ENERGY WORLD

The magazine of The Institute of Energy

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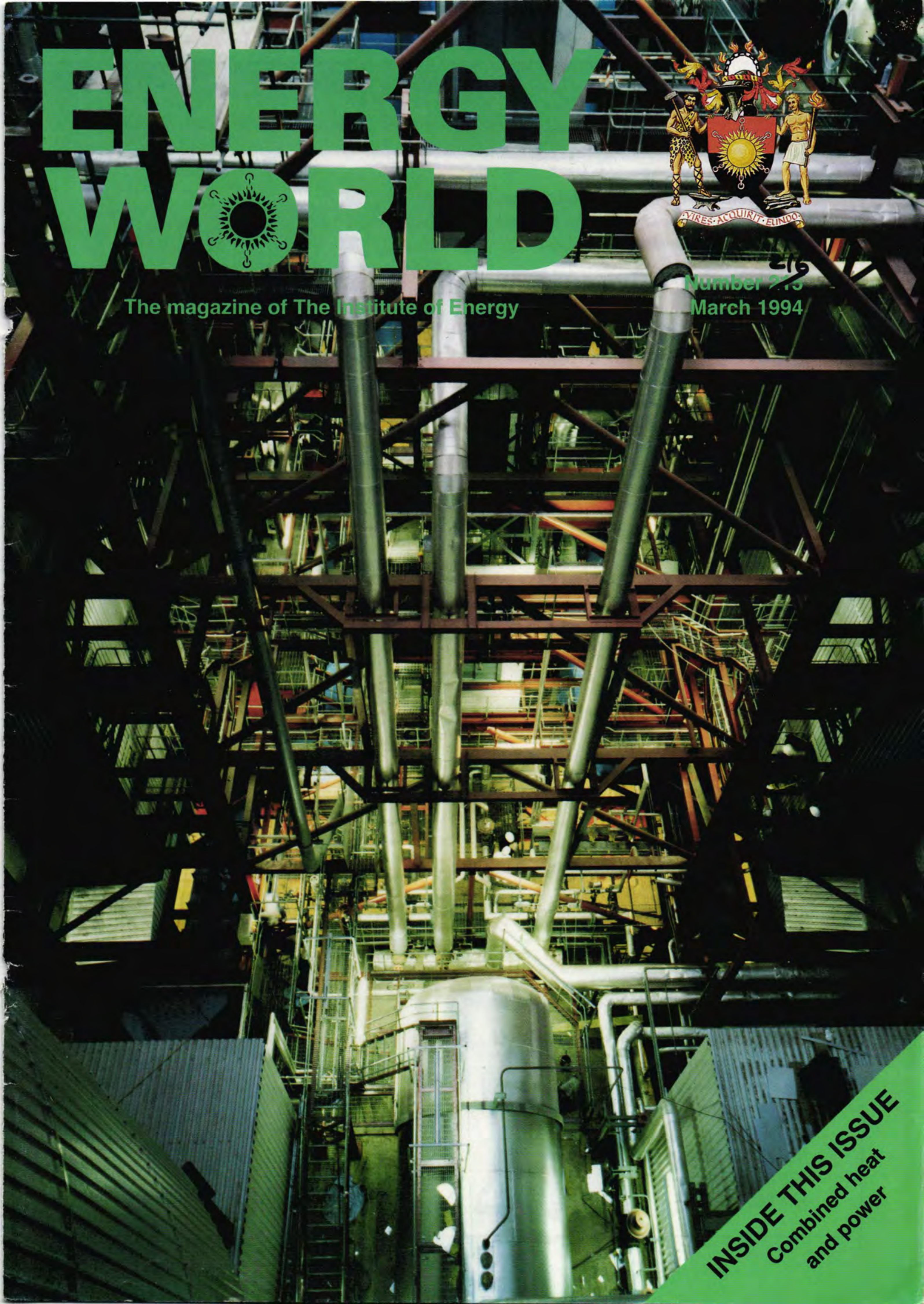

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Combined heat and power

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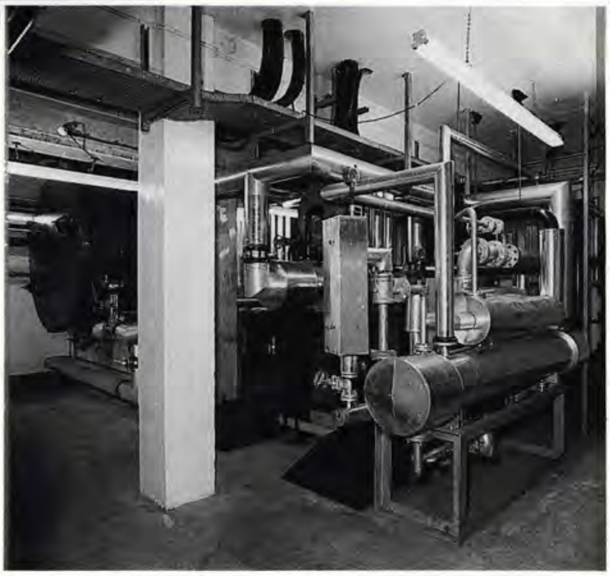

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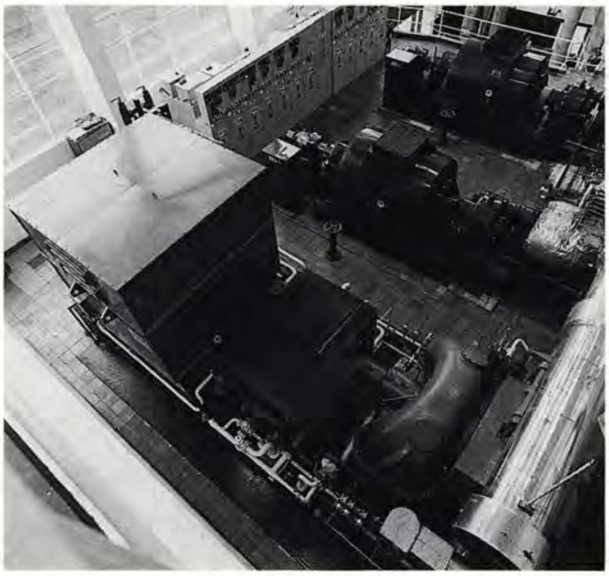

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CES HEADQUARTERS
THE OAKS
MOOR ROAD
BESTWOOD
NOTTINGHAM NG6 8TU
TEL 0602 272180
FAX 0602 770156

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Editor
Johanna Fender

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COVER

SELCHP — the South East London Combined Heat and Power Consortium — was formed in 1988, bringing together a cross-section of both public and private interests. Their aim was an environmentally-friendly waste-to-energy plant to provide heat and power for use by 7000 local residents, as well as connection to the National Grid. The plant began operation at the end of last year, and conforms to the latest European environmental standards. The front cover shows an interior view of the completed power station.

CHP — removing the barriers

Combined heat and power (CHP) has provided the UK with a major success story over the last five years. CHP is, through its inherently high efficiency, reducing energy costs for hundreds of industrial, commercial and private sector users of the technology, and preventing the emission of hundreds of thousands of tonnes of CO_2 per year.

But the potential impact of CHP is much greater. The Government has placed CHP at the heart of its CO_2 reduction programme, with a target to double the installed capacity of CHP from the present 2500 MW to 5000 MW. This would produce savings of about one million tonnes of carbon (MtC) a year — a tenth of the total target of 10 MtC)

The CHP industry is ready to deliver the capacity required and, indeed to exceed it, but CHP continues to face a wide range of institutional and regulatory barriers to its more widespread use. Many of these barriers will have to be removed if CHP is to fulfil its potential.

However, before looking at remaining barriers to CHP, I want briefly to describe the progress made recently with CHP in each of the areas in which it is used:

- small-scale packaged CHP is now the preferred energy solution and commonplace within hotels, leisure centres, hospitals and many other types of building. The current generation of units is highly sophisticated, reliable and easy to operate;
- the long and steady decline in the use of CHP for large industrial sites has been reversed, with a new generation of clean, largely gas turbine-based CHP systems being installed in paper mills, chemical plants, food manufacturing and other industries throughout the country;
- new, large-scale CHP-based community heating schemes are being developed again, to bring the benefits of CHP to commercial and public building as well as publicly owned housing across whole areas of cities. Many buildings within the City of London will soon be supplied with heat, power and chilled water (for air conditioning) from the system there, now in the final construction phase. The UK's longest established city-wide scheme, in Nottingham, has undergone a major refurbishment; the Sheffield scheme is to be expanded a third time and Edinburgh is the latest city to sign up for a new city-wide system;
- CHP is also being successfully introduced into smaller housing schemes, in both public and private sectors. The Department of the Environment's recent Green House programme of demonstration projects showed what could be done. Now, through a new initiative which the CHPA is administering on behalf of the Energy Saving Trust, 20 new CHP-into-housing schemes are being supported.

However, behind the success story is the CHPA's ongoing campaign to provide CHP with an opportunity to compete fairly. Developers and users of CHP still carry an enormous and unnecessary regulatory burden, and the environmental benefits of CHP do not receive the recognition they deserve.

Two recent victories show what has been achieved by the CHPA and its supporters. In December last year, the President of the Board of Trade, Michael Heseltine, announced important concessions for industrial CHP users. Heseltine said that he will exempt large CHP operators from the obligation to hold an electricity supply license and thus from paying the 10% nuclear levy. Energy Minister Tim Eggar went on to extend the exemption from operators of CHP schemes up to 10 MW to those up to 100 MW in size, and announced several other detailed changes, all designed to free up the generation of power by industry.

These are steps in the right direction, but problems for on-site CHP generators remain. The regulatory regime itself is complicated enough to act as a disincentive to potential CHP developers and must be simplified. Similarly, we believe that CHP generators should be exempted from having to become members of the electricity Pool, with all the costs that involves, and CHP operators should be able to sell surplus power directly into the franchise market. We are also lobbying for a fairer price for CHP-generated electricity from the RECs.

Like many industrial processes, CHP is highly dependent on competitive gas prices. Recent moves to raise the price of gas supplied on interruptible contracts can only damage the CHP industry, especially as liberalisation of the gas industry is taking place without real incentive to encourage the new suppliers to enter the lower cost industrial gas market. Measures must be developed to resolve this.

Barriers also exist outside the regulatory arena. We have called for all new power stations to be sited adjacent to sizeable heat loads so that CHP can be used to supply industry, or mixed, city-wide schemes with heat. However, the new generation of CCGT power stations is growing up in remote locations where CHP is not feasible — despite very enthusiastic support for CHP from the Department of the Environment.

Elsewhere, the Government's Non Fossil Fuel Obligation (NFFO) supports electricity generation from renewable sources, but fails to recognise the environmental advantages of simultaneous heat production. The NFFO operates as a disincentive to CHP, by encouraging project developers to maximise electricity sales at the expense of heat production. We have called for a separate category for CHP within the NFFO. The Government has finally recognised the argument. In its response to recent Commons Environment Committee report on energy efficiency it promises a review of the position of waste-fired CHP within the NFFO.

Space prevents me from listing all the barriers to CHP, but an extract from the Environment Committee report illustrates the urgency of the task: *"In 1993, just as in 1983 and 1973, the UK throws away more thermal energy from power stations than it obtains in the form of natural gas from the North Sea. This energy flow (100 GW) provides more than enough energy to heat all the buildings in England, Scotland and Wales."*

We in the CHP industry are working to end this gross waste of energy. Only when all the regulatory and institutional barriers are finally removed will we succeed. I am confident we can build on what we have done so far to achieve this, for the benefit of consumers, the environment and the economy.

David Green
Director, Combined Heat and Power Association

Lithuanian review

LITHUANIA is reviewing its options for the future operation of its only nuclear power station, as part of a national energy planning programme funded by the EC's PHARE initiative.

One option suggested by UK-based Environmental Resources Management (ERM) is for one unit of the Ignalina power station to be closed, in view of the sharp drop in electricity demand. Such a step could reduce overall costs as well as focussing attention on energy efficiency and promoting independent sources of energy supply.

ERM Energy identified a series of measures for improving energy efficiency in Lithuania, including the improved management and use of district heating, better insulation and the introduction of customer metering. District heating is seen as a viable form of supply which should be retained.

ERM are also about to undertake a major study to examine the impact of oil industry development on the Falkland Islands, following a series of seismic surveys in the region. Initial findings indicate 'very significant' reserves.

Exploration of Tarim Basin

IT WAS announced in February by Texaco, that agreement has been reached for the exploration of an onshore block in the Tarim Basin, a vast desert region in northwest China.

The agreement was made between the China National Petroleum Exploration Company (CNPC) and an international consortium, including Texaco China BV. Each partner holds a 20% share, with Agip (Overseas) Ltd serving as operator. CNPC has the option to participate with up to 51% share in development of the block.

The Tarim Basin is the largest relatively unexplored onshore region of China. The total area is 560 000 sq km, more than half of which is covered by the Taklamakan Desert. CNPC and China's Ministry of Geology and Mineral Resources have made several potentially significant discoveries in the northern and central parts of the basin since exploration began in the 1970s.

Texaco's entry into China's onshore petroleum industry follows on a series of activities as a partner in the offshore side of the industry. As operator, Texaco signed contracts last year to explore three contract areas in the East China Sea, covering some 8100 sq km, almost doubling Texaco's total offshore exploration area in China to 20 000 sq km. Texaco was one of the first foreign petroleum companies to reestablish operations in China in the early 1980s. Texaco first entered China in 1913, selling kerosene.

Go ahead for Czech PFBC

IN FEBRUARY the Czech government approved credit guarantees for a pressurised fluidised bed combustion (PFBC) CHP plant to be built in the northern suburb of Ostrava.

The decision is a prerequisite for funding from the Nordic Investment Bank and the Swedish Exports Credit Guarantee Board, and means that ABB Carbon of Sweden and ABB PBS of the Czech Republic can start work on the design and manufacture of the plant.

It will replace a 45-year old power station, and will supply 60 MW of power and 100 MW of district heating, as well as 10 MW of process steam to local industry.

Participants invited

INDIVIDUALS and organisations are being invited to register an interest in contributing to the work of the newly established European Environmental Agency (EEA).

They could take part in a national information network or as a topic centre.

The decision was taken last October to site the EEA in Denmark.

The EEA is an independent body which has been created to provide objective and reliable environmental information at the European level to help the EC and its member states formulate sound policies to protect the environment, through cooperation with member states involved in environmental monitoring and research.

The UK is to notify the EEA of the composition of its national network and potential topic centre candidates. The network will include those organisations who regularly collect and supply environmental data within the UK.

The national focal point for the UK is: Mr C D Martin, DoE, Room A104, Romney House, 43 Marsham Street, London SW1P 3PY.

A recent airlift from Stockholm's Arlanda International Airport in Sweden of a 82.3 tonne aircooled turbogenerator unit. The unit was delivered to a papermill in Louisiana, USA.

Following a major breakdown at the papermill last summer, part of the power system was damaged, resulting in partial shutdown of the plant. Instead of replacing the damaged equipment, the mill owners decided it would be more economical to transport it back to ABB in Sweden for repair. The airlift was carried out by Air Foyle and the Antonov Design Bureau. The 25 MW generator was dismantled into 13 individual component sections for transportation, including two 22.8 tonne copperwired stators in their cradles, as well as two rotors and a gas turbine. Asea Brown Boveri Group built and installed the original plant back in 1970.

Further job losses at BG

FOLLOWING the announcement of an overall loss for the last financial year, as a result of money set aside for restructuring, British Gas announced a further 5000 job losses, on top of the 20 000 announced last year.

The net loss of £533 million compared with a profit the previous year of £473 million, but much of this was accounted for in restructuring costs, made necessary after the recent monopolies and mergers (MMC) report. The 25 000 job losses will take place over a five year period.

Project aims to cut power losses

A MAJOR collaborative research programme aimed at cutting energy losses in electricity transformers is underway at EA Technology, based at Capenhurst in Chester.

Part-funded by the EC under its Brite-Euram programme, and by the UK ESI, the three-year project aims to develop a new route for producing bulk quantities of low cost, low loss steels for use in transformer cores.

The energy dissipated in the cores of transformers and motors in Europe alone is presently estimated to amount to between 80 000 and 120 000 GWh per year, worth £2 225m to generators, distributors and consumers.

Fuel used in power stations to generate this power results in emissions of around 80 mt of CO_2 annually. In addition the energy losses represent some 12 000 MW of electricity generating capacity operating at 100% load factor. However, because the average load factor of a power station is much less than 100%, the generating capacity required to compensate for these losses is proportionately larger.

An opportunity has been identified for reductions in production costs of low loss electrical steels using heat treatment regimes, developed by EA Technology at Capenhurst.

OFFER proposals will double independent capacity

AFTER complaints last year about price increases in the electricity Pool, Prof Stephen Littlechild, director general of electricity supply, told National Power and PowerGen he would not need to refer them them to the monopolies and mergers commission (MMC), provided they agreed on the voluntary sale of capacity and price reductions.

OFFER announced in February that it had obtained satisfactory undertakings from the generators on both issues, and an MMC reference would not be necessary.

National Power has agreed to negotiate to sell around 4000 MW of coal or oil-fired plant in England and Wales, within two years, with PowerGen agreeing to dispose of 2000 MW. The total 6000 MW, which is equivalent to about six large power stations, would double the present extent of independent generation.

In addition both companies have agreed to bid into the Pool in such a way over the next two years, that average purchase prices in the Pool may reasonably be expected to be up to 7% lower than the current financial year.

The Regulator has been criticised by the Association of Independent Electricity Producers, however, whose chief executive, David Porter, said: "I cannot understand why Prof Littlechild thinks that artificially depressing prices paid to generators in the Pool will encourage competition." But he welcomed the decision not to refer the generators to the MMC, as well as the proposal to dispose of a total of 6000 MW of capacity.

The AIEP recalled that in December 1992, OFFER published a report on Pool prices which concluded that payments to generators were unrealistically low, but when prices crept up in 1993, large industrial users complained to OFFER.

Two Midlands pits to re-start production

COAL Investments plc has agreed with British Coal on licence terms for Coventry and Hem Heath collieries (Hem Heath was the original — and now to be restored — name for the part of Trentham mine being licensed to Coal Investments).

Coal Investments is seeking to raise £11.5m through a Placing and Rights Issue of new Ordinary Shares and a Rights Issue of Loan Notes.

The aim is to recommence production at both mines in time to meet demand from customers next winter. The collieries were among the first to be offered for lease and licence following the Government's White Paper a year ago. Recoverable reserves identified by independent mining experts, Waltons, give a minimum potential mine life of about 50 years.

At the first stage of operations, the two mines will provide about 300 jobs, and at a later stage, after the passage of the Coal Bill and the removal of the present upper limit of 150 underground workers per mine, this will probably rise to about 500.

Executive chairman of Coal Investments, Malcolm Edwards, said: "Everyone stands to gain something from the re-starting of production at these two mines. The whole Midlands economy will benefit. Once again customers can count on getting proper British coal at competitive prices instead of improvised foreign substitutes. There will be well-paid jobs for men and the chance to invest in the business in which they work.

"Our immediate aim is to get these mines back into production in time for next winter so as to supply our customers' needs in the cold weather. We will lose no time in bringing these national assets back to life again."

HSC report on waste management

THE NEED to ensure the safe management of radioactive waste stored on UK nuclear sites, until the Nirex Repository is ready, was raised in a recent report by the Health and Safety Commission (HSC).

The report was prepared by the Study Group on the Accumulation of Radioactive Waste, and covers sites managed by AEA Technology. The report also looks at the issues associated with waste arising from decommissioning activities. A previous report, covering BNFL Sellafield and nuclear power stations in the UK was published in June 1992.

Dr David Harrison, chairman of the HSC's Advisory Committee on the Safety of Nuclear Installations (ACSNI), said the committee shared the study group's concern that delay in a national repository programme might lead to the risk of additional doses to workers dealing with waste on nuclear sites. "ACSNI was concerned about the potential risks. This is why my predecessor wrote to the government ministers on the matter. Mr Eggar has acknowledged our concerns and will be considering them along with a wide spectrum of factors affecting the industry.

Ron Campbell, chairman of the Study Group, said: "A common theme in both reports is the need for decisions to be made on the types of packaging required for various types of waste."

The Group accepted that on most AEA sites current waste management arrangements were satisfactory. However, at Dounreay there was a legacy of inadequate storage. It was noted that AEA is taking action to improve the situation with the agreement of the regulators. The latest equipment to be commissioned for examining and packaging the waste was acknowledged as 'first class'. "We are satisfied that the nuclear licensees and the regulators are aware of the issues identified in our reports," said Mr Campbell, "We know the Inspectorate is keeping up pressure for improvement."

Introducing Complete Energy Services

COMPLETE Energy Services is a newly structured organisation which has emerged from the long established Coal and Energy Services Division of British Coal. Now coal, gas and oil users can benefit from the CES range of energy management services which are designed to meet the needs of modern industry with a professionalism which is second to none.

The CES team retain the technical and scientific back-up of a major energy producing industry and combine this with their own considerable experience in providing energy services to industry, commerce, local authorities and health authorities.

The main areas of operation for Complete Energy Services are:

Energy services — contract energy management; plant operation and maintenance; plant commissioning and testing; energy surveys; training.

Environmental services — compliance; audits and impact assessment; testing and monitoring; plant specification.

Consultancy and project management — feasibility studies; project specification; design and build; main contracting.

A more complete description of these services follows.

CES combines the personal touch of a small consultancy with the vast resources and skills associated with a major energy producer. CES is strong in every field of energy management, contracts are available to completely remove the problems of boiler plant operation and servicing.

The cost of energy to industry will continue to rise and, in the highly competitive years ahead, users need to be sure this expensive overhead is kept to a minimum. That is only possible with the kind of professional skills available from CES.

Environmental monitoring and testing provides a vital service to determine how best to comply with existing and new legislation. Assessments are often required as part of the planning consent for new schemes or for authorisation and compliance with the Environmental Protection Act.

CES have vast experience of combustion and process plant, bulk solids, wastes and residues. The CES environmental control group specialise in designing systems to control particulate and gaseous emissions.

Complete Energy Services is the environmental consultant for five municipal incinerators, and for the installation of four clinical waste incinerators.

Custom designed instrumentation is available to provide spot checks for combustion conditions, alternatively, continuous monitoring can be used to optimise operation and ensure cost effective performance. CES also offer instrument hire for long and short term periods.

Feasibility studies are thorough investigations of user needs which include comparisons of all types of heating equipment most suited to individual requirements. Coal, gas and oil fired plant are considered fully to ensure each application has the right components.

Studies are carried out to exacting standards, analysing all relevant criteria against specific objectives such as capital cost, payback time, operating costs, maintenance etc. The final scheme can then be selected to meet clear objectives against the known facts ... it is at this stage when a final scheme is determined.

Project specification and control ensures the effective management of development programmes to maintain completion targets and cost control. CES can manage contractors and liaise with local authorities, statutory bodies, utilities and other agencies ... all these services designed to the best and most effective energy management. If you would like to discuss your project with Complete Energy Services, telephone 0602 272180 or fax 0602 770156.

Energetica designs CHP plant

COMBINED heat and power (CHP) is already a well established energy source in Europe and its economical and environmental advantages are now becoming widely appreciated in the UK. The benefits of CHP are recognised by all major political parties and most environmental groups — it represents a responsible way of producing energy with the least impact on the environment.

Energy specialist, Energetica Ltd, a wholly-owned subsidiary of British Gas, is playing a leading role in the national move towards CHP and runs a range of CHP plants throughout Britain.

One of the company's key contracts, worth over £12 million, is the design and build of a CHP plant for Cogeneration Investments Ltd (CIL), at the Stallingborough, South Humberside site of SCM Chemicals — Europe.

SCM Chemicals, a member of the Hanson Group, is one of the world's largest manufacturers of titanium dioxide, a white pigment used in paints, plastics, paper and many other products. The company employed CIL to provide most of its future energy requirements by means of a 15 megawatt CHP plant which is expected to be operational by the end of the year.

Energetica began foundation work for the plant's power house during January and subsequently the company will be installing two gas turbine EGT steam injected Tornados, each 6.2MW; two heat recovery steam generators and a 2.5MW back pressure steam turbine. An optimisation computerised programme system will be utilised to maximise on the efficiency of the completed project.

When fully operational the scheme will result in dramatically reduced running costs and a significant reduction in emissions from the factory.

The controls solution

SATCHWELL Controls has a wider experience of the UK HVAC controls market than any other company — writes Alan Woods, UK Sales Manager.

From multi-million pound turnkey projects to small engineered systems, Satchwell have significantly increased their market share in recent years. Involvement in providing a product to meet the needs of the client. Satchwell's strength is not only its product range, but more importantly the depth of expertise and experience of its engineers to provide a complete controls package.

In a continually changing market it is important to 'listen' to the customer and adapt your products and services to provide a 'win' situation for the client. Satchwell's research and development of products and its staff are implemented on this basis.

District heating — the green solution

LEICESTER City Council is one of the UK's most committed local authorities in its energy and environmental policies. Britain's first Environment City, the United Nations selected Leicester as one of just 12 schemes worldwide to receive honours at the Earth Summit in Rio de Janeiro. Seeking to reduce energy consumption in Leicester by 50% by the year 2025, the City Council is committed to develop combined heat and power (CHP) schemes; and to upgrade its existing district heating capacity. Two installations illustrate how APV plate heat exchangers have improved efficiency at Leicester boiler houses.

Rowlatt's Hill boilerhouse supplies the heating and hot water needs of two 23-storey blocks, totalling 264 homes. In addition to the installation of new CHP boiler technology, an APV Plate Heat Exchanger offering more efficient heat transfer has been installed as a replacement for a tubular heat exchanger. Primary water circulates in a closed circuit system from the boiler via a pump set to the phe. Incoming temperature to the APV unit is in the 70 to 90°C range, and this falls by 10°C as water for heating and domestic use is heated from 60 to 65°C. Domestic water is circulated to the flats at a constant temperature; a compensated circuit allows variation of temperature for heating purposes. Flow rate is 200 gpm on the primary side, 250 gpm on the secondary side.

Leicester City Council has also invested in 15 sets of SR26 plate heat exchangers from APV which will be used to improve efficiency by replacing calorifiers. A typical installation for one of these units is in the plant room of a 17-storey block of flats fed from St Peter's boilerhouse. St Peters, one of six boilerhouses in Leicester, feeds a total of 1000 dwellings; five blocks of flats via plant rooms, and directly to an estate of low-rise housing; it also provides heat to a school, a library, a health centre, and senior citizen's home. An extremely low heat loss made possible by excellent insulation and a sophisticated leak detection system. That water heats constant-temperature domestic water, and variable temperature water for heating purposes: temperature rise is between 10 and 20°C.

CHP contracts for N P Cogen

JAMONT UK, a leading tissue manufacturer recently announced the signing of a 15-year agreement to buy electricity and steam from a CHP plant to be built at its Bridgend site in Mid Glamorgan.

National Power plc will build, finance and own the £7 m CHP plant, and will provide back-up and top-up power as well.

The two 4.5 MW gas turbines, burning natural gas or distillate oil, will be combined with two waste heat boilers to produce up to 40 tonnes of steam/hour. An additional 16 tonne/hour boiler also forms part of the scheme.

The plant will have an overall efficiency of around 85%, with all the usual environmental advantages of combined heat and power plant.

Community heating

*by Robert L Skinner, BA DipM DMS CEng MInstE MIMgt**

Large-scale CHP systems for the purposes of district heating have been popular on the continent since the 1960s, yet for a number of reasons, the UK has lagged behind in this environmentally-beneficial technology — that is until recently. Robert Skinner was instrumental in the setting up of the Community Heating Group, and in this article, based on a paper given to a group seminar in Hull last October, he argues the case for the widespread use of district heating systems.

FUEL POVERTY is a term often used but I suspect little understood by those people who may use it in a casual manner. What does it mean? For me it describes those people in the lower income groups who spend a large proportion of their income on energy in an effort to keep warm. This proportion of spend can be so high they have to make considerable sacrifices to their standard of living to a level far below that anyone should have to endure.

The initial reaction may of course be to pay these people more, but I believe this may not be the answer because it is merely treating the symptom, and is not necessarily exercising a cure. Much, if not all, of the problems associated with fuel poverty result from thermally transparent buildings and inefficient heating systems. Increasing income support in order to compensate for this situation would not only increase the burden on the welfare state, it would cause an unnecessary increase in energy consumed, so acting contrary to all principles of energy conservation.

In this article I intend to look into what are affordable fuel costs and identify a possible solution to providing them.

Glasgow City Council carried out a Household Survey in 1985 and the results indicated heating bills were essentially unrelated to household income. As a result the burden of heating costs becomes far greater for the lower income groups. Customer satisfaction surveys also indicated Glasgow City Council tenants tended to spend about 50% of the fuel cost required to meet the comfort conditions set by the Building Research Establishment (BRE), which was still higher than they could reasonably afford. This tends to break down the myth that the problems of condensation and mould growth are the result of the householder's failure to heat and ventilate — it may be a question of they cannot afford to do so.

Glasgow, with supporting documentation, confirm family households often have to spend up to £25 per week on fuel in order to keep warm. This is not uncommon, as many local authorities are now finding to their despair all the UK. This is also a nonsense when you are considering low income groups and compare it to the income support levels for April 1993 onwards (see Table 1, overleaf). Such figures may be considered worst-case conditions, but when viewed in relation to the number of people in receipt of housing benefit for the various areas in the City of Hull (central/west: 72.34%; north: 70.08%; Branscombe: 71.43%; Bilton/east: 71.55% and city wide: 71.52%, a very large proportion of Council tenants are in the lower income groups, and are consequently suffering the pressures of spending a large proportion of their income on fuel.

The only indicator from central government on sums available to low income groups for the payment of fuel was the Notional Fuel Element, now incorporated into income support. In 1988 (when supplementary benefit ended) this figure stood at £8.80, or 10% of a typical pensioner couple's income. If this figure is applied to the income support levels shown in Table 1, the amount of income expended on fuel would be between 8% and 33%. Presently, the weekly fuel deduction for housing benefit is £11.40: £8.60 for heating; £1.05 for hot water: £0.70 for hot water and £1.05 for cooking.

Again applying this figure to the income support levels shown in Table One, the amount of income expended on fuel is between 10.48% and 43.1%. The 8% or 10.48% represents a couple with two children under 11 years: in reality this represents a lower figure than actual, because of the probable higher internal temperatures required and the greater use of hot water by a family compared to a single person. To spend such a high proportion of an income on fuel is clearly a difficult task, and for some may be simply impossible.

Of course, alternatives exist: eat less, wear older clothes, don't put the heating on, be cold. Consequently, people dependent on benefits will suffer a reduced standard of living. But the absence of heating, in thermally poor high rise flats, for example, generally results in high levels of condensation and subsequently in structural damage and unhealthy living conditions.

It can be seen from the fuel deductions for housing benefit, the greatest proportion is for heating and hot water, amounting to £9.65 per week or £501.80 per year. This is far in excess of the likely heating and hot water bill which could be expected for the average three-bedroom semi built to current building standards.

Considering the needs of the tenants and their ability to pay, as cheap as possible must be the target. Experience has now shown that heating bills under £5 per week are comfortably achievable. Heating bills under £3 per week are a more realistic target.

However, experience has also shown considerable investment is required in the building fabric, especially in pre 1970s housing in order to make the heating systems effective. It is clear socially rented housing requires a massive investment in thermal insulation and heating to eradicate fuel poverty.

The extent of the problem can be seen in Figure 1, which shows the thermal profile of the current council housing stock for the City of Hull in terms of National Home Energy Rating (NHER). It can be seen from the graph the vast bulk of the hosing stock has a thermal performance below the current Building Regulations. Of these 66% have a NHER rating of 4 or below. Again this is nothing special to Hull, if a distribution curve was drawn for other cities in he UK, a very similar line would be drawn. It must be remembered a NHER rating of seven is current Building Regulation standards, and these

**Chairman of the Community Heating Group*

standards represent the minimum standard to which all new dwellings must be built. It is not, therefore, a target to be achieved, but it is a representation of the minimum which should be done.

The problems associated with thermally poor buildings and heating systems is a common one for most, if not all, the local authorities and large housing associations within the UK. So much so the Community Heating Group evolved out of a gathering together of some of the UK's major local authorities and private sector housing companies to discuss some of the common problems they were all trying to address, especially in the areas associated with poor or inadequate heating systems: for example, unaffordable heat and fuel poverty, structural and health problems caused by condensation and mould growth, and general urban degeneration.

It soon became apparent that the most practical way of providing tenants with a heating system which they could afford to run, whilst simultaneously endeavouring to use energy wisely, was through community heating. That is, through the generation and distribution of environmentally friendly heat energy for communities. Basically, it is district heating, but considered from the consumer end — from the tenants' point of view.

Continuing investigation by the Community Heating Group has shown that community heating not only provides low-cost heating for the tenants, but it can also use a variety of fuel sources such as municipal waste, it can be linked to electrical power plants and many more applications, but most

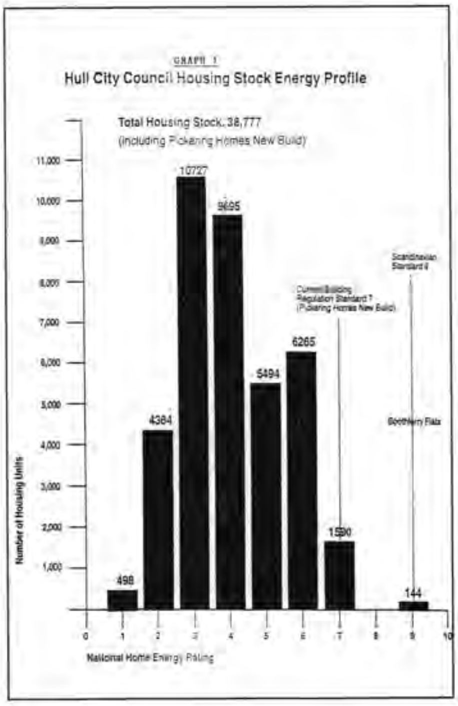


Fig 1: Hull City Council housing stock energy profile.

Table 1: Low incomes groups, by age, compared to income support (IS) levels (April 1993)

Income group (by age)	IS level (£)
(single person)	
under 18	26.45/34.80
18-24	34.80
25-59	44.00
60-74	61.30
75-79	63.30
80+	67.55
(couples)	
18-59	69.00
60-74	95.25
75-79	98.00
80+	102.70
(couples + 2 children, under 11)	
18-59	108.75
(single parent + 2 children, under 11)	
18+	88.65

importantly of all, it can be adapted to suit the tenants.

The heating system within a dwelling linked to community heating is no different from any common central heating system found in the average home, except that in a community heating system there is no boiler within the dwelling. Instead, heat is distributed to each dwelling from a central boiler plant (or other heat source), and usage is individually monitored by a heat meters within each dwelling, with the addition of a prepayment heat controller (PHC).

The PHC has a special significance. It is the nearest thing to the old fashioned 'coin in the slot' gas or electricity meter. It allows easy budgeting and management of heat usage by the tenant — no quarterly bills. Users are able, for example, to save up heating credit across the summer for use in the winter. The PHC also eliminates the need for the counter productive Pool charging system, the principle of which is totally contrary to the energy conservation principles of community heating. I say counter productive because the Pool charges are usually established by taking last year's fuel, maintenance and management costs, adding them together and dividing them by the number of households on the system, and then adding that cost to the weekly rent. Human nature being what it is, tenants usually take the attitude 'if I'm paying for it I will have it', so setting their system on 24 hours, setting the thermostats up high, removing the thermostat valve heads on radiators (if any) and controlling the system by opening and closing the window. The end result is steadily rising fuel costs which in turn results in the tenant paying well in excess of £10 per week for their heating.

A recently completed example of an insulated district heating system is the Boothferry Flats, Hull, which consists of three twelve-storey tower blocks each containing forty-eight dwellings made up of one and two bedroom flats in each. These flats, built in the mid '60s were very inefficient from an energy point of view. The heating system consisted of electric under floor heating which was inefficient, costly to run and inoperative in many of the flats. Consequently, many of the tenants were left with a single electric fire in their living room to keep the whole flat warm. An uninsulated thermal cavity, single-glazed, poorly-fitting windows and an external balcony which acted as a cooling fin, resulted in low thermal efficiency and high running costs.

As part of the Greenhouse Demonstration Programme, the blocks were overclad and thermally insulated. A gas-fired district heating system was installed using condensing and conventional boilers in a boiler house located centrally, close to one of the blocks. Highly insulated underground pipes, laid approximately one meter deep connect the blocks through a heat exchanger at the point of entry to each block. Each flat is served from rising mains at each floor level to a PHC unit located in the kitchen of each flat.

PHC tickets are purchased from the local estate office and inserted into the unit by the tenant. The tenants have a full thermostatic control of their central heating and hot water system so they can regulate their own comfort level. The average heating and hot water bill is expected to be £3 per week or less, compared to previous bills of £10 to £20 per week.

The cost of improving the thermal performance of the building could be considered relatively cheap, especially in relation to demolishing and rebuilding. The cost of the thermal improvements to the building fabric to raise the NHER rating of Boothferry Flats from an average of 2.3 to 8.7 was £6235 per dwelling.

The cost of installing the heating system within the dwelling is no different to installing a central heating system into the average domestic dwelling. The central plant can be cheaper to install and maintain than numerous individual boilers. However, what can be expensive and is usually a stumbling block for many a potential district heating system is the cost of installing the underground mains. The cost of running underground distribution mains from a central boilerhouse to Tower Blocks is approximately £250-£300 per dwelling and to low rise buildings approximately £800-£1000 per dwelling.



Before (left), during (centre) and after (right) the external works on Boothferry Flats in Hull.

In unoccupied buildings the savings made on energy are returned to the rate fund or the housing revenue account. Any energy savings made for the tenant are retained by the tenant. This may cause a general reluctance to spend money in this area because of the desperate need for resources in general.

The potential returns which could be accrued from a long-term investment programme wholly driven by an energy strategy cannot be understated in terms of tangible and intangible benefits. The refurbishment of Rossett House, Thornton Street, Hull, which included overcladding and insulation and the installation of a community heating system, showed a 35% reduction in heat loss which gave a 55% reduction in CO_2 emissions for a typical maisonette. But more importantly, the average tenant's fuel bill was reduced by more than 70%.

The block is now extremely popular, with a waiting list of people wishing to move in because of the lower heating costs and the absence of dampness and condensation within the dwellings. In addition, the careful landscaping and changes to communal areas mean the block is now more private, and vandalism has been eradicated.

The intangible benefits to the environment are, of course, of concern to everyone, however, in general, these benefits automatically occur when the energy consumption of a dwelling is reduced and so are the fuel bills of the tenant.

It is the reduction of fuel bills which can manifest itself in tangible benefits to a number of providers, which, when savings are made, will have a wealth-generating effect for the local economy and the nation in general.

In a dwelling which has no thermal improvements and has an inadequate heating system, rising fuel costs reduce the amount of disposable income a tenant has to spend. For people on fixed incomes this usually means a reduction in their standard of living. Income support will have to increase at a level higher than the rate of inflation simply to keep in line with rising fuel prices. Increasing disposable income through lower fuel costs will reduce that pressure.

Dwellings which suffer poor thermal insulation and inadequate heating can also suffer from high levels of condensation and associated mould growth. Research is now linking respiratory illness, particularly among young children, with the incidence of condensation and mould growth. Providing warm and dry environments whilst simultaneously increasing a household's disposable income should provide the basis for reducing dependence on the Health Services.

Energy savings for a company go straight on to the bottom line, that is, they are immediate profit. Energy savings for a tenant show an immediate increase in disposable income. Consider a £5 per week saving in fuel costs for an area of 2000 dwellings, for example, this represents £520 000 per annum of disposable income which can be injected into the local or city economy, so stimulating the retail sector.

Reduced fuel bills and a warm and cosy environment can be reflected in reduced rent arrears, reduced turnover of tenancies, increased value of property, reduced maintenance and the unquantifiable benefit of pride in one's home and the associated self esteem.

There is no short cut. The objective must be a long-term one for the future. It has to start with the tenant — what is best for them? What do they need? What do they want? They want heating they can pay for. This can only be achieved through long-term investment in energy systems such as community heating which can provide low cost heating at a price they can afford to pay. Achieve this and other things, such as energy conservation and reduced greenhouse gases, occur naturally, and then everyone benefits. ❑

Formation and purpose of the Community Heating Group

Whilst interacting with several local authorities, who were in the embryo stages of installing district heating, ISS Mainmet, manufacturers of heat meters for district heating, found a tremendous enthusiasm for such systems, being fuelled by the drive to 'go green'. Unfortunately, this enthusiasm was in 'pockets', and was not a collective voice.

Someone then had the bright idea of bringing these individual voices together into a group to discuss the way forward.

Supported by ABB Power Ltd (underground pipes) and APV Baker Ltd (heat exchangers), Mainmet arranged a group meeting in a hotel in Nottingham for senior officer representation from six of the largest local authorities in the UK, plus one large private housing company. After only two meetings the potential of the group was recognised, a chairman was elected, and the group began the task of assimilating what information they had about district heating and their own experiences.

It soon became apparent to the group all the technical problems had, or could, be solved and ample experience existed in mainland Europe, where district heating had made huge progress over the past 20 years. The problem in the UK was basically one of ignorance.

A district heating system essentially involves the generation of heat at a central source (a boilerhouse, waste incinerator or power station) and the distribution of that heat through water carried in an underground network of pipes between buildings, and through normal pipework with in the building, where a heat exchanger (or by direct connection) transfers the heat to the building's heating system. In the domestic situation the heat source plant basically replaces the domestic heating boiler commonly found in the average

domestic dwelling, after which the central heating systems are the same.

The production of heat on a large scale allows for much greater efficiencies in energy usage, especially when the fuel used is municipal waste, for example, or the heat which would have normally gone up the cooling tower of a power station. When the heat is produced in large boiler plant, bulk purchasing power can result in gas prices at half the normal domestic tariff. This results in low cost heat production for consumption on the district heating (DH) system network.

Although such systems are considered to be very environmentally friendly, only about 1% of dwellings in the UK are heated in this way, compared to in excess of 62% of dwellings in Denmark, for example. Although, cultural differences exist in the application of DH in local authority housing, which must be taken into consideration.

There are many reasons for the lack of development of DH in the UK. Some of the main ones are:

- when such systems were installed in the 1960s, UK manufacturing technology was poor, especially when such systems were linked to waste incineration plants. This was also true of installers, who had not developed their expertise, and installed networks badly. Much criticism, indeed prejudice, was directed towards DH systems in the area of inadequate plant and systems to do the job efficiently and cost effectively. In many respects this criticism was often justified, ie, the waste incineration plant was unreliable, there was no accurate method of charging for heat used, and the distribution mains wasted heat and were prone to failure;
- much of this prejudice remains, even though the technology developed in Europe, in particular Denmark, Germany and France, has resulted in very reliable systems;
- the cost of installation was high. The installation cost of the underground mains network on average doubled the cost of installation compared to an individual electric heating system. (The cost of installation is still high);
- electricity production in the UK, before the 1970s oil crisis, was cheap. (Off-peak tariffs still compete with gas in the domestic market);
- North Sea gas and oil discoveries maintained an energy-rich condition, which disguised the need for energy conservation. (Energy conservation is still low on the national agenda);
- the emerging privatised power and gas companies were in strong competition to sell their product. (This is becoming a very competitive market, now third party suppliers have been allowed to enter the market. However, this situation is now changing with some RECs actively seeking CHP/community heating schemes);
- there was no national energy policy — this situation has not changed.

However, growing environmental concerns and the need to provide low-cost heating, particularly in urban regeneration areas, has reawakened the interest in district heating and has laid open a potentially large market in the UK.

The group then decided it needed an identity, and since its concerns were that of the community and district heating could benefit all of the community, the 'Community Heating Group' was the name chosen.

A mission statement was developed: *"To promote the generation and distribution of economic and environmentally friendly heat energy for communities."*

BRECSU, the energy conservation support unit of the Department of the Environment, was given an invitation to join the Group as an independent adviser and duly accepted. The group now had the support of a government department.

The drive for an identity continued with the production of a group letterheaded paper, using the logo of the Danish Board of District Heating, with their permission. A publicity brochure was designed, directed towards elected members, senior officers and particularly customer organisations, and to convey the concept of community heating, using a friendly, caring 'family' approach.

The purpose of the group is its mission statement, and it is trying very hard to achieve those aims.

The time span of the initial meeting of the Group to the lauch of the brochure at the BRE Housing Group Conference in March 1993, was ten months. At this venue members of the Community Heating Group were given three slots to talk about community heating, as well as a free stand facility, in recognition of the Community Heating Group's potential contribution.

When BRECSU now receive enquiries about district heating, they distribute the community heating brochure as part of any package.

The Community Heating Group is now organising its own seminar/conferences. These will be at each of the founder members' facilities, with invitations going out to surrounding local authorities. The first one was staged by Thamesmead inside the M25 doughnut, in June 1993. The organisers shall be a member of the group, and the speakers shall be in accordance with the support the organiser thinks is necessary to support the promotion of community heating in that area.

The group has continued to expand with the inclusion of many more local authorities, representatives from the Combined Heat and Power Association (CHPA) and the Department of the Environment to give special advice, and thermal radiators increasing the contribution of specialist manufacturers knowledge.

Most importantly, people are now taking a second look at community heating.

- *This article is based on a paper given by Robert Skinner at* ***Community Heating for Social Landlords*** *seminar, hosted by Glasgow City Council, on behalf of the Community Heating Group on 25 January 1994.*

The social implications of domestic CHP

There is undoubtedly a resurgence of interest in community heating in the UK. Unlike the rest of Europe, community heating in Britain has been the poor relation, with only about 2% of the county's dwellings using community heating compared with nearly half the homes in, for instance, Denmark and Finland. With the introduction of modern electronic technology in all three sectors of community heating — the heat source, the distribution mains and the controls within the dwellings — the reputation of community heating is rapidly changing, and with good reason: the advantages of this type of heating are enormous, and affect every aspect of society. And when community heating has the added bonus of being fuelled by CHP, these advantages are maximised.

To look briefly at the social effects of community heating, the most obvious benefit to the consumer is probably that of enjoying affordable heat. Affordable heat is defined as the proportion of income which a family can afford to spend to heat their home to adequate temperatures, without experiencing hardship. Community heating is affordable because fuel can be purchased in bulk at a far lower and more stable rate than for individual systems. In addition, a central heat source can be run at maximum efficiency: and when the central source is a combined heat and power unit, affordable heat is a realistic expectation.

The warmth and comfort of such systems is enhanced by the immediacy of the heat, since hot water is immediately available, 24 hours a day, without the conventional warm-up time needed by other systems. These advantages apart, community heating is exactly like any other conventional wet-system central heating.

When heating is affordable it is used. Health risks associated with damp and cold homes are reduced, as is condensation and mould growth. Sadly, condensation problems hit unemployed people and pensioners hardest, partly because they are likely to be occupying the home for longer periods of the day, all the time pumping moisture into the atmosphere. For some local authorities the need to provide affordable heat is vital, when in excess of 70% of council tenants receive housing benefit.

Insufficient heating, poor ventilation and excessive moisture in the home are the main causes of mould growth and condensation. But one of the benefits of a communal heating system is that a minimum temperature can be maintained and guaranteed within a building, leading to fewer maintenance requirements, and banishing the spectre of condensation, mould growth and their associated evils.

These are some of the immediate effects of community heating on our society. In a wider sense, and more long term, the use of communal heating — particularly when fuelled from a CHP source — has the potential to significantly reduce pollution and greenhouse gas emissions, whilst at the same time helping to conserve our natural resources. Fuel flexibility is one of the greatest strengths of community heating, enabling a variety of fuels to be burnt (including heat from waste and renewable sources) with high energy efficiency and low energy consumption.

No wonder, then, that community heating has 'upped' its image. New schemes are being developed, and old ones — which a few years ago would have been ripped out without question — are now being refurbished. Community heating is becoming a viable option in the UK for installations ranging from small sheltered complexes, multi-storey blocks of flats, estates of mixed housing, to include large city-wide schemes.

One recent example of where community heating with CHP is reaching new heights is in Leeds, where two of the highest residential blocks in the UK are currently being refurbished. 25 storeys of freezing, expensive, damp boxes are being re-roofed, reclad, and double glazed. Gas-fired CHP will provide both heating and electricity, giving affordable warmth, with power savings to the council of £12 000 per year. It is also expected that the scheme will cut carbon dioxide emissions to less than a third of current levels.

The dwellings were originally heated with electric storage heaters, but these were replaced by a gas-fired group scheme, whereby gas-fired central boilers with CHP provide heat to full wet central heating system in each flat. Inside the flats are individual heating controls to give both time and temperature control, with electronic heat meters to record actual usage, and card operated prepayment units so that residents can pay for the heat as they need it. There is also a minimum temperature control facility to protect the building fabric.

Enough electricity is also generated to provide outdoor security and communal lighting, and to run the newly installed high speed lifts, drive security cameras and run a ventilation with heat recovery system for each flat. The end result of this will not only be a significant saving in energy and a welcome reduction in harmful emissions, but residents who were paying between £7 and £8 per week for their heating are expected to pay under £3.

This particular scheme was the subject of a successful bid by Leeds City Council under the Greenhouse Demonstration Programme which included energy efficiency and affordable warmth within its essential criteria. Energy efficiency in housing has now become a central issue within local authority housing management policy, since the government now requires authorities to 'take fuller account of the need to improve the energy efficiency of their housing stock and to reflect this in their annual housing investment programme submissions.'

In addition to housing investment allocations, help to fund community heating schemes can be sought from capital receipts, and from various government programmes such as Estate Action, or from Europe with the EC Thermie programme. In the case of expanding large city-wide schemes, partnership with the private sector, or the formation of utility companies are ways forward to get scheme up and running.

In a move to encourage the use of CHP in a domestic context, the Energy Saving Trust is funding a nationwide pilot programme designed to test out the scope for using CHP in a domestic setting, by providing grants to install new CHP systems. The programme, which will enable significant improvements in energy efficiency to be made in the domestic sector, is backed by British Gas and OFGAS, and is being administered by the CHPA.

This growing awareness of both the economic and ecological sense of installing community heating and CHP, is reflected in many of our major cities whose councils are working towards a total energy policy to include community heating. Manchester, for instance, has recently won a European grant to fund feasibility studies, and estate action grants to carry out upgrading work.

Sheffield is expanding its present city-wide community heating scheme which currently serves 3500 flats and over 50 commercial buildings. The scheme uses heat produced by burning municipal waste, with gas-fired CHP stations planned to supply the next phase of the scheme. A joint venture energy utility company, Sheffield Heat & Power, operates the scheme for the local authority.

Nottingham has also benefited for the last 20 years from a CHP community heating scheme using heat produced by refuse incineration backed up by a coal-fired power station, providing heat and electricity for both domestic and commercial outlets in the city.

All these cities, together with other major local authorities, are committed to the future of community heating in the UK, and are all members of the Community Heating Group formed in 1992, dedicated to promoting the generation and distribution of economic and environmentally friendly heat for communities. The group maintains that community heating means not just low cost heating: it means caring about the environment and the future. ❑

Shirley Wilde, Community Heating Group

Community heating and the Best Practice programme

*by Helen Sutcliffe BSc PhD**

THE IMAGE of district heating is changing fast. Technology that was once perceived as inefficient and expensive is emerging as a reliable, cost-effective and environmentally responsible way forward for heating in the 1990s. District heating in its modern form is known as community heating (CH), and can serve all types of buildings, from domestic to commercial properties. Most existing community heating schemes in the UK serve predominantly domestic properties, but some schemes are now developing their networks to supply city centre customers, which may include local authority buildings, leisure facilities and commercial office developments.

Combined heat and power (CHP) in community heating schemes is of growing interest, because of concerns to improve energy efficiency and reduce harmful emissions to the atmosphere. The heat from CHP can easily be harnessed for community heating schemes using highly insulated underground pipe distribution networks and increasing numbers of community heating schemes are now considering the implementation of CHP.

This article gives a brief introduction to community heating and combined heat and power, and gives a few examples of successful schemes. In particular it describes the role of the Energy Efficiency Office and its Best Practice programme for encouraging the use of CHP and community heating. The range of outputs from the programme and its future direction are described. Links with industry, both UK and international are also highlighted. The Best Practice programme is managed and promoted for the Energy Efficiency Office by BRECSU at the Building Research Establishment and ETSU at Harwell.

**BRECSU, Building Research Establishment*

In line with the Department of the Environment's Greenhouse Programme, BRECSU at the Building Research Establishment, have recognised the importance of community heating schemes.

Community heating is a term which describes a heating system where heat generated in the form of either hot water or steam is piped from a central source into other buildings. The buildings may be some distance apart and the heat travels via an insulated pipe distribution network. The pipes are normally buried under the streets, similar to other services such as gas or water supply. The water carrying the heat flows in a continuous circuit, with pipes paired. One carrying the hot water to the consumer and another carrying the cooler water from the consumer's installation back to the central heat station for reheating. So in principle community heating is just like a household central heating system, but on a much larger scale: instead of separate rooms, separate buildings are heated.

The modern UK schemes generally supply hot water to the mains at temperatures of between 80°C an 120°C. The mains distribution network is known as the primary circuit and buildings may be connected to it either directly or indirectly. Direct connection means that the primary circuit water flows through the heating installation inside the building; indirect connection uses a heat exchanger to break the circuit and supply heat to a separate secondary circuit within the building. Conventional hot water radiators provide the heat into the rooms and it is not immediately clear to the occupants that they are being served by a community heating scheme.

Community heating has been used in the UK for well over twenty years, with differing degrees of success. Many of the operational and engineering problems suffered by the early schemes have now been overcome with the introduction of new technologies, new efficient controls, increased levels of pipe insulation and strict quality control procedures. Recent developments in pipe laying techniques and procedures have also meant that less disruption occurs in the local community when pipes are installed. All these developments now mean that community heating schemes can run effectively and provide a reliable service to their customers all year long. Homes are warm and comfortable for an affordable price. Overall cost savings can be achieved from community heating when compared to more conventional heating systems.

It is clear that modern community heating can have many environmental and energy benefits. The use of CHP as a lead heat

Community heating network: heat supplied to different buildings from a central source.

source is growing and the potential exists for using alternative energy sources, such as waste heat from refuse incineration or industrial processes. If waste heat is harnessed (heat which would otherwise just be thrown away) then less energy needs to be produced in the first place. If we produce less energy then our natural resources can be reserved for the future. The Sheffield Heat and Power Community Heating scheme is an example which uses waste heat from a domestic refuse incinerator to heat over 3500 domestic dwellings and over 20 commercial properties in the centre of Sheffield.

CHP, the simultaneous cogeneration of heat and power, significantly enhances this environmental bonus. In the production of electricity by traditional means, low temperature heat energy usually goes to waste through a cooling tower, whereas with CHP the heat can be utilised in community heating schemes.

The term 'efficiency' is used to compare the primary energy input to a system to the useful energy output. CHP efficiencies can be as high as 85%, (for every 100 units of primary energy burnt in a CHP system, 85 units will be produced in a useable form, either electricity or heat) compared to a modern combined cycle gas turbine (CCGT) power station which run at efficiencies of approximately 45%. Older coal-fired power stations are much less efficient, running at around 34%. These differences in efficiency clearly highlight that the use of CHP displaces the need for fossil fuels. If less fossil fuels are burnt then carbon dioxide (CO_2) and other greenhouse gases are reduced.

The electricity produced from a CHP system can be used on site or sold to the local electricity company; eventually it will be possible to sell directly to the customers of the scheme. Electricity generated by CHP at Aldriche Way in the London Borough of Waltham Forest runs the landlord supply on the estate which includes the pumps in the boiler house and the communal lighting across the estate. The excess electricity is sold to the local regional electricity company to provide extra income for the landlord.

Installation of highly insulated heat distribution pipes.

The Government White Paper — *This Common Inheritance* — recognised that CO_2 is a major contributor to the greenhouse effect. The majority of CO_2 emissions are related to energy usage so that increasing energy efficiency is seen as an important element in a strategy to control them. The government, therefore, set a target to stabilise CO_2 emissions at 1990 levels by 2000, and CHP was identified as one means of achieving this target based on the highly fuel efficient nature of the technology. The government is committed to increasing the uptake of CHP in the UK; it has recently raised the target from 4000 MWe to 5000 MWe by the year 2000.

To encourage reduction of CO_2 emissions from existing local authority housing stock, the Green House programme for the Department of the Environment was initiated. This programme includes cost-effective energy efficiency measures such as CHP and several demonstration projects are now complete. The Energy Savings Trust is encouraging the use of CHP in the domestic sector via a nationwide pilot programme for residential applications, which targets community heating schemes in high rise and sheltered blocks. Clearly there is a commitment to the promotion of the use of CHP in the UK.

The majority of existing UK community heating schemes heat only boilers burning fossil fuels, but there is increasing interest in CHP. For example, CHP is an integral part of the Stockport community heating schemes, where four CHP units have been installed which are to serve over 700 residents on three estates. CHP linked to large scale community heating is set to grow and the Citigen, City of London project, currently under construction, includes two large CHP engines. The project will meet the full heat and power demands of some of the Corporation of London's major buildings, including the Guildhall, the Barbican Arts

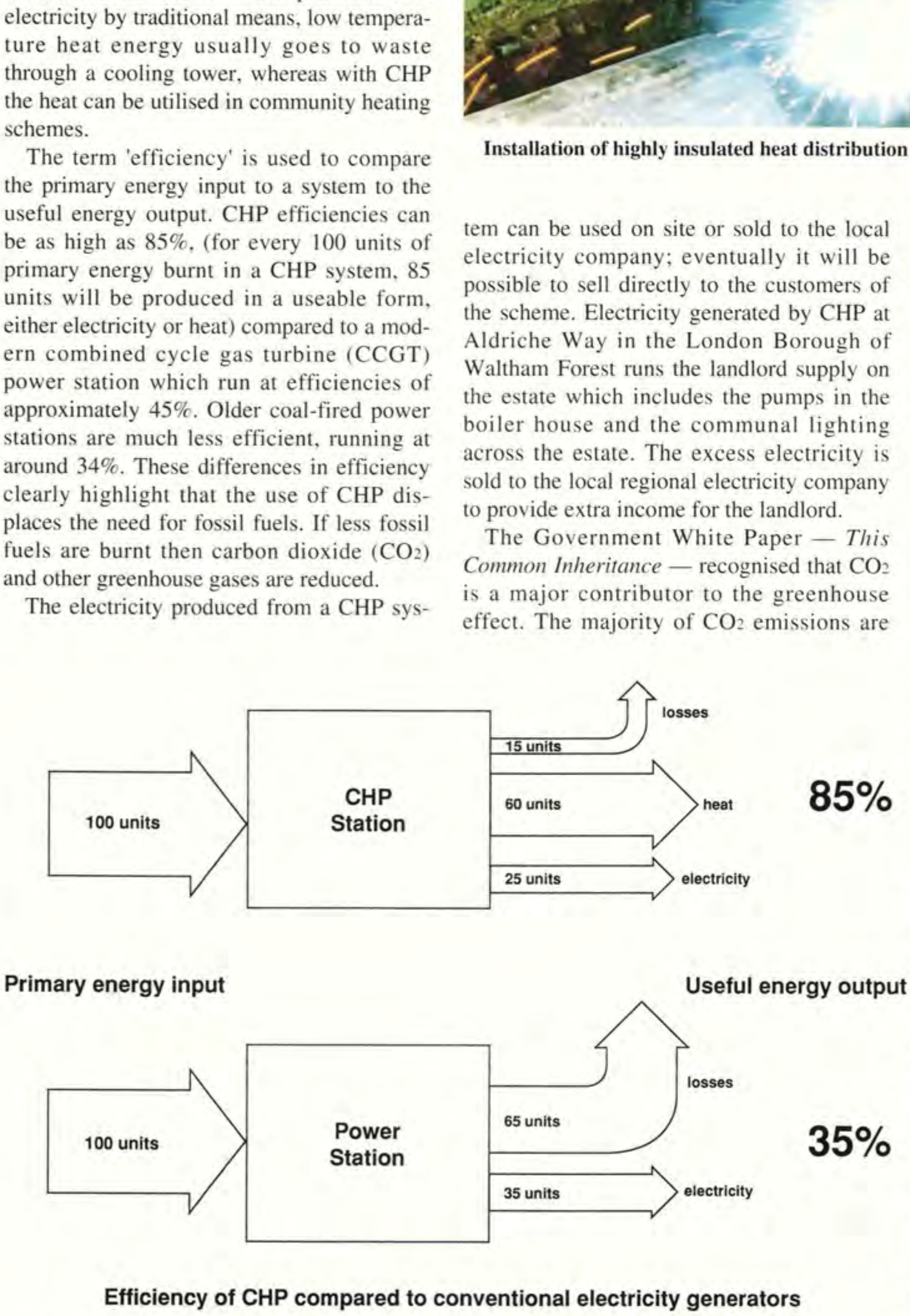


Fig 1: Efficiency of CHP compared to conventional electricity generators.

Centre, the Museum of London and Bastion House.

The Citigen scheme will also provide district cooling for the first time in the UK, using a second pair of distribution pipes, which will carry chilled water to the buildings. Chilling is achieved by absorption chillers which are powered by the heat from the CHP plant. The use of absorption chillers helps the summertime operation of CHP, when the heating demand is at its lowest. This improves the overall operating efficiency of the CHP plant, which improves the environmental impact. A further environmental benefit is that the centralised chilled water supply displaces the need for individual air conditioning plant which may contain chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs), which damage the ozone layer. This reduces the customer's reliance on refrigeration plant and reduces direct maintenance costs.

Several other cities are now considering the implementation of new CHP community heating schemes, including Camden, Edinburgh and London Docklands. Existing schemes in Sheffield and Thamesmead Town are being reexamined with a view to incorporating CHP. The best of these schemes are expected to be used to provide examples and guidance for others as part of the Energy Efficiency Office's Best Practice programme.

Because of the environmental benefits and energy efficiencies associated with modern community heating and accompanying use of CHP, the Department of the Environment's Energy Efficiency Office (EEO) is promoting CHP and community heating with the assistance of BRECSU and ETSU. BRECSU, based at the Building Research Establishment (BRE) in Watford, is the UK's leading centre for information and expertise on energy efficiency in the built environment and for the promotion of that information. ETSU, based at Harwell in Oxfordshire, deals with the energy efficiency of technologies and processes and has accumulated considerable expertise in the development of CHP units.

BRECSU is promoting community heating and associated CHP in different ways; this includes publishing information to exhibiting and speaking at conferences and seminars. A series of Good Practice Case Studies will be produced which will cover many different aspects of a successful community heating scheme. For example, this will include a general overview of what community heating is and how it works, and will also deal with specific areas in more detail, for example the pipe distribution networks.

Community heating can apply to large city-wide schemes, serving several thousand buildings, or much smaller scale sheltered blocks which may have only a handful of residents. Account will be taken of the differences associated with size of schemes when guidance material is produced.

CHP — an integral part of the Waltham Forest community heating scheme

The case study material will highlight modern successful community heating schemes. The first document describes a scheme in general terms; it aims to explain clearly what community heating is and how it works. The example used is the Sheffield Heat and Power Community Heating scheme, which has been serving domestic and commercial properties in Sheffield for over four years.

The second case study relates more specifically to consumer connection to the scheme. It explains why non-domestic customers decided to hook up to the system and their reaction to connection. These publications are intended to provide impartial guidance to potential customers and operators of schemes, such that they have all the information available and are able to make an informed choice as to whether or not community heating is for them.

In 1990, a guide was jointly produced by the EEO and the Combined Heat and Power Association (CHPA). This document is the guide to implementation of CHP/community heating schemes, and is based on continental and UK experience. The guide aims to provide local authority and energy utility companies with detailed guidance on a step by step analysis and design of a scheme. It covers the financial assessment of schemes including initial market appraisals, detailed engineering design (based on types of heat source and load), tariff structures and charging systems, regulations and contract provisions and quality control and long-term reliability. An information sheet has been produced which briefly outlines the contents of the guide; this is being distributed to ensure that the guide itself reaches its maximum audience.

Links with industry through the CHPA and the Community Heating Group ensures that the necessary information is delivered to would be installers/users of schemes. The Community Heating Group is comprised of local authority members, all of whom have considerable experience of community heating in their area, together with two or three partners from the community heating industry. The Group is committed to providing affordable warmth to domestic residents and commercial customers with minimal effects on the environment. We are also aware that community heating is very much more widespread in continental Europe, and that there are many lessons to be learnt from abroad. Therefore, links with the International Energy Agency (IEA) have been made through the IEA District Heating and Cooling Project.

The EEO is represented on the IEA's project by BRECSU. Membership of this project allows lessons to be learnt from abroad, especially from Scandinavia, where community heating is more widespread than in the UK.

The programme's objective is to demonstrate the environmental and economic benefits of introducing district heating and cooling (DH&C) and CHP schemes. The project has been running in three annexes for the past 10 years, with the work shared between the member countries of the IEA. Outputs from the project include over twenty detailed technical reports which cover many different aspects of community heating and district cooling. The areas covered include different methods of heat production, heat distribution, networks, heat meters, etc. A brief summary of these reports is available from BRECSU. This covers the documents produced in annex III of the project, and gives a brief introduction to the content of the full reports.

Future plans for promoting CHP and community heating under the Best Practice programme include the publication of further guidance material. Projects financed by the Energy Saving Trust will be followed with a view to producing case studies based on CHP/community heating schemes. Retrofit of CHP to community heating schemes will also be monitored, to ensure that guidance material is produced which covers the latest developments.

The developing interest in CHP and community heating will be nurtured to ensure the appropriate uptake of this technology. Combined CHP/community heating schemes will increasingly serve UK customers to provide economic and reliable heating whilst minimising environmental impact. ❑

● *For any further information on combined heat and power in buildings, community heating or the Best Practice programme in general, please contact the enquiries bureau at BRECSU on 0923 664258. For CHP technology enquiries, contact ETSU on 0235 436747.*

Royal Docks energy company initiative

BACK in June 1993, Energy World reported on a radical scheme for supplying energy — particularly electricity — for the last remaining area of London's Docklands to be developed: the Royal Docks. Since then a feasibility study has been completed, concluding that there are no insurmountable legal, regulatory or commercial barriers to the local provision of energy by an independent energy company. The opportunity to establish such a company has arisen from the convergence of three current government policies: the Private Finance Initiative, the UK CO_2 programme and, of course, the introduction of competition into electricity supply.

The Royal Docks offer 350 acres of development land with frontages to 240 acres of water, situated at the western end of the East Thames corridor. Projects currently under consideration, which include business villages, leisure and tourist attractions as well as hotels and conference facilities, would lead to a considerable increase in electricity demand in the area.

The London Docklands Development Corporation (LDDC) envisages new supplies of electricity being provided in an incremental way, in the form of 10 MW combined heat and power (CHP) modules, to match the pace of development in the area. This is in line with the government's policy of sustainable development. Investment decisions could then be made on a demand-led basis. Using CHP plant would give the additional advantage of supplying cooling and heating networks, and developers would therefore be encouraged to design their buildings without boiler and chiller provisions.

In addition to the environmental and cost advantages of CHP, the pace of development would minimise the public sector contribution by bringing in private sector funding on a joint-venture basis. In November 1993 the Department of the Environment launched the Royal Docks Energy Project as one of its Private Finance Initiatives.

The launch marked the beginning of the second phase of the feasibility study, whose purpose was to gauge the appetite of the private sector for investment in the joint venture company. Over 100 companies have registered their interest, and LDDC's consultant team have been discussing the business opportunity with four 'blue chip' UK energy companies, on a non-committal basis, to reinforce the results of the first stage of the study.

To ensure the highest standards of energy efficiency, LDDC are preparing a policy statement which will set standards of environmental responsibility as well as identifying ways in which these can be achieved at no extra cost. This policy statement is the cornerstone of the approach that LDDC wish to explore with the private sector. The independent energy company would be expected to provide electricity, heating and cooling through its own distribution system at cheaper rates than could be obtained from any alternative source. This would be achieved by building a linked network of CHP plants in pace with growing demand. The first 10 MW unit would service existing loads. A 10 MW connection to the public supply grid would act as a standby and top up for the first module. The new company would work closely with the promoters of new developments to match demand and supply, and to minimise peaks and troughs in demand. In addition it would explore the commercial opportunities of supplying local large energy users. It would seek long-term contracts with both customers and suppliers, and should have supply contracts in place for new developments before it incurred the costs of expanding the network. Finally, the new energy company would offer its customers, and other local businesses, a range of services, including demand-side management and building energy management services.

Market research in the development industry has been undertaken, with reference to the possible savings on two development opportunities currently being promoted in the Royal Docks: an urban village and an exhibition centre. A start-up scheme has also been identified which could offer attractive rates for energy supplies to both existing LDDC and local business loads, and could have capacity ready to service the urban village and exhibition centre developments. This scheme will form the basis of any competitive tendering process for forming the joint venture.

The results of this marketing exercise will be examined at the end of March 1994, when approval will be sought to go ahead with the selection process for the joint venture. The LDDC Board will also be asked to endorse the policy of energy efficiency and environmental responsibility for the development of the Royal Docks. ❑

CHP — a solution to environmental problems

by Steve Minett

The Scandinavians lead the way in the development of CHP. Varying in size from small turbine generators to large-scale district heating schemes, they can run on domestic refuse or biofuels, aside from the more conventional fuels. A conversion efficiency of 80% or more is just one of their environmental advantages.

THE ENERGY efficiency of large conventional steam power stations is low: only about 35% of the fuel they consume is converted into electricity. The remaining 65%, which is presently lost as 'waste heat', could, for example, heat every home in Europe. The Scandinavians are making a start in this direction by converting district heating schemes into combined heat and power (CHP) plants.

The district method of heating employs a single, central boiler house to supply hot water, via a network of pipes, to whole communities, often as large as 300 000 people. Heat losses in such systems are low, usually less than 10%. The hot water used is normally metered and each customer is charged accordingly. In the post-war period district heating has become more and more common in Scandinavia. In Sweden and Denmark, for example, it now supplies heating and hot water to half of the residential and commercial properties.

The basic concept of the CHP plant is to integrate a steam-driven, turbine generator into a district heating system so that the sensible heat from the generator can be utilised for the heating system. This combination enables CHP plants to attain thermal utilisation efficiencies of more than 80%. This article looks at two such plants in Scandinavia, where the UK-based firm Peter Brotherhood has supplied turbo-alternator sets. The first is at Thisted in Jutland, Denmark, and the second at Sandviken, in Sweden, which is located about 200 km north of Stockholm.

The original district heating plant was built at Thisted in 1979. It was designed from the start to use domestic refuse as a fuel. The burning of waste materials is, in itself, a great step forward in energy conservation: though domestic rubbish varies a great deal in composition and, consequently, in calorific values, its estimated that the energy content of three million tonnes of waste is approximately equivalent to that of one million tonnes of coal.

In 1986 an official Danish National Power Policy was introduced. This banned the use of coal in new district heating systems. It also required that every effort be made to utilise waste heat, eg, that arising from electricity generation. The CHP plant is one answer to this stipulation, and in 1991 the Thisted facility was converted to CHP operation.

The plant is currently owned and operated by an enterprise jointly owned by Thyra, the local refuse disposal company, Thisted Varmeforsyning, the district heating company and Nordkraft, the regional power company. A condensing steam turbo-alternator set, manufactured by Peter Brotherhood, and capable of generating 3.3 MW was installed. Peter Brotherhood also supplied a heat condenser, to link in with the district heating system, and a by-pass station which safety dumps the steam when the turbine is not in operation. Delivery, erection and commissioning of the turbine was carried out by this British company.

A second boiler was added to the plant to supply steam for the turbine. Steam emerges from this at a temperature of approximately 400°C and at a pressure of 45 bar. The steam is then passed through the turbine. The exhaust steam, leaving the turbine, is sent to the condenser where it is condensed by water returning from the city's heating system. The condensate is returned to the boiler to start another cycle and the district system water, now hot from the condenser, goes back out

The author

Steve Minett holds a BA in politics from the University of Sussex, and an MA from Stockholm University, where he also taught organisation theory for four years. In 1989 he received a grant from a Swedish research fund to carry out a study of decision-making in 450 Swedish companies. His book based on this study was published in the UK in 1992.

Since the 1970s, Mr Minett has worked as a technical writer, language consultant, freelance journalist and press consultant. He has contributed over 50 articles to 20 different international journals.

In 1992 he founded the Minett Media Network, together with First Edition Translations and the design company Omega. In 1993 the network was contracted to produce the international customer magazine of IMO AB.

Mr Minett is a member of the British Association of Industrial Editors and of the Society of Authors.

Steve Minett

to heat the city. The two circulating water systems are completely separate; only heat is exchanged between them.

This system at Thisted enables up to 2.9 MW/h of power to be generated per tonne of refuse burned. The plant consumes 45 000 tonnes of refuse annually, which provides 80% of the fuel for the turbine boiler. The remaining 20% consists of wood chips which are mixed in with the refuse.

The plant currently obtains its wood chips from a German supplier and pays for them by a barter arrangement; scrap metals recovered from the furnace at Thisted are exchanged for wood chips. The plant generates 22 000 MWh of power, and supplies 65 000 Gcal of heat per year. Of the utilisable energy generated 20% is converted to electricity and sold to the national grid, the remaining 80% supplies the district heating system.

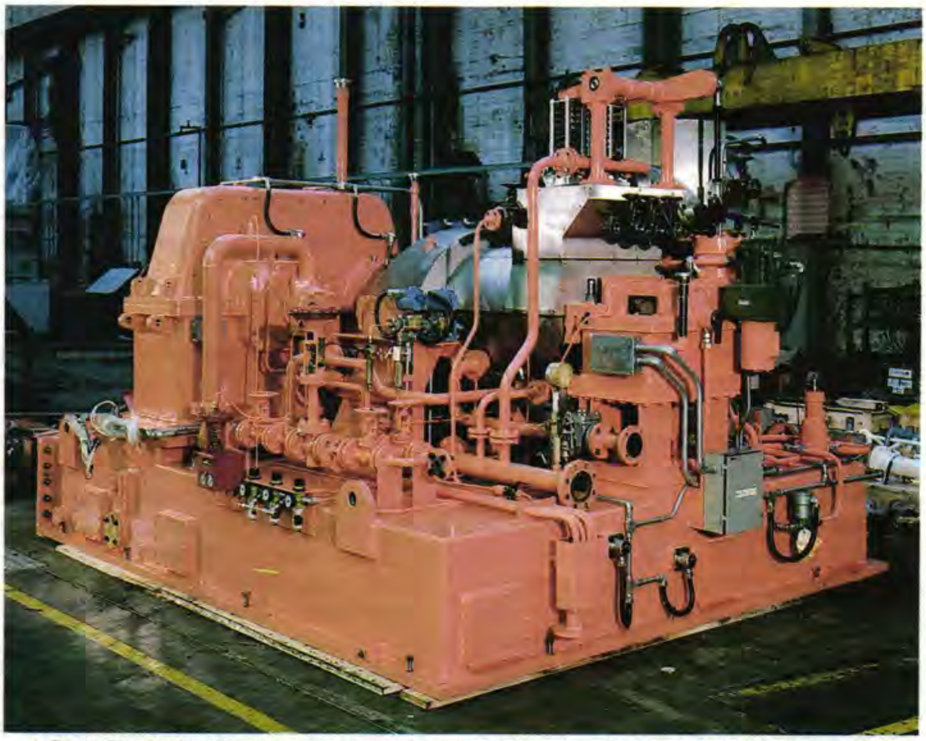
Even the heat from the flue gases leaving the furnace is utilised for the district heating system. These gases emerge at a temperature of 150°C and provide about 12% of the system's heat. They are also carefully cleaned before being emitted to the atmosphere, passing first through filters which remove the dust particles, then into a recycled water cleaning system with a flow of 500 m^3/hr. These cleaning processes ensure that emissions do not exceed the Danish legal limits of 300 mg/m^3 for carbon dioxide and 20 mg/m^3 for hydrochloric acid: average emissions at Thisted are, in fact, 100 mg/m^3 respectively.

In addition to the metals recovered from the furnace, most of the remains of the burnt refuse are also utilised. The slag and ash are used as construction materials. In Denmark this has the economic advantage that every tonne of waste which can be put to a useful purpose, rather than having to be disposed of (for example by landfill) entitles the company involved to a tax rebate of DK 160. In fact only 2% of the material burnt at the Thisted plant has to be finally disposed of at landfill sites.

For supplementary heat during the winter months the original, refuse-fuelled boiler, and a natural gas powered-boiler are available at the Thisted plant.

The background to the development of the CHP plant at Sandviken is Sweden's national energy policy over the last twenty years. The oil crises of the 1970s prompted the Swedish government to investigate alternative technologies for power generation. Prior to this Sweden was heavily dependent on oil, which provided more than 70% of the country's energy needs. As a result of this reappraisal of energy sources, minimal growth in overall energy consumption was achieved and the use of oil-based fuels fell by more than 50%.

The original district heating plant at the Sandviken site was built in 1976, by Sandviken Energi AB, who still own and operate it. The plant employed five boilers which were originally fuelled by heavy fuel oil. (These are now only used as reserve heating capacity for exceptionally cold periods in the winter, when temperatures can fall to below -15°C.) In 1983 the basic fuel was changed to locally obtained peat and the plant was converted to a CHP system in the summer of 1990. (In addition, two of the original boilers were converted to liquefied petroleum gas.) A gas turbine, capable of generating 4.2 MW, was installed.



A Peter Brotherhood waste heat recovery steam turbine, installed at the Thisted refuse-burning district heating plant in Denmark.

The two peat boilers were converted to steam production. The exhaust from the gas turbine is used to superheat the steam, which is then passed through a condensing turbo-alternator set, specifically designed and manufactured by Peter Brotherhood for this project. This steam turbine can generate an additional 5.3 MW of electricity, providing a total power output capacity for the Sandviken CHP plant of 9.5 MW. The electricity it produces is firstly used within the plant. Power surplus to this requirement is sold to the national grid.

The gas turbine is fuelled by liquefied petroleum gas (LPG), which is fed into the turbine via a high-pressure compressor, which increases the pressure from nine to 70-75 bar. This converts the petroleum to its gaseous state. The working pressure of the peat boilers is 20 bar. They produce steam at a temperature of 520°C. The superheated steam is then passed through the steam turbine at a pressure of 18-19 bar.

The incoming water from the district heating system picks up heat at three different points: first from the steam turbine's condenser (where it acts as cooling water); second, from an economiser, which takes heat from the gas turbine's exhaust after it has superheated the steam; and third, from a heat exchanger, through which water is fed back to the peat boiler, via a boiler drum. Again the two recycled water systems — the one for steam/power generation and the one that flows through the pipe network for district heating — are kept entirely separate; only heat is exchanged between them.

In 1984 the capacity of district heating system was boosted by the installation of a heat pump: cold water returning from the city is passed through the heat pump. In the summer, from May to mid-September, the heat pump alone provides enough heat for the entire system, which represents between 45-50% of the total heat requirement for the whole year.

The Sandviken plant currently supplies heat and hot water to 239 detached house and 8634 apartments covering the whole geographic area of Sandviken local authority. In normal years, the Sandviken plant supplies 220 GWh to its customers, but during the exceptionally warm winters of the period 1988-91 this has been reduced to 204 GWh. The pattern of fuel consumption which the plants uses to satisfy this demand has changed completely over the years: from 100% in 1976, oil-based fuel consumption has shrunk to 5.7% (1991). Also in 1991, biofuels, ie, peat and sawdust, provided 48.5% of the heat for the district, while the heat pump supplied an additional 39.1%.

CHP turbines are constantly monitored for temperature, pressure and vibration. (The necessary equipment for this was supplied in these two cases by Peter Brotherhood). When a fluctuation occurs in one or more of the above parameters, an audible alarm sounds which alerts the operator. If no appropriate action is taken within a pre-determined time, the turbine will be automatically shut down. In CHP plants there can be many reasons for changes in these basic parameters. It is, therefore, appropriate to rely, as a first reaction, on operator judgement rather than automatic adjustments. Speed and load can, however, be safely adjusted automatically.

At the temperatures and pressures associated with CHP systems, heat losses occur over the nozzles, resulting in a nozzle efflux velocity of more than 1000 m/s — which is too high for a single-stage, impulse turbine to use efficiently. In addition, in a single-stage impulse turbine designed for this type of application, the nozzles and blades are relatively small, resulting in leakage and fluid frictional losses, which absorb a major part of the potential turbine output. (It is possible to scale-down gland clearances from those used in larger turbines.) The high velocities necessary with steam under these conditions also result in other types of losses. Single-stage, small turbines in CHP plants do not work very efficiently.

There are two possible ways of overcoming this problem: one is to use multi-stage turbines. They are more expensive to build than single-stage machines, but, on the other hand, the only other possibility is to change the working fluid. Unfortunately here, the most obvious alternative to water would be one of the CFC-based refrigerants, such as Freon 12. These have a higher molecular weight than water, which would reduce heat loss over the nozzles and so prevent the occurrence of nozzle efflux velocity. Optimum efficiency would be achieved with much reduced blade velocities. This type of turbine is especially useful in recovering energy from low temperature waste heat sources.

The problem, however, is that gland leakage of Freon would certainly occur at either end of the turbine, which virtually rules out the use of Freon (or other CFCs) on environmental grounds. International agreements require the phasing out of CFCs by the mid 1990s. Alternative commercial refrigerants are expensive and maybe toxic, or corrosive, requiring expensive specialised handling equipment and the implementation of rigorous safe working practices.

Water, on the other hand, is readily available, at least in Europe. Its non-toxic and is, therefore, safe to use without specialised storage or handling techniques. Consequently, its a low cost material. These factors combine to ensure the continued use of steam turbines for the foreseeable future, given increasing environmental and economic pressures.

Furthermore, the efficiency losses from using water as the working fluid in CHP turbines are further mitigated by the overall strategy of these plants: in the CHP concept it is total energy conversion efficiency of the plant which is important. The fact that the waste heat from the turbine is channelled into the district heating system more than compensates for the steam efficiency losses. Overall CHP system efficiencies are, in fact, high: around 75-80%.

Small, high-speed turbines (with rotor speeds of between 6000 to 15 000 rpm) are the most suitable for CHP plants. By designing a small turbine to run at high speed it can be induced to provide the same power output as a larger, slower machine. Small, high-speed turbines offer benefits of size, weight, cost and operational flexibility. They're less expensive to manufacture and install. When running, small machines have lower transient thermal stresses, which arise during starting, stopping and load changes. As a result they are much quicker to start and load. This is an important factor in CHP plants, because steam availability and inlet conditions may vary widely and rapidly.

The later stages in a multi-stage turbine operate at much higher temperatures and pressures than turbines used in conventional power stations. This is, again, because of the requirement to provide hot water to the district heating system. As a consequence the steam, towards the low pressure end of a CHP turbine, is much dryer. This significantly reduces the possibility of problems with metal corrosion, from water droplets.

Peter Brotherhood has also now won another contract to supply a steam turbine to a Danish CHP plant, this time in Frederikshavn. The plant will burn industrial, municipal and commercial refuse to raise steam in a boiler. The steam will drive a condensing turbo-alternator from Peter Brotherhood, which can generate up to 3MW of electricity. Cooling water from the turbine condenser, typically at temperatures of between 80 to 90°C, will be pumped into the district heating pipe network. The new plant will provide approximately 30% of Frederikshavn's maximum heating requirements. ❑

Distribution pipe systems for community heating

When district heating was introduced into the UK in the 1950s, the heating water was distributed in pipe systems that were badly manufactured and poorly insulated, with the result that a large number of the installed systems were abandoned by the 1970s.

Since the middle of the 1970s, there has been renewed interest in providing heating for domestic and commercial premises from central sources because of the improved efficiency in the use of energy and because of benefits to the environment.

This renewed interest coincided with considerable improvements in the manufacture and installation of pre-insulated pipe distribution systems and these improvements have been enhanced by:

- national and European standards for pipe systems manufacture and installation, with British Standard EN 253 published, and eight or nine further standards to follow to cover complete pipe systems;
- electronic fault location systems capable of detecting the ingress of moisture into the polyurethane foam insulation. These systems enable the position of the fault to be detected within one or two metres and for repairs to be made to the pipe system without the steel pipe corroding;
- Quality Assurance Certificate to International Standards to ensure the quality of pipe system manufacture and installation. The latter is of particular importance as it has been recognised that most of the faults in earlier systems were produced by lack of knowledge and control at the installation stage;
- service/maintenance agreements that are provided by the pipe system supplier and installer in order that the responsibility for the maintenance of the system is removed from the system owner for up to 15 years;
- training of the installers and operators of pre-insulated pipe distribution systems for community heating forms an essential part of incorporating in the advances that have been made in the last 20 years.

The owners and operators of community heating distribution networks can now look forward to at least 30 years, and probably 50 years, of trouble-free operation.

Not just a lot of hot air

*by Joe Knowles**

Although by no means a new technology, CHP has come into its own in recent years, with the renewed awareness of the need for energy efficiency. Biddle Air Systems have recently entered the CHP market, with a new slant to the approach of combined heat and power.

COMBINED heat and power (CHP) is a much older technology than many people think. Since the industrial revolution, progressive manufacturers have sought means of improving their efficiency, and using waste heat from the production of mechanical power was a sensible option in the self-contained factories of the 19th century.

With the widespread introduction of electric power, and ultimately the ready availability of this source of energy through the National Grid, all but the largest industrial complexes abandoned their independence and hence the opportunity for high energy efficiency. The 'bigger is beautiful' syndrome in power station development in the 1950s and 1960s, together with low energy prices and lack of environmental awareness, has left us with a legacy of inefficient energy use.

In 1993 the average thermal efficiency of installed power generating equipment in the UK was 29.4%. The other 70.6% of the fuel energy, plus transmission losses, goes directly to atmosphere. Small-scale CHP has proved that moving the point of consumption, ie, into the building or industrial plant, is enormously beneficial to the environment and to the profitability of the user.

With great foresight, nearly three-quarters of a century ago, Oscar Faber, then an emergent structural design engineer with no knowledge of building services, but with qualifications in electrical engineering, designed what must be considered one of the earliest CHP systems for the redevelopment of the Bank of England in Threadneedle Street.

In the mid-1920s before the national grid was established, power cuts were an all too frequent occurrence. There was also civil unrest which led Oscar Faber to persuade his client to install a power-generating station in the Bank's basement.

Oscar Faber took the design a stage further by using the waste heat from the diesel cooling system and engine exhaust gases, to create hot water for the building's heating system, thus providing both power and heat from one source.

Although this new approach to power and heat supply proved both practical and economic, its wider application lay dormant throughout the decades of cheap energy that followed, until the first Gulf oil crises in the early 1970s. Even then only industrial, large-scale schemes were considered practical and viable; equipment and systems for small-scale schemes still required many years of development.

Most large-scale CHP plant was designed around gas turbines, or larger reciprocating engines, and were generally multi-megawatt systems. The majority are designed to produce steam in waste heat boilers for process heating in, for example, the petrochemical and paper manufacturing industries. A few include back-pressure steam turbines with the exhaust low-pressure steam being used for process heat, and are early examples of the modern combined cycle gas turbine (CCGT) systems.

Small-scale CHP

It was not until the early 1980s, several energy crises later, that small-scale CHP systems began to appear, bringing the benefits of locally produced power and heat to individual buildings, such as sports halls, leisure centres, hotels, hospitals and factories.

Like their larger-scale counterparts. these small-scale CHP units produced impressive results, improving energy performance dramatically compared to conventional energy sources; giving a thermal efficiency of about 80%, maintaining electricity generation efficiency at about 30% and recovering up to 50% of the fuel energy in the form of low-pressure hot water (LPHW). Being designed to serve individual buildings, some with base load electricity demands less than 50 kW, these systems could be configured to give security as well as economy.

Now, in the environmentally conscious 1990s, a further major advance in thermal efficiency of CHP systems has been achieved. At the same time, combined heat and power has become a feasible proposition for a wider range of building types, most of which would previously have been considered inappropriate applications for CHP.

Responsible for all of this is a unique product, known as 'air CHP', designed and manufactured by a leading British heating and air conditioning company, Biddle Air Systems Ltd.

As its name suggests, air CHP is an air heating system, and it has been developed through the integration of three well established technologies in a uniquely beneficial arrangement. Biddle has married its applications knowledge of air handling equipment and building energy management systems (BEMS), to the power generation equipment familiar in existing CHP systems.

In its simplest form, air CHP incorporates the power generating equipment in the return air section of a push-pull air handling unit. The building return air and the required minimum fresh air are mixed at this point and drawn forward through the unit. They therefore collect radiated heat energy from the engine and generator surfaces, oil cooler and other uninsulated hot surfaces.

Immediately downstream of the engine are two simple airstream mounted heat exchangers. One of these is connected to the engine jacket water system and passes all of the system heat to the airstream. The other is connected to the exhaust system and extracts the major portion of the exhaust gas energy leaving the engine, passing this directly to the airstream. Final routing of the exhaust system is towards the fresh air inlet to ensure exposure to the coldest air, thereby maximising heat recovery.

Having collected the waste heat from the power generation process, conventional air

Technical Director, Biddle Air Systems

conditioning hardware is used to transport it back to the buildings heating and ventilating system. The system employs two fans, one each for extract and supply, and between these fans is a three-way mixing box. The purpose of the mixing box is to temper the air returning to the building by introducing more fresh air. At the same time, any excess of heated air can be ejected from the system. Air filtration, cooling and humidification systems are provided as required by the building system.

The result of this, the company claims, is a gross thermal efficiency of 95% for air CHP at peak output. This efficiency has been exceeded on the development prototype air CHP system, which has now been operational for three heating seasons. The prototype can achieve 97% energy conversion efficiency at full load using only two heat exchangers. The effect of reducing engine load, ie, generated electricity is, surprisingly, to increase further the total energy efficiency of the system.

Such high efficiencies are only achievable by condensing the water vapour content of the products of combustion. By ensuring that the coldest air entering the system leaving the air CHP unit, more than 50% of the latent heat is recovered into the ventilating airstream.

In common with other types of CHP, environmentally, air CHP is good news, saving up to 50% on both CO_2 and heat emissions compared to conventional coal-fired power and heat sources.

Control range

Flexibility is a major attribute of the air CHP system, and manifests itself in a number of ways. Control of recovered heat is an integral feature of the system. Any unwanted hot air can be ejected and replaced by ambient air, giving precise control of the building air temperature. The control range is 0-100%, therefore the air CHP system can generate power even if there is no heat requirement. A further major advantage of using air CHP is that, because the ambient air source and not the heat source is modulated, a larger portion of the air returning to the building is fresh air, which potentially reduces the likelihood of sick building syndrome.

About 25% of the fuel energy is transferred to the air via the engine jacket water system. Hot water is an easily transportable fluid, therefore to export to other locally situated heat emitting devices is practical. Alternatively, if wider export of this portion of the energy is desirable, then the water heat can be simply converted into LPHW through the addition of a three-port valve and one inexpensive heat exchanger.

Several options exist for the sizing of air CHP. Because of the ease with which the heat can be controlled, it is practical to rate the plant against the peak heat load for the building. If the electrical output available is then around the base load for the building, an ideal match has been achieved.

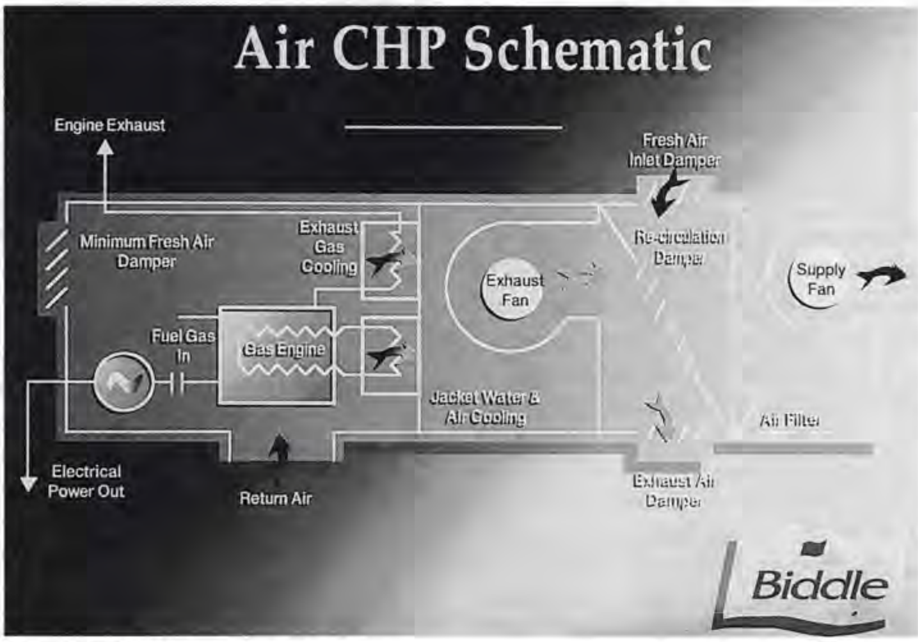


Fig 1: Biddle Air System's air CHP design.

Occasionally, the peak electrical and heat loads are in the correct ratio, allowing the air CHP system to be sized for 'island mode' operation. It is unlikely, however, that the peak heat and power demands on a building are often concurrent. Biddle have overcome the problem of lower heat output at part engine load by installing top-up electric heating batteries in the system, which only operate when the heat demand exceeds what is available from the engine heat rejection. For each kilowatt of electric heating switched in, approximately three kilowatts of air heating is obtained and the plant operates at better than 95% total efficiency.

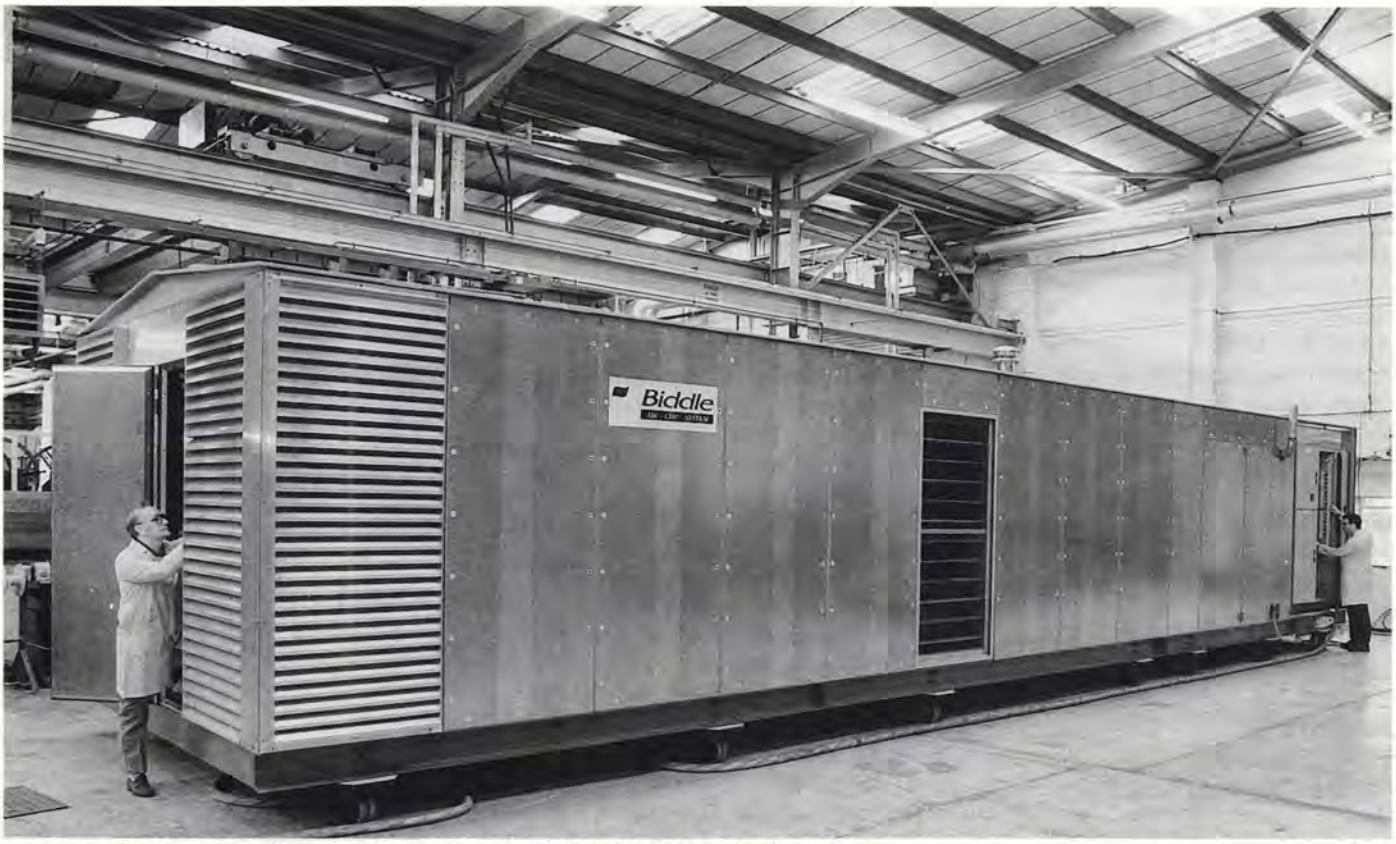
Parallel connection of private generating plant with the national grid requires compliance with G59 to ensure protection of both the private and national systems. Because of the practicality of more closely relating air CHP systems to the total energy needs of the building, the possibility of using the simpler 'alternative connection' option exists. If the power generation can be split between two or more engines, then no connection to the mains power supply may be necessary, allowing true island mode operation.

Biddle has also taken a fresh look at the service and maintenance aspects of its air CHP unit, and the gas engine in particular. Off-site monitoring is provided via a modem integrated with the BEMS-based control system. It was important to Biddle that they should be able to use popular BEMS systems hardware and software to control and monitor air CHP, as this is immediately beneficial to both the company and its customers.

The gas engine is at the heart of any small-scale CHP system, and its condition is vital to long-term reliability and availability of the CHP system. It is a tall order to expect an internal combustion engine to operate on load continuously for long periods, to stop and start on demand, and to do so without constant or even frequent attendance. To help achieve targets for reliability, engine manufacturers rate outputs very conservatively and take relevant measures in the design of engine components and sub-systems to improve service life.

CHP system manufacturers, through remote monitoring, trend analysis, oil sampling and efficient service and maintenance routines, are able to ensure high availability and long engine life in service.

Biddle have taken the next major step in improving engine reliability and life and reducing the outage time required for routine service. The life and reducing the outage time required for routine service. The life blood of the engine is the lubricating oil circulating constantly to all the moving (and wearing) parts of the engine. Because of the dryness of the natural gas fuel, the oil in a gas engine has to work harder, particularly in the hot upper cylinder areas. Oxidation rates are high and generally an oil change is required every 500 to 1000 operating hours. Engine manufacturers have a limited ability to affect this by increasing sump size. CHP system manufactured provide make-up oil systems for automatic replenishment of oil consumed by the engine and therefore could do much. Biddle's solution is simple. By introducing an external oil circulation sys-



Biddle engineers complete the company's first commercial unit at their Nuneaton factory.

tem, the stored oil from the make-up system can be continuously available to the engine. This bulk oil will oxidise very slowly and ensures that the condition of the working oil in the sump is of best quality over the whole operating life of the engine. Oil changes are don on line and less frequently.

Development and innovation is continuous at Biddle Air Systems Ltd and the next step forward for air CHP has already been taken with the integration of an absorption refrigeration system with the prototype air CHP unit to provide the potential for year-round air conditioning.

Existing CHP driven absorption machines rely on the elevation of the engine water jacket temperature and pressure to achieve a sufficiently high temperature in the absorption system boiler. Working at the threshold of these conflicting processes, the high engine water temperature is detrimental to long term operation and the pressures require higher integrity engine seals and connections, whilst the boiler of the absorption machine is oversized to deal with the low level heat input, and has a relatively low tolerance of variations in the input temperature.

The Biddle system uses only high grade exhaust heat to drive the absorption machine, keeping engine water temperatures low to maximise engine life, and providing cooling over a wide range of engine duty. Absorption output can be boosted by supplementary gas firing, or additional top up cooling can be provided by conventional vapour compression refrigeration. Commercial availability of the cooling systems is still 12-18 months in the future, but the additional flexibility that absorption refrigeration adds to air CHP will further widen the scope for application of the technology.

When discussing the application of their product, the company are careful to point out the air CHP should not be considered as an alternative to existing CHP systems. In general, the type of building which benefits from small-scale CHP designs, based on a wet heating system, would be unsuitable for air CHP.

If you consider all buildings to be one or only two generic types, then there are those made up of many little boxes and those which predominantly comprise one or more larger boxes or spaces.

CHP systems which provide only hot water serve the former admirably. These buildings are hotels, hospitals, offices, prisons, halls of residence, etc. The latter type, buildings comprising large ventilated spaces, such as supermarkets, leisure centres, sports halls, airports, factories and warehouses would generally be considered unsuitable for water heating via CHP, but are perfect applications for air CHP.

The first commercial air CHP units are being delivered to one of the major food retailers for a new supermarket, and for a large parcel processing and distribution centre.

Biddle offers a range of unit sizes from 45 kWe up to about 500 kWe, though any output can be satisfied by a number of units operating in parallel. The flexibility of the system allows Biddle to offer a wide variety of configurations to suit the needs of individual buildings. The largest units are shipped in sections designed for ease of assembly on site.

The equipment is designed for installation outdoors, freeing internal space for other uses. Roof-top installation is ideal, but due to the weight of the air CHP unit may be impractical for some existing buildings. On most buildings, however, installation in a plant room is an available option. In all cases, the casework construction of the unit ensures high acoustic and thermal insulation integrity. As the air CHP unit produces little additional noise compared to the heating and ventilating systems it displaces, environmental noise attenuation is simple.

Air combined heat and power is a simple concept. It is, however, a new idea, developed and brought to market by a British manufacturer. The invention has been registered and both British and International patent applications are pending.

In summary, air CHP is a unique product which is destined to address an entirely new and diverse market for CHP. It provides exceptional benefits through high efficiency and operating flexibility, thereby maximising the energy cost savings to the user. ❑

Institute of Energy branch meetings

London & Home Counties

17 March 1994
Developments in the UK Gas Market
Dr M B Morrison of Caminus Energy Ltd
At the Royal Institution, tea at 5 pm, AGM at 5.30 pm, talk at 6 pm.

April/May 1994
Visit to Tower Bridge. Details to be confirmed. Contact Hon Secretary, A Kearsey on 0702 586893.

Midlands

14 April 1994
Modern Coal Firing Technology for Industry
A J Minchener
At the University of Aston, Senior Common Room. Commencing 7 pm.

26 April 1994
The Ellis Memorial Lecture
Peter Rost, Chairman Major Energy Users' Council
At the Staff House, University of Birmingham. Reception 11 am, lecture 12 noon. Contact Hon Secretary, David Evans on 0384 374329.

Scottish

6 April 1994
AGM and Annual Dinner at the Royal Scottish Automobile Club, Glasgow.
Full details from Hon Secretary, Dr R McElroy on 0389 65177.

South Wales & West of England

24 March 1994
AGM and Prestige Lecture
The Future of the British Coal Industry
A Horsler, Director General of Marketing, British Coal Corporation
At the Trevithick Theatre, University of Wales, Cardiff. AGM 5.30 pm, tea at 6.30 pm, lecture at 7.15 pm.
Contact Harry Hibberd on 0272 276407

22 April 1994
The 21st Idris Jones Memorial Lecture
Direct Smelting — Shaping the Iron and Steel Industry in the 21st Century
Dr R J Batterham, CRA Technological Resources, Melbourne, Australia
At Cardiff Castle (morning and lunchtime)
Contact Doug Mustoe on 0656 654070

11 May 1994
Visit to West Wales Opencast pit, Merthyr Tydfil. Attendance is limited to the first 30 applications. Contact Harry Hibberd on 0272 276407.

Yorkshire

8 March 1994
Windfarming
Angela Willis, Yorkshire Water
Joint meeting with the Institute of Petroleum at Mansion House Hotel, Boundhay, Leeds.
Commencing 7.30 pm

27 April 1994
Continued Professional Development
John Willetts
At AHED House, Ossett, Wakefield.
Commencing 2.30 pm to be followed by the AGM. Contact branch Chairman, David Penfold on 0484 429306.

North East

16 March 1994
Repairs to Offshore Pipelines
Joint meeting with the Institution of Gas Engineers. At British Gas Engineering Research Station. Commences 5.30 pm.

30 March 1994
Growing Awareness of Wind Power
Joint meeting with Tyneside Energy Managers Group. At Newcastle Breweries Hospitality Suite. Lunch 12.30 pm, meeting 1.30 pm.

11 May 1994
AGM and technical meeting
Solar Power
Joint meeting with Tyneside Energy Managers Group. At Northern Electric Training Centre. AGM at 11 am, lunch at 12.30 pm, meeting at 1.30 pm.
Contact Hon Secretary, Ian Thompson on 091 221 2000.

New Members

Fellow

John Gordon Collier, Nuclear Electric plc, Gloucester
Barry Charles Gasper, Nuclear Electric plc, Kent *(Transfer)*
John Douglas Owen, Conoco UK Ltd, London
Roger Mellor, Techcord Consulting Group, Canada *(Transfer)*
Alan Gray Rutherford, United Distillers plc, Edinburgh
Michael John Soars, NIFES Consulting Group, Birmingham *(Transfer)*

Member

John Douglas Atkinson, Sheffield Hallam University
Fereshteh Akbari Kalhor, British Gas Research Station, London
Mark Roy Benson, National Grid, Cheshire
Stanislaw Andrezej M Burek, School of Engineering, Glasgow Polytechnic
Robin Halliday Curtis, GeoScience Ltd, Falmouth
Stephen Michael Cornwell, Airoil Flaregas Ltd, Middlesex *(Transfer)*
Christopher Duckworth, NIFES Consulting Group, Birmingham
Keith Donald Ellis, British Gas Eastern, Herts
Gillian Hand-Smith, White Young Prentice Royle, Leeds *(Transfer)*
Stephen Hugh Jones, C Haswell & Partners, Birmingham *(Transfer)*
Sin Tong Lau, Enviroplace Ltd, Hong Kong
Jill Anne Lees, PowerGen, Ratcliffe-on-Soar, Notts
Colin James MacMillan, British Gas, London
Christopher John Marquand, University of Westminster, London
Alan Jamieson MacFarlane, Fife Regional Council, Fife
Christopher Kenneth Ord, Amey Facilities Management, Abingdon
John Grenville Pritchard, Nottingham County Council, Notts
William Proudfoot, AHS Emstar plc, Glasgow *(Transfer)*
Ronald George Plummer, Johnson Control Systems, Surrey
Robert Timothy Reed, Zenith Engineering Consultants, Merseyside *(Transfer)*
Robert Forbes Thomson
Mamdouh George Salameh
Paul Marsden Thorne, Snamprogetti Ltd, Basingstoke
Brian Williams, British Coal, Nottingham
Hoi Hung Wu, Hong Kong Hilton Hotel, Hong Kong

Associate Member

Alun Edward Davies, Building Services Design, South Glamorgan
Trevor Graham Fowler, DTI, London
Shaun Sanders, PowerGen plc, Nottingham
Raymond James Strudwick
Philip Newstead Radley
Stephen John Weaver, BA Estates, Leeds

Associate

Stephen Thomas Fitzsimmons
Peter Jonathan Hickey, Shell UK Downstream, London
Gwyn Rogers, National Power, S Glamorgan

Restricted appeal

"Steam Plant Calculations Manual" (second and enlarged edition) by V Ganapathy (ABCO Industries, Texas, USA). Published by Marcel Dekker Inc, New York, 440 pp, $69.75 (£47.00)

THIS BOOK is one of a series of about 90 volumes covering many practical engineering topics, including several on energy-related subjects. They are targeted on students and non-specialist engineers.

The text takes the form of questions and answers. Some of the questions are simple, requiring just a formula and calculations based on the formula while others are complicated, requiring an assumed answer and a check that the answer fits, eg, a boiler circulation estimate.

In these days of computers, the temptation, particularly when time is pressing, is to feed numbers into the machine and accept, without adequate checking, the answer provided. Little understanding of the engineering behind the calculation can be acquired in this way.

So this book, and, presumably, some of the others in the series, at least partially fill the gap. If the problem the engineer has to solve is one covered by the book, he can turn to that section and quickly check his computer answer. However the level of background information behind the formulae given differs greatly from problem to problem, often just a formula with no explanation is given, but in many cases there is a useful summary of the technical issues associated with the problem. As is only too prevalent in the academic approach there are generally no indications of the level of accuracy associated with the calculations. Some arithmetic in engineering has an accuracy of plus or minus five or ten per cent; while others (two phase pressure drop, for example) may be, at best, no better than plus or minus 20 or 30%.

The correlations used are standard ones, for example Grimison (strangely called Grimson in this volume) for cross-flow pressure loss and heat transfer. Here I would draw the author's attention to the excellent and comprehensive work on both bare and finned tubes, of Zukanskis in Lithuania, published in two volumes. On two-phase pressure loss the correlations derived from the careful work of John Thorn at Cambridge is used and the 'burn-out' correlation is that of Macbeth, who worked at Winfrith.

For users outside the United States of America, the main drawback of this book is that, even in a volume published in 1993, only the American form of British units (although the 'long' ton rather than the mre usual 'short' 2000 lb ton is used) are employed. With the rest of the world wedded to IS units, this must restrict the potential appeal of this book as well as making many of the examples more complicated than they need be.

Norman Worley

Recently published

"Britain's North-West Oil & Gas Frontier"
Published by Smith Rea Energy Analysts Ltd, Hunstead House, Nickle, Chartham, Canterbury, Kent CT4 7PL. Tel: 0227 738844; fax: 0227 738866. Price £500.00.

"Energy efficiency in schools"
Published by the Building Research Establishment as part of the EEO's Best Practice programme. Price £3.50 (plus 35p p&p). Available from BRECSU, BRE, Garston, Watford WD2 7JR. Tel: 0923 664444; fax: 0923 664099.

March 1994

Sources of Energy Information
Course, 29 March, London. Details from David DuBuisson, Science Reference and Information Service, 25 Southampton Buildings, London WC2A 1AW. Tel: 071 323 7470; fax: 071 323 7947.

April 1994

2nd European congress on economics and management of energy in industry
5-9 April, Estoril, Lisbon, Portugal. Details from ECEMEI, c/o Prof Albino Reis, Rua Gago Coutinho 185-187, 4435 Rio Tinto, Portugal. Tel: 351 2 9730747; fax: 351 2 9730746.

Fluid sealing
14th international conference, 6-8 April, Firenze, Italy. Details from Mrs Kristine Stones, Fluid Sealing, BHR Group Ltd, Cranfield, Bedford MK43 0AJ. Tel: 0234 750422; fax: 0234 750074.

Essential Management Skills for Engineers
Annual conference for young engineers, 7-9 April, Keele, UK. Details from Corinne Paine, IMechE, tel: 071 973 1297.

Industrial Air Pollution Monitoring
Short course and exhibition, 11-13 April, Leeds, UK. Details from Miss Julie Charlton, Dept of Fuel & Energy, University of Leeds, Leeds LS2 9JT. Tel: 0532 332494; fax: 0532 332511/440572.

Institute of Physics Congress
11-14 April, Brighton Metropole. Details from Lucy Bell (congress programme) 071 235 6111, ext 243; Graham Balfour (exhibition) 071 235 6111, ext 221.

Corporate Environmental Awareness
Easter school, 11-15 April, Oxford. Details from Amanda Wright, IBC Technical Services Ltd, tel: 071 637 4383; fax: 071 631 3214.

Telescon 94
1st international telecommunications energy special conference, 11-15 April, Berlin. Details from Mr F Schneider, c/o FTZ, G13, Am Kavalleriesand 3, D-W-6100 Darmstadt. Tel: +6151 83 3950; fax: 6151 83 3938.

Gas Cyclones
Continuing education course, 12-14 April, Bradford, UK. Details from Dr Ing J Svarovska, Course Director, 8 Carlton Drive, Bradford, West Yorkshire BD9 4DL. Tel/fax: 0274 546276.

Institute of Energy Annual Luncheon
13 April, Four Seasons Hotel (formerly Inn on the Park) London. Details from IoE, 18 Devonshire Street, London W1N 2AU. Tel: 071 580 7124; fax: 071 580 4420.

Nuclear energy in the 21st century — an environmental bonus
Two-day international conference, 14-15 April, Bath, UK. Details from Sarah Ashmore, IBC Technical Services Ltd, tel: 071 637 4383; fax: 071 631 3214.

Diesel particulates and NOx emissions
Course, 18-22 April, Leeds. Details from Miss Julie Charlton, Dept of Fuel & Energy, University of Leeds, Leeds LS2 9JT. Tel: 0532 332494; fax: 0532 332511/440572.

Renewable energy — its commercial exploitation
Two-day conference, 19-20 April, London. Details from Sarah Ashmore, IBC Technical Services Ltd, Gilmoora House, 57-61 Mortimer Street, London W1N 7TD, fax: 071 631 3214.

DEGREE DAYS: JANUARY 1994

Source: **Degree days direct**

These regional figures, calculated from daily outside air temperatures, provide an index of demand for space heating over the month and thus enable excessive consumption to be detected.

A well-controlled heating system should manifest a straight line relationship between monthly fuel used and the local degree-day value; any significant deviation from this 'target characteristic' is likely to signal the onset of avoidable waste (such as a stopped timeswitch or an open isolating valve).

Readers can get more information on the use of degree days from Vilnis Vesma, 17 Church Street, Newent, Glos GL18 1PU (0531-821350)