foundation year optio and pertinent joint honours schemes.

The academic environment has been built to withstand dynamic change

It would be all too easy to dismiss the poor academ response as a case of lethargic and myopic researcher The exercise in revision is difficult and intertwined wi bureaucratic procedures that set academics ar industrialists apart. There is considerable organisation inertia, which is a greater obstacle to change decentralised infrastructure like a university departme than in autonomous, centralised multinationals. Mone and prestige are vested in academic departments, whic in general show an unwillingness to stake preciou resources in new and untested areas leading beyond the exclusively disciplinary boundaries. The problem c resource allocation, however, may not be as effective barrier as intellectual inertia — indifference, fear, an pyscho-sociological factors. And who is qualified to teac and supervise in a multidisciplinary field when so few hav the required expertise?

The academic environment has been built to withstan dynamic change. Innovation is discouraged in favour c continuity of purpose. During these times when imag building of our colleges is becoming increasingly vita should universities not be seen to be as concerned wit research performance as they are about grant allocations Respected figures, such as Lady Warnock have voiced a opinion that academics should not mimic British busines which after all is already in a 'parlous state'. M observations indicate that in this particular aspec academics would be ill-advised not to do so. It i reasonable to suggest that some of our more affluer research councils could easily afford to experiment int different methodologies by sponsoring a handful of suc studentships (a dozen say). Only if the results ar encouraging, would further funding be advised. It woul be erroneous to end with prognostic and alarmist clichés but this much can be stated; without the contribution o the education system in developing the attitudes and skill which make up Britain's technological research capability the economic recovery of our industries will b increasingly contingent on our innovative serendipity. □

Pollution abatement
'Need not be costly'

Environment Minister William Waldegrave has announced that he has asked his department to consider how best the Government can encourage the development and use of pollution abatement technology.

Speaking at the Royal Society of Arts conference, *Industry: Caring for the environment* in London, Mr Waldegrave said; 'The Government already provides encouragement for industrial innovation of products and processes to meet current standards. In this context I believe we should look at the feasibility of positively encouraging innovations arising from industrial R and D that will actually *improve* the environment and win potential for commercial return thereby. We need to consult other departments concerned and have regard to R and D expertise already funded by Government. I have therefore asked officials to consider the possibilities of such a scheme as a matter of urgency.'

Mr Waldegrave stressed that concern for the environment need not be prohibitively costly and that pollution prevention can pay. He went on to say, 'Good environmental care gives a company a modern image more than any other single factor. Companies should put environmental goals in corporate plans and should be explicit about the means to implement them.

'They should have high standards for their operation in any part of the world and should implant environmental expertise centrally in management. Senior managers should encourage the whole workforce to *think environment*. This is a sound investment for the future prosperity of the company and for the well-being of us all.'

A booklet about the conference will be available from the RSA later this year.

Source: Dept of the Environment

Chip technology
Goes into the pit

The first colliery methane gas extraction plant for the Selby coalfield has been completed at the Riccall mine. The new system, the first central gas extraction plant to use microprocessor technology instead of the traditional hard-wired control system is compatible with the overall mine control system and is a major technological step forward in methane drainage.

The plant is designed to drain methane from three mines, Riccall, Stillingfleet and Wistow. A gas suction pipeline installed in the Riccall shafts, connected to the drainage plant on the surface will be extended underground to connect firstly the Stillingfleet mine and then Wistow. The quantities of methane at 50% methane air mixture released from each coalface based on an operating rate of 1Mt a year is likely to be 200 l/s at Wistow with 300 l/s produced at Stillingfleet and Riccall.

With deeper coal seams the anticipated quantity of gas increases, so separate methane extraction units identical to the Riccall plant are to be provided during 1986 for the Whitemoor mine and in 1988 at North Selby. The quantity of methane released at both mines will be about 500 l/s at 50% air mixture.

The planned extraction rate commences with the start of the coalfaces and the rate of extraction of methane will match the increase in production of coal from the mines.

Source: British Coal

Railway streamlining
Saves energy

Reductions of up to 5% in the energy used to haul express passenger trains can be achieved by a simple improvement to the streamlining of railway coaches, according to the results of a demonstration project funded by the European Community. Applied to typical 120-150 km/h inter-city services, the additional streamlining would save 0.17 MWh per annum for each nine-coach train.

The report of the demonstration project, submitted to the Directorate General for Energy of the European Communities describes the series of full-scale comparative tests carried out by French railways to measure the effect of underbody streamlining on the resistance to motion of passenger trains. The report contains full details of test results and performance calculations.

The resistance to motion of a train is made up of three components — a constant force, a frictional force proportional to speed, and aerodynamic drag proportional to speed squared. At the high speeds of modern passenger trains, aerodynamic drag is thus the dominant factor.

Below body level the otherwise smooth airflow along a train is interrupted by the gaps between the undercarriages. Underbody skirts, which fill this gap, maintain smooth airflow and reduce aerodynamic drag.

French railways 25.5 m long Type VSE deluxe coaches were used for the tests. Test trains were formed of five or nine coaches, with or without additional streamlining, plus a CC 6500 electric locomotive.

On each test run, the train was accelerated to 160 km/h and then allowed to coast to a halt. During coasting the rate of retardation was recorded continuously by a linear accelerometer. Resistance to motion of the train was derived from the results of the retardation tests. By deducting the known resistance of the locomotive, the resistance of the coaches, and thus their drag coefficient was determined.

A reduction in the drag coefficient of 10% was achieved by coaches with both underbody skirts plus additional end fairings. For the coaches with underbody fairings only, the improvement was 14%. It is assumed that the higher drag coefficient with the end fairing was due to disturbed air flow around the undercarriages.

Computer simulations show that on a 579 km Paris-Bordeaux service with an average speed of 151 km/h, the improved drag coefficient value gives a reduction in energy consumption of 4.8%. For the 713 km Paris-Toulouse service, with a 123 km/h average speed, underbody streamlining would save 2.5% of traction energy.

Source: EIBIS

DIY energy
Is it the answer?

In a recent article in *The Observer* Dave Andrews* put the case for the mini-power station.

Nuclear power stations have low running costs but they are expensive to build. A new method of generating power with the same low running cost of nuclear power but at one third the capital costs, may become a viable alternative to nuclear power and even to large centralised power stations.

Mini-power stations consist of an industrial-type gas engine, coupled to an electric generator. The mini-power stations are so small they can be fitted inside buildings like hospitals, hotels and swimming pools.

The generator is connected to the consumers' supply on their side of the electricity meter, so that electricity generated by the mini-power station is either fed into the building, running equipment and electrical goods, or fed back and sold at a profit to the local electricity board. This has often caused ordinary electricity meters to go backwards, much to the amazement of the meter readers.

On top of this, special heat exchangers pick up the waste heat from the mini-power station and use it to produce domestic hot water. In effect the generators use the same fuel twice (for generating electricity and hot water).

Conventional power stations dump their waste heat in the cooling towers. Overall, the efficiency of the CEGB and area boards is low — only 28% of the fuel delivered to the CEGB actually ends up coming out of the consumer's plug.

In a mini-power station, 90% of the input fuel is used: 25%-30% as electricity, the remainder as heat. So mini-power

*Area manager for Applied Energy Systems of Watford stations are more than three times as efficient as conventional power stations which makes them cheap to run by comparison.

What about capital costs? The CEGB's own figures show that a large nuclear power station costs about £1500 for each kilowatt of output (for each one bar electric fire it can run). A mini-power station only costs £500 for each kilowatt of capacity.

So far there are about 200 mini-power stations in the UK, and 600 in Holland. If they are so good, why do the CEGB not install them? The CEGB has advanced various reasons for not going ahead: none of which have stood up to scrutiny.

☐ 'They are not reliable.' — It can be shown using the CEGB's own analysis that these mini-power stations are much more reliable than the CEGB's large generators.

☐ 'They won't last very long.' — Industrial gas engines have been used in the oil industry for many years, and are extremely long-lasting. Some engines in the US have run for more than 30 years.

☐ 'Maintenance costs are too high.' — Independent studies by the Gas Board, and numerous satisfied users have shown this is not true.

In the meantime, local councils are finding they can achieve large savings by installing this equipment in swimming pools, old people's homes and blocks of flats. Water authorities are installing them in sewage works running on the digestor gases, and the Devon and Cornwall police installed a unit at its headquarters in Exeter. All these installations are on target to recoup the capital spent in less than three years.

Independent measurements at Exeter's police headquarters by Exeter University's Dr John Crabbe, of the Energy Study Unit, show that the cost of power, including maintenance of the engine, is only 1.5p per unit, which is about one-third of the normal price.

Calculations show the potential users of mini-power stations would together produce all the power generated by the CEGB without using any extra fuel, in total safety, with little pollution and at one-third of the cost.

Source: The Observer

Nuclear waste disposal Synroc demo plant

A demonstration plant to test the feasibility of an Australian-developed method of immobilising radioactive waste from nuclear power stations is being built near Sydney, *Engineers Australia* reported recently.

A typical 1000MW nuclear power station produces about 30t/y of spent fuel and long-term disposal of this remains one of the most contentious issues in the use of nuclear energy.

The demonstration plant is being built at the Australian Atomic Energy Commission's Lucas Heights research laboratories.

It will test a high-level radioactive waste immobilisation method using Synroc. Synroc is a synthetic rock composed of three titanate minerals and a small amount of metal alloy. It was developed in 1978 by a team led by Prof Ted Ringwood at the Australian National University.

Small-scale laboratory tests of Synroc have shown it to have a high capacity to contain radioactive waste. However, it is only now that the feasibility of full-scale production is to be tested.

The demonstration plant will operate to all intents and purposes as if radioactive waste was actually being processed, but non-radioactive elements of a similar composition will be used instead.

The immobilisation process involves the simulated waste being mixed into a slurry with the main Synroc ingredients. The slurry is then injected into a rotary calciner operating at 750°C under a reducing gas atmosphere. The slurry is converted in the calciner to a powder to which 2% by weight of titanium metal is added for oxidation-reduction control.

While the powder is being discharged into a storage hopper, a three-axis manipulator robot positions a bellows-type stainless-steel container under the hopper.

The powder is poured in and the bellows removed by the robot. A second robot places the lid on the bellows, removes any excess powder from around the rim and seals the container by welding the lid on.

The first robot then takes the bellows to a weighing station, and from there it is transferred to a decontamination unit where it is thoroughly washed and dried. It is then taken to a prepress where it is compressed by about one-third of its height.

When the compression is complete a third robot removes the bellows and inserts it into a preheating furnace and from there into a 250t/250kW hot press. It is compressed again by about one-third of its original height at 1150°C. Gas discharged from the bellows during compression is collected and treated.

The bellows are returned to the preheating furnace to allow their cooling rate to be controlled.

The cooled, compressed bellows are then loaded on a conveyor which takes them to a storage area where they are loaded into a disposal canister ready for burial.

The AAEC says that one advantage of Synroc over the immobilisation technology used overseas, borosilicate glass (developed in France), is that it is said to be much more resistant to leaching from high-temperature ground-water and can withstand temperatures up to 300°C without suffering any detrimental effects.

Another major advantage, it says, is that Synroc can be buried immediately after being processed whereas borosilicate glass must be kept for 30-50 years in specially cooled vaults.

The AAEC says that in tests conducted in its research reactor, Hifar, using fast neutron irradiation. Synroc has withstood a simulated 450 000 years of high-level waste containment without experiencing any significant physical damage.

The AAEC is collaborating closely with the ANU on the project and has also been collaborating on Synroc research with Britain, Japan and Italy.

The plant should be operating by the latter half of this year and be producing about 10kg/h of Synroc on production runs.

Source: Engineers Australia

Energy from waste Sweden is switched on

We know that methane generated by the biological decaying of rubbish can be used on a commercial scale as an alternative fuel for many different applications including process heating, glasshouse heating and for fuelling brick kilns. Not only can the methane be used directly but it could also be used to fuel combined heat and power units so that both heat and electricity can be derived.

For a number of years prime sites around the country have been and are being used by local authorities and other organisations to dispose of unwanted household and industrial waste. Approximately 25 Mt of waste are deposited each year in this way. As the site becomes full the land is covered over with soil to allow its use for other purposes such as building and farming. In a very short time the waste material in the landfill site decomposes under a biological decay process to form a methane rich gas known as landfill gas. In many cases the amount of gas produced is sufficient to make the extraction and use of the evolved gas a viable, commercial proposition.

In the UK only a few sites have as yet been developed but in Sweden the gas from one urban site is being used by three large consumers to provide process and building heating. The methane output peaks at 3MW and it is estimated that the site will last for 10 to 15 years.

Apart from the commercial aspects there are also environmental benefits because the process involves the area being covered and landscaped.

It has been estimated that by the middle of the next decade landfill gas will provide the equivalent of over 300 000 t of coal per year in the UK.

Source: Press release

Energy from sun and wind Domestic experiment

Sun and wind energy will be used to provide domestic electricity to nine houses in an experiment at the new Milton Keynes Energy Park, reported the *Financial Times*.

Each house will have a bank of solar arrays on the roof and the group of houses will be served by a wind generator with 30 ft blades mounted on a 60 ft tower.

The combined 30kW output of arrays and wind generator is fed to a battery bank in a control room where the direct

current is turned into alternating current at 50Hz, 240 volts for supplying the houses. If a combination of low wind and no sun over a period reduces the battery's ability to supply demand from the houses, they are automatically switched over to the normal mains supply.
Source: Financial Times

Wind farms
Australia's first

A cluster of six wind turbines, representing Australia's first wind farm, is expected to whirr into life on a coastal site near Esperance later this year.

It is part of a project being jointly funded by the State Energy Commission of Western Australia and the National Energy Research Development and Demonstration Council (NERDDC) to show how locally-designed wind turbines perform in a commercial operation.

The six 60 kW wind turbines in the 'farm' will be linked to the Commission's power system at Esperance.

It is expected that the turbines will annually produce about 1MkWh of electricity, which is equivalent to just under 4% of the Esperance area's overall power needs.

The turbines are a modified version of a 60kW machine that has been tested at South Fremantle since March 1984. That machine has so far generated about 240MWh for the Commission's interconnected grid system. Each turbine will be 22 m high and will weigh about 12 t. The blade assembly has a diameter of about 16 m.

The cost of establishing the Esperance aerogeneration project is estimated at Aus $594 000 and linking the six wind turbines to the local power grid at Esperance is expected to reduce the Commission's oil fuel purchases for the Esperance power station by approximately 250 000 l/y.

Research information already to hand indicates that not only are there several locations along the Western Australian coast with wind power potential, but some elevated inland sites as well. Among the inland sites where useful levels of wind speed have been recorded are Mount Magnet and Cue.
Source: Press release

USA
Coal-fired turbines

For 30 years engineers have envisaged a high-efficiency, low-cost combustion turbine that could run on coal. Inevitably their concepts fell victim to coal's harsh constituents that can chip away or corrode turbine blades or build up efficiency-robbing deposits inside critical components.

The US Department of Energy has begun a five-year programme to overcome this persistent problem and move coal into the gas turbine market.

The Department told four leading US turbine manufacturers that it will join them in a cost-shared research programme — potentially totalling more than £75 M — to develop new turbine technology that can withstand the rigours of direct coal firing. As much as 23% of the programme's costs could come from the private participants.

This new phase in the Department's coal-fired turbine programme follows nearly four years of Federally funded research that has established the basic feasibility of using coal in turbines fuelled to date almost solely by much cleaner fuels, such as petroleum or natural gas. This background work used state-of-the-art understanding of the effects of fuel characteristics on combustion products and the effect of those products on turbines to develop an understanding of the technology barriers that had obstructed coal-burning gas turbine development over the last 30 years.

Research proposals span the full scope of the turbine market — power for transportation, on-site industrial cogeneration, and utility electrical power production.
Source: US Dept of Energy

Fuel cell development

The US Department of Energy will continue the development of the solid oxide fuel cell, an advanced power generation technology. The research covers manufacturing and design technology, applied particularly to high power operation.

The solid oxide fuel cell is technically based on ceramics that produce electricity and heat from chemical reactions. Like other fuel cells, the solid oxide fuel cell operates much like a continuous battery. When fuel (hydrogen or carbon monoxide) and oxidant (air) are supplied, the solid oxide fuel cell produces electrical current and heat. These fuel cells run hot — the tubular design being developed operates at 980°C. The high temperature of the fuel cell means that coolant streams removing the excess heat from the cell are very hot and therefore have ample energy for bottoming cycles and cogeneration. The system's electricity generation efficiency should exceed 50%. Most conventional power plants convert between 30 to 40% of the energy in their fuel to electricity.

This concept uses a porous tube surrounded by ceramic layers; an air electrode, a solid electrolyte, and a fuel electrode. The assembled fuel cell is like a series of tubes, each fitting inside the next largest and bonded together to make one thick walled tube. This design overcomes many of the problems of forming ceramics into complex shapes.

Although it has been proven that the tubular solid oxide fuel cell concept is technically sound, much development work remains to be done. This new work focuses on the fabrication, testing, and improvement of the tubular solid oxide concept. Fabrication and testing of larger, advanced, multi-kilowatt modules are planned. New and improved fabrication techniques to reduce costs and improve efficiency are sought for these larger modules. Technical problems that prevent scale up of these power generation devices to useful sizes need also to be addressed. This work will identify possible system designs, select manufacturing equipment and processes, optimise cell-module performance, and test a first-of-a-kind module to verify that the design is feasible and affordable.
Source: US Dept of Energy

Japan
Research in fuel cells

A molten carbonate fuel cell was operated for more than 10 000 hours, in Japan recently. The fuel cell is a single-cell type with an effective electrode area of 270 cm^2. The success marks a big step toward the target of 40 000 hour continuous operation of the molten carbonate fuel cell that features high generation efficiency of more than 50% at a high temperature of 650°C.

Research and development efforts are under way worldwide on the molten carbonate fuel cell, which is expected to become the next generation fuel cell because it is highly efficient, requires no platinum catalyst, and can also use coal gas containing carbon monoxide as fuel.

But its high temperature operation requires highly advanced technological innovations both in the material and structural aspects to attain the target of 40 000 hours of continuous operation. In the United States, continuous operation has reached 15 000 hours for a single-cell battery and only 5000 hours for a stack of cells with a capacity of several kilowatts (see above).

In the continuous running experiment in Japan, the molten carbonate fuel cell registered output voltage of 740mV initially and 690mV even after 10 000 hours of operation, proving it features a low drop in voltage even after continuous operation. The small fall is close to the target of several milli-volts per 1000 hours for a practical plant.

The porous nickel anode was impregnated with ceramics to prevent creep and maintain stability over a long period.

Generally, existing cells require replenishment of the electrolyte every 3000 hours to make up for losses from evaporation, leaking and corrosion. This cell prevents electrolyte leakage with an improved cell structure and the use of anti-corrosion sealing materials.

A small-scale test power generation plant using the molten carbonate fuel cell will be produced within the coming year.
Source: Mitsubishi Electric

Working with China
....Australia

The University of Queensland has signed an agreement with China to produce more efficient coal-water mixes as alternatives to fuel oils.

Prof Alban Lynch, of the university's mineral research centre, said research on coal-water mixes was being conducted through a co-operative programme which the university set up last year.

He said the university would use its national research fellowship funding for a study, using an experimental pilot plant for the production of coal-water mixes at the China Institute of Mining and Technology at Peking.

The university will carry out studies on computer simulation and optimisation of the plant, taking into account the characteristics of the coal. In turn, the Chinese will provide information about the plant and the results of burning coal-water mixes.

Source: Australian Information Service

....Britain

British Electricity International, is a member of a partnership which has been awarded a contract worth £10M to manage the operation and maintenance of a new coal-fired power station in the People's Republic of China.

Senior staff from the British electricity supply industry will help to commission the new Shajiao B power station and operate it in its early stages, whilst training their Chinese counterparts to take over.

It is the first project in which BEI, the overseas consultancy company of the British electricity supply industry, has been involved in China and it will provide both the staff and management of the industry with a good opportunity to gain first hand experience of working there.

Shajiao B, in China's Guangdong Province, will be a 2x 350 MW power station fuelled by Chinese coal supplied in colliers using the nearby Pearl River. It is due to start commissioning in the spring of 1987.

The specialised nature of training in control and instrumentation technology will require some of the Chinese staff to gain practical experience in the UK with the CEGB, with the rest of the training being conducted on site. All on-site training will be carried out in Chinese, using interpreters and translators.

Craftsmen and engineers will be recruited to allow them to participate in the commissioning phase. Chinese instructors will be trained so that skills learned by the initial intake of workers are passed on when the Chinese take over the full operation of the power station.

Source: BEI

East Asia
Positive outlook

'One of the most important questions facing decision makers in East Asia is the appropriate balance between stability and growth. The strong economic management and adeptness of countries in the region in responding to shifting world conditions suggest they will meet new challenges very ably and continue to bridge the gap with the industrial countries of the world.'

This assessment was made by Attila Karaosmanoglu, the World Bank's vice president, East Asia and Pacific region, while speaking recently on the growth and adjustment challenges of East Asian economies.

Mr Karaosmanoglu said that after a significant recovery in 1984, economic growth in the region slowed considerably during 1985. He cited a combination of factors that caused the decline, including low prices of commodities, reduced demand in industrial countries for manufactured imports, and monetary and fiscal 'restraint' in many countries which limited further the scope for economic expansion.

Two developments during the past several months have drastically altered the economic setting not just for the East Asian economies but the world economy at large: these are the decline in oil prices and the depreciation of the United States dollar.

In view of the magnitude of the decline in oil prices, the direct impact on balance of payments 'will be large', he said.

From his perspective he felt 'somewhat like the father who didn't know whether to pray for rain for his son, the farmer, or to wish it didn't for his other son, the potter'.

He noted that the developing countries of East Asia are evenly split between oil exporters — Indonesia, Malaysia and China — and importers — Korea, the Philippines and Thailand.'

Although the impact of the sharp decline of the US dollar will be most severe for the oil exporters, all East Asian countries will tend to be adversely hit. But these effects will be largely positive in the medium term because the drop in oil prices and in the value of the dollar will help to stimulate growth in industrial countries, reduce interest rates further, and lead to higher commodity prices.

He went on, 'The decline in oil prices and change in outlook poses a major adjustment challenge for the oil exporters in the region. Adjustment in Indonesia and Malaysia is made more difficult in that imports and public investment have already been compressed in both countries, economic growth rates in recent years have been low, and significant losses in output and employment would lead to severe social strains.

'For China, the decline in oil earnings will complicate the stabilisation of the external accounts.

'Although Thailand and the Philippines will enjoy a substantial windfall from the oil price decline, their ability to pursue more growth-oriented policies will be constrained by the still precarious external and fiscal balances. Also, both countries must still grapple with depressed commodity prices and stagnating exports.

'Only in the case of Korea is there significant scope for the pursuit of more expansionary policies.' The gross domestic product in Korea is expected to recover from its 1985 level of 4.5%.

In the Philippines, a modest recovery of economic growth is projected in 1986 after three years of decline. Growth will remain sluggish in Thailand and will decline from 1985 levels in Indonesia, Malaysia and China.

The challenges posed by the uncertain export environment suggests policy responses that need to be considered by the East Asian countries Mr Karaosmanoglu said that these include: creating new products and markets; increasing productivity in order to remain competitive in international markets; and maintaining a balanced approach between exports and domestic industries.

These policy initiatives must be supported by efforts to boost domestic savings so that these countries will not have to rely too much on foreign capital, and Mr Karaosmanoglu concluded, 'As in the past, this would provide the foundations for technological progess, industrial diversification, and the growth of industrial capacity.'

Source: World Bank News

Batteries
New monitoring technique

Testing the charge state of a conventionally vented lead-acid battery is a simple case of removing the vent plugs and measuring the specific gravity of the electrolyte with a hydrometer. However, a more sophisticated approach is needed for a modern non-spill sealed battery.

A battery condition monitoring technique to meet the requirements of sealed battery users is being developed which involves the battery being subjected, momentarily, to a defined current pulse.* The response is then interpreted, with the help of rapid microcomputer processing, to determine the current state-of-charge.

By imposing a series of sensing pulses throughout the service period, the status of the battery can be continually up-dated.

Instrumentation monitors automatically the state-of-charge and state-of health of batteries used in battery powered equipment and installations. This has many advantages, for example: increased efficiency and lower operating costs; early indications of incipient faults (batteries and ancillary equipment); greater systems reliability and improved battery management, particularly for sealed battery systems.

Source: ERA Technology

Protectionists...
...Under pressure

Offshore service and supply companies are being hit much harder than their clients by tumbling oil prices. Soon, it could be the Norwegian suppliers who find themselves in the most exposed position, concluded a report in *Offshore Commentary.*

With Norway's oil-dependent economy looking increasingly fragile,

*ERA Technology

here are now prospects that this market's protectionist barriers will break down under the pressure, the article said.

Until now, Norwegian protectionism has yielded major benefits for domestic suppliers. They have been able to generate profit margins far in excess of equivalent UK companies over a wide range of offshore services — including logistic activities, air transport operations, supply of muds and cements and drilling services. This has helped the Norwegian industry to invest heavily in new equipment and technology.

However, the Norwegian service and supply companies' rich and protected home market is now at risk. At the same time, these companies have been insulated from the global market for too long and are ill-equipped to compete on international terms for work worldwide.

It must be questioned whether Norwegian oil producers and Government can continue to absorb the cost penalties associated with protectionism. In a low oil price world, they may have little option but to open their own service and supply requirements more fully to competitive pressures.

A possible Norwegian bid for EEC membership has been mooted, in an attempt to obtain preferential market access for oil and gas exports. 'Such a move would certainly inspire European suppliers to attack the Norwegian market more vigorously.'
Source: Smith Rea

INDUSTRY YEAR *1986*

Career opportunites

In a recent issue of *Manufacturing Matters* G J Stubbs, senior training advisor to the Engineering Careers Information Service, described the opportunities for careers activity in Industry Year.

Engineering has suffered an image problem in the eyes of the public at large for many years and this has often been suggested as the main reason for the difficulty many companies have in recruiting the bright young people they need to develop technological innovations in their products and methods of manufacture. With the weight of the *Industry Year 1986* initiative behind us, we in the engineering industry should decide that during 1986 we will all do something to correct the misguided impression many people have of what goes on 'behind the factory gate' The ball is in our court, no one is going to improve our image for us, we have to do it ourselves.

Unless people working at all levels in engineering companies take the time to ask themselves the questions: 'What do people outside the firm think about us? Do they know what we make, how we make it and its value to the community? If they did, would they like to work here?', the questions will never get asked at all. Nothing will be done to provide the people outside engineering with the answers. The vast majority of these people are parents and friends guiding and influencing the next generation of bright young people and they will continue to believe that the traditional cloth cap and oily rag image of working in engineering continues to be the norm.

The Engineering Careers Information Service (ECIS),* which is sponsored by the Engineering Employers' Federation, the Confederation of Shipbuilding and Engineering Unions and the Engineering Industry Training Board is one organisation which has been actively helping the industry to attract recruits of the right calibre. Those involved in careers activities with local schools will be aware of the wide range of leaflets, booklets, posters and classroom project material ECIS has available. Their most recent publications include a folder of company sponsored sheets entitled *New dimensions in engineering careers* highlighting career opportunities arising from applications of new technology; a video and supporting booklet *Formula for success* illustrating the problem-solving role of technicians in engineering with particular emphasis on the way mathematics is used; and the booklet *Engineering careers film and video review* which provides details of a whole range of engineering careers films and videos with content descriptions, recommended audiences in terms of age and academic standard and an assessment made by a panel of industrialists, careers advisers and parents. All these publications, are available from EITB Publications Department.*

ECIS has a role to help the industry to help itself. The material mentioned has been specifically developed for that purpose and the message to engineering companies is a simple one: To attract the people we need to take advantage of technological developments as they arise, we must ensure that those outside the industry are more aware of what we do and the way we do it today — not yesterday.

We can use this year as a vehicle to make a major impact on our public image. There are organisations, particularly ECIS, which are able to provide active support in a number of different ways.

Don't let us lose this opportunity. Think about organising an 'open day'. Think about inviting local school-children *and their parents* to have a look at the work you do.
Source: Manufacturing Matters

£200 000 education venture

In May Sir James Cleminson launched a new initiative to increase industrial support for management and industrial education in Britain's secondary schools, reported *CBI News.*

The new venture is a National Education Programmes Unit, run jointly by Rank Xerox, who are investing a total of £200 000, and Understanding British Industry — the schools-industry arm of the CBI's Education Foundation.

The unit's priorities will be to-

- ☐ Expand the provision of training workshops on education management for head teachers and others.
- ☐ Make available to schools a book to help young people make the change from school to adult life.
- ☐ Keep secondary schools up-to-date with developments in information technology.
- ☐ Launch a secondment programme for teachers into the sponsoring company.

Sir James said: 'This is the biggest ever grant of its kind to UBI, and will enable UBI to expand the successful work it has been doing during the last few years.

'Head teachers today need, more than ever before, to be managers; we can provide workshops which will help them develop their management skills and deal with a whole range of management tasks — in which an understanding of information technology is increasingly important.

'We want teachers to know more clearly how industry operates, and what its requirements are, so that they will be able to produce school-leavers who have at least been given some insight into what life in the real world is about.'
Source: CBI News

Queens award for oil industry

The *Queen's Award for Technological Achievement,* which is given to companies that have shown 'significant advance, leading to increased efficiency, in the application of technology to a production or development process in British industry or the production for sale of goods which incorporate new and advanced technological qualities' has been awarded to Conoco for their pioneering work on the Hutton field tension leg platform.

The company won the award for the first commercial application of the TLP concept, which paves the way for oil production in deep water areas that are beyond the feasibility of conventional platforms, where much of the world's future reserves are thought to lie.

The award is shared with two of the principal contractors on the Hutton project — Brown and Root, and Vickers — who contributed to the design of the floating platform.
Source: Conoco (UK)

*For further information: ECIS, 54 Clarendon Road, Watford, Herts, WD1 1LB. EITB Publications, PO Box 75, Stockport, Cheshire, SK4 1PH.

Institute of Energy conferences in 1986 to 1988

The following programme of conferences are currently being organised by the Institute of Energy, and its associated overseas societies, and other UK societies 'in association' for the event.

You are invited to note for your diary pages, and to respond, where indicated to the respective calls for papers (see also loose enclosures this issue).

1986 19 November	**Fuel additives** (in conjunction with the Yorkshire branch, and in association with: Combustion Engineering Association; Institute of Hospital Engineering; Institute of Petroleum; Institution of Plant Engineers. **Venue:** AHED House, Ossett, Yorkshire **Chairman:** Philip Hands (Dearborn Chemicals) **Papers:** Notification of intent immediately please: Phone 01-580 0008
1987 4 March	**Energy policies and market forces** (in association with the Parliamentary Group for Energy Studies; the Institution of Mechanical Engineers (and others to be confirmed) **Venue:** The Institution of Mechanical Engineers **Chairman:** P C Warner (NEI, Newcastle upon Tyne) **Papers:** Individually invited
23/24/25 June	**First European dry fine coal conference** **Venue:** Harrogate, Yorkshire **Chairman:** Dr J M Topper (BC CRE) **Papers:** Synopses invited by 30 September to Institute of Energy
24/25 Sept	**Influence of inorganic constituents on coal** Combustion in small to medium-sized boilers **Venue:** Imperial College **Chairman:** Dr A Sanyal (Babcock Power) **Papers:** First 'call' — see loose insertion this issue
1988 (Spring) (dates to be announced)	**Gasification — status and prospects** **Chairman:** H B Locke (Codogan Consultants) **Papers:** Synopses by 1 September
Autumn (dates to be announced)	**Institute of Energy 4th Fbc conference** (fuller announcement shortly)

Conferences with which the Institute is in association: in 1986

16/18 Sept	**Gas cleaning at high temperatures** (IChemE/Filtration Society) **Venue:** University of Surrey
19 Sept	**Aluminium and energy: a 100 years partnership** (Anglesey Aluminium Metal/University College North Wales) **Venue:** UCNW, Bangor
In 1987 7/9 April	**Energy options: the role of alternatives** (IEE) **Venue:** University of Bath
7/10 Sept	**International symposium on coal combustion** **Venue:** Tsinghua University, Beijing, China (call for papers in this issue)
16/18 Sept	**Innovation in process energy utilisation** (IChemE S Wales branch) **Venue:** University of Bath
21/23 Sept	**3rd European conference on coal liquid mixtures** (IChemE) **Venue:** Sweden
23/24 Sept	**Small engines and their fuels in developing countries** (University of Reading) **Venue:** University of Reading
— October	**New developments in optical diagnostics** (Combustion Physics Group of Institute of Physics)

.nnual Luncheon

ıe Annual Luncheon of the Institute of ıergy took place at the Inn on the Park London on 29 April 1986. The esident, P C Warner, presented the stitute of Energy Awards. A number of is year's recipients were from overseas d consequently were unable to receive eir awards at the Luncheon. Among the vards presented were: Honorary llowships to Dr J H Chesters and Sir hn Hill, Companionship of the Institute Prof Richard Eden.

r Warner then introduced the principal est and speaker, the Rt Hon Peter 'alker MBE, Secretary of State for ıergy.

Peter Walker, Secretary of State for Energy speaking at the Institute of Energy Annual Luncheon

Mr Peter Walker speaking in reply to e president first expressed his ppreciation for the support and thusiasm that the Institute had given, the campaign that the Energy ficiency Office was waging on energy ficiency. The campaign was going well d, was going to have quite a dramatic fect on both the energy and economic ene in the country.

Mr Walker began by asking why there ould be a need for an energy efficiency mpaign at all. He said that the reality as that since the enormous energy price creases of 1973, virtually every one of ır major industrial competitors had ne far more to improve energy ficiency than we had. This ought to be matter of deep concern.

He had received a letter from an dustrialist saying that he had attended Breakfast Special Briefing at Grosvenor ouse, 14 months ago. He enclosed a py of his company accounts to be ıblished that day, in which it could be en that the profits were a result of tending the Breakfast Special. Profits d improved by £1.5 M. Total profits ere only £6.5 M. This was clearly a markable achievement. Mr Walker added that he was tempted to write back to him and say 'you must feel very guilty at having wasted £1.5 M a year, for so many years in the past.'

He was concerned that although it was possible to communicate the new technologies, new methods and the latest ways of saving energy, it was a communication that was fresh and new to a great bulk of the industrial, commercial activity of the country. What, he wondered, were the reasons for this?

One of the reasons Mr Walker thought, was that we did not have enough people with the appropriate qualifications in British commerce and industry. He went on the say there was a need for the country, to have a far greater volume of qualified engineers and scientists than we enjoy at the present time. There was also a need for those qualified engineers and scientists to be aware of the commercial realities of the world; to recognise the problems of cash flow, profit and rewarding investments. We have both qualities in engineering and science, and in commercial judgement. These had to be married together.

Before the energy efficiency campaign began the Energy Efficiency Office had done some market research, and it was discovered that only a minute number of companies actually had someone responsible for energy within their managerial operation. It was realised that a campaign for more people to be appointed to these positions was needed. An initial aim of the campaign was to double the number of energy managers. In fact within 15 months the number of energy managers had doubled and it was hoped that by the end of the year the number would have trebled or even quadrupled.

Energy managers had been organised into energy management groups in order that the Government, could feed into them latest advice and technology. By the end of this year Mr Walker hoped that there would be over 10 000 appointed energy managers in the country. The next stage would be to think of a way in which they could form some kind of association, a way in which they could be linked with the professional skills that were available in institutes, such as the Institute of Energy. But what was certainly important to the recovery of this country, Mr Walker said, was that we apply engineering and the scientific skills with commercial judgement to the success of the country.

Recently Mr Walker had the opportunity to talk to members of the Gorbachov Government in Moscow. He was particularly interested in their ambitions for the next five to 15 years, in that area. He found that the Soviet Union wanted to double its industrial production between now and the end of the century and to improve consumer standards. These, he believed, were considerable ambitions, and he anticipated that Mr Gorbachov would have many problems in endeavouring to achieve them.

Earlier, in 1984, he himself spoke with Mr Gorbachov whose view then was that

(continued on p 21)

Dr J H Chesters (far left) and Sir John Hill (left) are pictured receiving their certificates of Honorary Fellowship from the president (see Energy World, February 1986, p23)

Some of the 1985 prize-winners are pictured receiving their awards from the president: below left: Dr J Wilhelmi (Imperial College) receiving the R H Gummer Exhibition. Middle: T David (University of Leeds) and below: Ali A Hamidi (University of Sheffield) who both received the Foxwell-Memorial award

Other prize-winners who were unable to attend the luncheon were: Dr G F Robinson (Foster Wheeler Award of the Institute of Energy and the Townend-BCURA Award); G J Duffy (Steetley Award of the Institute of Energy); Dr M R Dataevernier (Babcock Power Award of the Institute of Energy)

Engineering Council
Composition of Council

The composition of the new Engineering Council as from the annual meeting held on 9 May 1986 is:

Chairman

Sir Francis Tombs BSc FEng Hon FIChemE FIEE FIMechE; chairman Rolls-Royce; chairman, Turner & Newell.

Members

George Adler OBE BSc(Eng) FEng FICE FIMechE; former director of Research of the British Hydromechanics Research Association.

Prof Gordon Beveridge BSc ARCST PhD FEng FIChemE FRSE; head of Department of Chemical & Process Engineering, Universtity of Stathclyde; chairman, Cremer & Warner; vice chancellor-designate, the Queen's University, Belfast.

Timothy Beynon MA FRGS; headmaster of the Leys School, Cambridge.

Frank Chorley CBE FEng FIEE FIERE; deputy chief executive, Plessey Company.

Prof Bernard Crossland CBE MSc PhD DSc MRIA FRS FEng FIMechE FIProdE FWeldI MASME; chairman, Crossland Consultants; professor emeritus, Mechanical Engineering, the Queen's University, Belfast.

Stan Davison OBE: deputy general secretary, the Association of Scientific, Technical and Managerial Staffs.

Jean Denton BSc(Econ) FInstM FIMI; director, External Affairs, Austin Rover.

Prof Derek Embrey OBE CEng FIEE FIERE MIGasE FIMechE: group technical director, AB Electronic Products Group.

John Fairclough BSc(Tech) DSc(Hon) CEng FBCS FIEE; chief scientific adviser, Cabinet Office.

Denis Filer TD BSc FEng FIMechE; director engineering, ICI.

Prof Alec Gambling DSc FRS FEng FIEE Hon FIERE; British Telecom professor of Optical Communication, Department of Electronics & Information Engineering, University of Southampton; director, York.

Eric Hammond OBE; general secretary, Electrical, Electronic, Telecommunication & Plumbing Union; member, General Council. TUC.

Michael Harrison CBE MA FBIM; former chief education officer, City of Sheffield; vice president, Standing Conference on Schools Science & Technology.

Dr Gordon Higginson PhD BSc CEng FICE FIMechE; vice chancellor of Southampton University.

Norman Holland TEng FIElecIE MIEEE; UK group standards manager, Philips Electronic & Associated Industries

Ronald Hooker CBE FEng FIProdE CBIM; chairman, Henry Sykes; chairman, Dubilier; chairman, Sarasota Technologies; deputy chairman, UKO International; director, Suter; director, GEI International; director, Airship Industries; director, Hambros Industrial Management; industrial adviser to Hambros Bank; president, Engineering Employers' Federation.

Dr John Illston PhD DSc(Eng) CEng FICE; director, Hatfield Polytechnic.

Robert Malpas CBE FEng BSc DTech DUniv FIChemE FIMechE FIMH; a managing director, British Petroleum Company.

Sir Richard O'Brien DSO MC; chairman, Policy Studies Institute.

Baroness Platt of Writtle CBE DL MA CEng Hon DSc FRAeS Hon FIMechE; chairman, Equal Opportunities Commission.

Ray Roberts FEng FIMechE FIProdE AMIBF; group manging director, GKN.

James Stevenson BSC ARCST FEng FICE FIHT; director, Balfour Beatty.

Sir Robert Telford CBE DL MA FEng FIEE Hon FIMechE FIProdE; honorary president, Marconi Company; chairman, Prelude Technology Investments; chairman, DRI Holdings.

John Waters TEng FSCET; laboratory manager, Structures Laboratory, Wimpey Laboratories.

Two members of the Institute of Energy were among the eight members of the Engineering Council who retired from the Council at the annual meeting: *G R Hall* (past president and Senior Fellow) CBE BSc FEng FRSC; director, Brighton Polytechnic; member, Science and Engineering Research Council; director, Macmillan Intek; *P L Martin* (Fellow) CBE CEng FIMechE FCIBSE AMRAeS MConsE.

*The shortage of mathematics and physics teachers**

The jobs of maths and physics teachers should be made more financially attractive to overcome a grave shortage of qualified teachers, says the Engineering Council.

The Council, which has been campaigning for more youngsters to take up a career in engineering and technology, believes that the present teacher crisis is partly responsible for Britain's loss of competitiveness in world trade because our schools are not producing enough technology students to go on to higher education. *'Solutions have to be found if we are to remain an advanced industrial nation in the 21st century,'* it says.

Immediate remedial action is needed if the nation is to become more numerate and more literate in science and technology, with a base for future technological and economic competence. Both emergency and long-term actions were required.

The Council says: *'The problem of a shortage of qualified teachers is so complex that no one remedy will sort it out. A co-ordinated national programme is needed'.*

The Council suggests that local education authorities and the Department of Education and Science should explore all possibilities for enhancing the financial attractions of teaching maths and physics.

*Copies of the paper *The shortage of mathematics and physics teachers* may be obtained from the Engineering Council, 10 Maltravers Street, London WC2 3ER (tel 01-240 7891).

East Midlands branch AGM

Dr Vic Hanby (left) hands over the chairman's badge to Brian Chamberlain (right) at the East Midlands branch AGM, held at BSC Scunthorpe Works on 24 April 1986

New members
Fellow

Robert James Brown, British Gas, Cardiff *(transfer)*

Brian William Gainey, Shell International Petroleum, London

Michael Philipp Goldsmith, Sturtevant Engineering, Brighton *(transfer)*

Peter Harry James Johnson, *(transfer)*

Brian Campbell MacKintosh, Babcock Power, London

Christopher John Reeves, Simpson, Coulson & Partners, Stockton-on-Tees *(transfer)*

Member

Maurice Bolton

Ian James Bridge, James C Bell & Partners, Bolton, Lancs

Victor Alfred Hart, Haringey Health Authority, London

Robert Lorton, Walker Crosweller, Cheltenham, Glos

Stuart Alexander MacGregor, University College, Cardiff

olin McBurney, NCB, Coal Research stab, Sheffield
mon Stephen O'Leary, Esso Chemical, bingdon, Oxfordshire *(transfer)*
enneth Gerard Patrick, British Gas chool of Fuel Management, Solihull
abeel Abdullah Rammah, Gasco Bu asa, Abu Dhabi, UAE
ohn Thomas Girdwood Richardson, Vimpey Asphalt, London
eepak Jivraj Shah, Babcock Power, ondon
avid Nigel Smith, W S Atkins & artners, Epsom

Technician Engineer

ohn Bellingham, NEI International ombustion, Dumfries & Galloway
ohn Burke, City Engineers Dept, orporation of London
hilip Albert Hardy, Basford Hall ollege, Nottingham
tephen Robert Thomas, British Gas, lewcastle
llan Gordon Troup, NEI International ombustion, Dumfries & Galloway
vor John Robert Wills, Project lanagement, Dublin *(transfer)*

Associate

avid Eric Terrell, Tower Hamlets lealth Authority, London

Graduate

hristopher Duncan Ellison, Cranfield nstitute of Technology, Beds
dam Richard Gregory, University ollege of Swansea
ordon John Kilpatrick, Royal rdnance, Strathclyde
ustin Philip Lowe, British Gas
an Fai Mak, Oscar Faber, St Albans, lerts
ohn Steven Milne, NIFES, Glasgow *ransfer)*
evin Alexander Pennycook, BSIRA, racknell *(transfer)*
David John Ryan, Matthew Hall Engineering, London *(transfer)*
Gary Ross Trapp, DMS Energy, Midlothian

Student

Dean Johnston, IDC Consultants, Stratford-upon-Avon
Joseph Owuvor Lalah, Leeds University
Bindu Mistry, University of Sheffield

Personal

Prof Bernard Crossland CBE FRS FEng, a leading figure in academic and industrial circles in Northern Ireland, has been elected 1986/87 president of the Institution of Mechanical Engineers. He succeeded the retiring president, Sir Philip Foreman, with effect from the Institution's annual meeting on 28 May 1986.

Dr V Jayaraman (Fellow) has been appointed director, R & D Operations by the American Gas Association in Cleveland. Previously, he was director, Research & Development with the Holcroft division of Thermo Electron Corporation.

K N Palmer (Fellow) has been appointed honorary visiting professor in fire science in the Department of Chemistry at the University of Manchester Institute of Science and Technology, in addition to his present position as head of the Fire Research Station. He will enhance the links between FRS and UMIST by lecturing and supervising research.

Prof Palmer joined the Fire Research Station in 1949 as a scientific officer. During his career at FRS his main interests have included research into industrial fires, gas and dust explosion hazards and the burning of plastics. In 1973 he was made head of the Fire Protection Division, where he was responsible for research into fire detection and extinction, the identification and reduction of explosion hazards, use of automatic fire protection systems for life safety in buildings and the generation of smoke and toxic gases from fires involving structural materials and the contents of buildings.

In 1983 he became head of the Fire Research Station Borehamwood, Herts and an assistant director of the Building Research Establishment of which FRS is a part. Since the publication of his book, *Dust explosions and fires,* he has presented papers at symposia and lectured widely in Europe and North America on this and other allied topics.

Sir Denis Rooke CBE FRS FEng (Honorary Fellow), chairman of British Gas since 1976, has been reappointed chairman for another three years.

In May Sir Denis was awarded the Rumford Medal of the Royal Society in recognition of his contributions to scientific developments in the gas industry. Sir Denis will receive his medal from the president of the Royal Society, Sir George Porter FRS, at the anniversary meeting on 1 December 1986.

Fellowship of Engineering
Recent elections

At the tenth annual meeting of the Fellowship held in London on 2 July, *Sir Denis Rooke* CBE FRS FEng (Hon FInstE) was elected president for five years. Among the sixty new Fellows elected were *Dr E G Masdin* (president-elect, FInstE) and *Dr T N Marsham* CBE (FInstE).

Annual Luncheon continued)

nere was a great need in the Soviet Jnion: they were training so many ngineers and scientists of high ualification to apply their skills to nprove the commercial and industrial erformance of the country. The main neme of the Gorbachov message was: to se the scientific and engineering skills of ne Soviet Union to be far more succesful n productivity, commerce and exports nan anything that has been achieved over ne last 70 years of Soviet history.

We have a different system, in this ountry, with much more freedom and nuch more inducement to personal pplications and personal enterprise but ve do have similar problems and similar ailures. Mr Walker said: 'We must ask urselves, how is it that a country like urs, which was the first country in the ndustrial revolution of the 19th century, as (over the post-war period) had a elative decline compared with the United tates, compared with Germany, ompared with France and compared with Japan. How is it that some of the effects of the recession are bigger here than elsewhere, and how is it that the effects of a revival in some areas of manufacturing are less here than elsewhere?' He thought that at the end of the day, it boiled down to the application of human talent, to what was required in the economy of the modern world. He went on to say: 'I think we have failed partly, and many would agree. We were not producing the volume, or the quality of the engineers or the scientists, that our nation requires, or those we have are not applying their abilities and talents in the way that was required. If this country was going to achieve a commercial and economic revival of some importance it was because we recognised that in the coming revival the skill of the qualified engineer, the skill of the highly qualified scientist and the application of all that was best in technology, with speed and effectiveness was the key to commercial and industrial success.'

Mr Walker stressed the role that Government, local parties from the educational system, industry and its leadership had to play.

The very fact that a fairly crude, but an enthusiastically organised campaign on energy efficiency would, over quite a short time scale, reduce our energy costs by several billion pounds, and would therefore improve our competitiveness, industrial performance, balance of trade, reflected firstly what had not been done, but what should have been done, and the potential of all that should be done in future if we applied our minds and enthusiasm to it. Mr Walker finished by paying tribute to the professional institutes, to their skills and talents that they organised and posessed.

He concluded: 'Members of your Institute are playing, and have played, a very important role in the economic and commercial activity of the country. My hope and ambition is that you will be able to play an even fuller role in the years ahead'.

□

The Queen's birthday awards

We congratulate the following whose names appeared in the list of the Queen's birthday awards:

Knights Bachelor
Thomas Philip Jones, chairman, Electricity Council.
Ian Kinloch MacGregor (Honorary Fellow), chairman, British Coal.

CBE
J Lyons, general secretary, Electrical Power Engineers' Association and Engineers' and Manufacturers' Association.
C E Needham (Senior Fellow), director, Coalite Group.

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

Institute of Energy new special interest group: Safety and reliability in the energy industries

A special interest group on *Safety and reliability in the energy industries* is being formed in the North West. All members of the Institute with an interest in promoting the safe and reliable operation of plant and control equipment in the energy industries are invited to attend the inaugural meeting at Safety, Availability and Reliability Assessments Limited, 67 Bewsey Street, Warrington, Cheshire. This will take place on *Thursday 25 September* at 1830 h.

It is hoped to promote visits, talks and other exchanges of mutual benefit. The venue is easily reached via the motorway network, Warrington Central and Warrington Bank Quay stations. Intending participants should contact *Dr A R Churchley* at the above address (tel (0925) 573161).

New European title for professional engineers

Following an agreement just reached by FEANI, the European Federation of National Engineering Associations, a new title 'European Engineer' is to be introduced. It will be open to Europe's one million professional engineers including the UK's 200 000 Chartered Engineers. The agreement, reached after several years of negotiation, marks an important milestone in setting European-wide professional standards and providing for mutual recognition of qualifications.

The agreement reflects an initiative taken by the British National Committee, which succeeded in raising standards by embodying training and experience as well as academic qualifications in the formula now accepted by the twenty countries of FEANI. The British National Committee works under the auspices of the Engineering Council's Board for Engineers' Registration.

The new title will be granted to engineers who have successfully completed an approved degree, training and experience of not less than seven years in total. These minimum requirements will act as an incentive to individual improvement and as a lever for raising standards. FEANI regards the question of standards as crucial if the European industrial base is to compete with the United States and Japan.

The United Kingdom's Chartered Engineers will generally be recognised as possessing qualifications satisfying requirements for the European Engineer title. The Chartered Engineer title, therefore, should become a passport for working at professional engineer level throughout Europe both in EEC countries and elsewhere. It will also be possible f Technician Engineers (TEng) to register in a different sectio of the new FEANI register and this may eventually develo into another European title.

Possible basis of EEC directive for engineers
FEANI has already been in contact with the Europea Commission, whose officials made important suggestio which have been incorporated into the new FEANI agreemer FEANI will now enter into formal negotiation with th Commission with the aim of securing the adoption of i agreement as the basis for a possible forthcoming EE directive for engineers.

New officers for the National Combine Heat & Power Liaison Group

The National Combined Heat And Power Liaison Grou brings together all those local authorities with an interest i combined heat and power development, together with th Combined Heat and Power Liaison Group. The members ar *Belfast City Council; Edinburgh District Council; Leicester Ci Council; City of London; Lothian Regional Council; Newcast City Council; Sheffield City Council; Southwark Boroug Council; Tower Hamlet Borough Council; Kingston upon Hu City Council; Combined Heat and Power Association.*

At the Liaison Group annual meeting on 19 May 1986, th following new officers were elected:
Chairman: Cllr Les Russell (Newcastle)
Vice chairman: Cllr John Hall (Leicester)
The secretary to the Group is David Green, energy adviser t Newcastle City Council.

Further information from D Green, 43 Grainger Stree Newcastle upon Tyne NE1 5JE (tel 091 261 6776 (work); 09 265 8104 (home).

Progress in cement and lime burnin technologies

This international energy symposium has been arranged by th Fuels and Energy Research Group (FERGUS), University o Surrey. It will be held at the University of Surrey, Guildfor on 18 and 19 September 1986.

Programme

Thursday 18 September

1400	Registration
1500	Tour of FERGUS laboratories
1700	Tea
1730	Session I *The cement and lime industries*
1830	Sherry reception
1915	Symposium dinner

Friday 19 September

0930	Registration
1000	Coffee
1030	Session II *Burning technologies*
1200	Lunch
1330	Session III *Process engineering*
1530	Tea
1600	Panel discussion
1700	Symposium close

Further information from Short Courses and Conferenc Section, Bureau of Industrial and External Liaison, Universi of Surrey, Guildford, Surrey GU2 5XH (tel (0483) 571281 e 2104; tlx 859331).

Members are invited to make use of the Institute of Energy's national register of energy courses, through which we can supply salient details of forthcoming courses of all types. As well as the member's name and address, we need to know (a) the specific subject in which he is interested; (b) his present level of technical qualification; and (c) the preferred geographical location. Only details of suitable courses will be sent in reply.

We take this opportunity of listing a selection of courses due to start in the near future, and details of each can be obtained by quoting the reference number shown against the entry. Please enclose a stamped addressed envelope.

Course No 42-330.5

Title: Fundamentals of formation evaluation.
Duration: 5 days.
Location: Heriot-Watt University, Edinburgh.
Starting: 18 August 1986.

Course No 42-330.5 (continued)

Content: Historical introduction. Formation properties. Data sources. Theory and development of electric logging. Theory and development of porosity logging. Theory and development of lithology logging. Borehole environment. Practical logging combinations. Logging programmes and procedures. Lithology response of logs. Wellsite interpretation. Complex lithology. Carbonate evaluation. Shaley sand evaluation.

Course No 42-330.6

Title: Production technology.
Duration: 5 days.
Location: Heriot-Watt University, Edinburgh.
Starting: 25 August 1986.
Content: *Part 1* — Well completions; subsea completions;

Course No 42-330.6 (continued)

Content: wellhead systems; early production systems (EPS); perforating; well servicing fluids; completion programmes; well productivity; vertical lift performance; well performance/tubing selection.
Part 2 — Remedial/stimulation treatments; well diagnosis; acidisation; fracturing; artificial lift processes.

Course No 42-330.7

Title: Economic evaluation of petroleum projects.
Duration: 5 days.
Location: Heriot-Watt University, Edinburgh.
Starting: 1 September 1986.
Content: Evaluation concepts. Measures of value. Role of government. Finance. Risk analysis. Decision analysis. The future.

Special announcements (continued)

Second Australian coal science conference

The conference will be held at the Novacastrian Motor Inn, Newcastle, New South Wales, on 1 and 2 December 1986. A full technical programme will include:

Baragwanath Lecture: *Understanding coal at many levels,* by Dr G H Taylor.

Special Guest Lecture: *A review of the contribution of Japanese coal scientists to the understanding of Australian coals,* by Prof Y Sanada.

Papers dealing with recent work pertinent to *coal science,* including the use and need for it, are invited.

Enquiries about attendance and papers should be directed to: Dr T G Callcott (chairman), M Field (sec). Aust Institute of Energy *Coal science* conference, Post Office Box 321, Mayfield, NSW 2304, Australia.

Pitch: science of a future material

This conference will be held at the University of Newcastle upon Tyne from 24-26 March 1987. It will give emphasis to the sciences related to pitch as a material, its composition, properties and carbonisation behaviour with a view to future developments of carbon artefacts, carbon: carbon composites and other carbon applications. Petroleum and coal tar pitches will be considered.

Titles and 150-word abstracts should be sent by *30 September 1986* to Dr A Grint, British Petroleum Co, BP Research Centre, Chertsey Road, Sunbury-on-Thames, Middlesex TW16 7LN (tel (0932) 781234). General information from Dr H Marsh, Northern Carbon Research Laboratories, School of Chemistry, University of Newcastle upon Tyne, Newcastle upon Tyne NE1 7RU (tel (0632) 328511).

Coal science

The 1987 international conference will be held in Maastricht, Netherlands from 26-30 October 1987. *Suggested topics:* coal structure and characterisation; basic reactions of coal; fundamentals of coal combustion; coal gasification, pyrolysis; liquefaction; beneficiation, storage and transport.

Titles and 500-word abstracts, in English by *30 September 1986* to Dr H A G Chermin, chairman, 1987 international conference on *Coal science,* Dutch Centre for Coal Specimens — SBN, PO Box 151, 6470 ED Eygelshoven, The Netherlands (tel (045) 468535; tlx 56189).

Energy economy 86

The Engineering Industries Association (EIA) will organise a British Group Pavilion at the second international energy economy exhibition at the Rai Centre, Amsterdam from 9-11 December 1986, provided there is sufficient response from industry.

Energy economy 86 will concentrate on equipment, materials and services for research into application of industrial energy-saving systems. The exhibition programme comprises gas and steam turbines, diesel engines, gas engines and other prime movers/waste gas boilers for steam and/or hot water, steam boilers, boilers for other fuels (coal, brown coal, wood)/generators/measuring and control systems/gas safety devices/switchgear, distribution systems/fuels, lubricants/total energy modules/heat pumps/insulation systems, valves/switches and other peripherals/environmental technology for energy supply/heat regenerating equipment/lighting systems/cooling systems.

Further information from Engineering Industries Association, 16 Dartmouth Street, London SW1H 9BL (tel 01-222 2367).

CONFERENCES

The following conferences, courses and meetings are organised by bodies other than the Institute of Energ
For Institute conferences please see page 18

September 1986

86 Energy conservation

Exhibition, S Korea, 1-10 September 1986.
Details from Korea Energy Management Corporation, San 33-8, Banpo-dong, Gangnam-gu, Seoul 135, Korea, Gwang Hwa Mun PO Box 806 (tel 583-4441 ext 454-455; tlx K25377 (KEMACO)).

Quality in the metals industries

BNF sixth international conference, Birmingham (Metropole Hotel, NEC), 2 and 3 September 1986.
Details from Miss Julie Fletcher, National Crusader (Birmingham), Spencer House, Digbeth, Birmingham B5 6QD (tel 021-622 3651).

Carbon fibres — properties and applications

Conference, University of Salford, 15-17 September 1986.
Details from Institute of Physics, Meetings Office, 47 Belgrave Square, London SW1X 8QX, UK (tel 01-235 6111; tlx 918453 instp g).

Membranes in gas separation and enrichment

Fourth BOC Priestley conference, Leeds, 16-18 September 1986.
Details from Dr John F Gibson, Royal Society of Chemistry, Burlington House, London W1V 0BN (tel 01-734 9971).

Energy efficiency: the key to good building

Conference, Cranfield Institute of Technology (Bedford), 18-20 September 1986.
Details from Mrs E Howe, CICC, PO Box 50, Nottingham NG2 7JP (tel 0602 813078).

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

Building 86

Exhibition, London (Earls Court), 5-9 October 1986.
Details from David Burwood, Building 86 Press Office, 11 Manchester Square, London W1M 5AB (tel 01-486 1951 *or* 01-487 5831).

November 1986

ArabBuild 86

Fifth Middle East building and construction show, Bahrain (Exhibition Centre), 9-13 November 1986.

November 1986 (continued)

Details from Peter Rosenvinge (ArabBuild 86), Overseas Exhibition Services, 11 Manchester Square, London W1M 5AB (tel 01-486 1951; tlx 24591 MONTEX G).

Chemical information

Second symposium, Lyon (France), 13 and 14 November 1986.
Details from 55 montée de Choulans, 69323 Lyon, cedex 05, France (tel 78. 42. 29. 53; tlx PACK 330 295).

Energy 86

Asian international power generation, energy resources and conservation conference and exhibition, Bangkok (Thailand), 14-17 November 1986.
Details from Atec Management (S), 190 Middle Rd, 13-05 Firtune Centre, Singapore 0718.

Coal technology 86

Ninth international coal utilisation conference and exhibition, Pittsburgh (PA, USA), 18-20 November 1986.
Details from Industrial Presentations Inc, PO Box 721948, Houston, TX 77272, USA (tel (713) 981-1294).

Fire protection for the nuclear industry

One-day seminar, Moreton-in-Marsh (Fire Service College), 19 November 1986.
Details from Institution of Nuclear Engineers, Allan House, 1 Penerley Road, London SE6 2LQ (tel 01-698 1500; tlx 8812093 NUTRON G).

November 1986

Petroleum-based fuels for automotive applications

Conference, London (IMechE), 25 and 26 November 1986.
Details from Institution of Mechanical Engineers, 1 Birdcage Walk, London SW1H 9JJ (tel 01-222 7899).

December 1986

Online information

Meeting, London, 2-4 December 1986.
Details from Learned Information, Besselsleigh Road, Abingdon, Oxford OX13 6LG (tel (0865) 730275; tlx 837704 Inform G).

WAGR decommissioning

BNES/BNF/I Nuc E annual dinner/lecture, by Dr H Lawton (UKAEA), London (Royal Lancaster Hotel), 4 December 1986.
Details from Institution of Nuclear Engineers, Allan House, 1 Penerley Road, London SE6 2LQ (tel 01-698 1500; tlx 8812093 NUTRON G).

February 1987

Energy-sources technology

Conference and exhibition, Dallas (TX, USA), 15-19 February 1987.
Details from ETCE, PO Box 59489, Dallas, TX, USA 75229 (tel (214) 358-7601; tlx 795529 POBOX Richardson, TX, USA).

March 1987

Powtech UK

International power and bulk solids technology conference and exhibition, Manchester, 10-13 March 1987.
Details from Specialist Exhibitions, 16 High St, Croydon, Surrey CR0 1YA (tel 01-686 5741; tlx 889371).

Offshore computers

Exhibition and conference, Aberdeen, 17-19 March 1987.
Details from Offshore Conferences and Exhibitions, Rowe House, 55/59 Fife Road, Kingston upon Thames, Surrey KT1 1TA (tel 01-549 5831; tlx 928042).

Energy technology

Fourteenth annual conference and exhibition, Washington, DC (USA), 23-25 March 1987.
Details from Government Institutes, Inc, 966 Hungerford Drive, 24, Rockville, MD 20850, USA (tel (301) 251-9250).

Large-scale applications of heat pumps

Third international symposium, Oxford, 25-27 March 1987.
Details from Conference Dept, BHRA, Fluid Engineering Centre, Cranfield, Bedford MK 43 0AJ (tel (0234) 750422; tlx 825059 BHRA G).

April 1987

Nuclear containment

International conference, Cambridge, 6-8 April 1987.
Details from INucE (see address above).

Metering apparatus and tariffs for electricity supply

Fifth international conference, Edinburgh, 14-16 April 1987.
Details from Conference Department, IEE, Savoy Place, London WC2R 0BL (tel 01-240 1871 ext 222).

May 1987

Fluid machinery for oil, petrochemical and related industries

Third European congress, The Hagu (Netherlands), 18-20 May 1987.
Details from Conference Dept, IMechE (see address above).