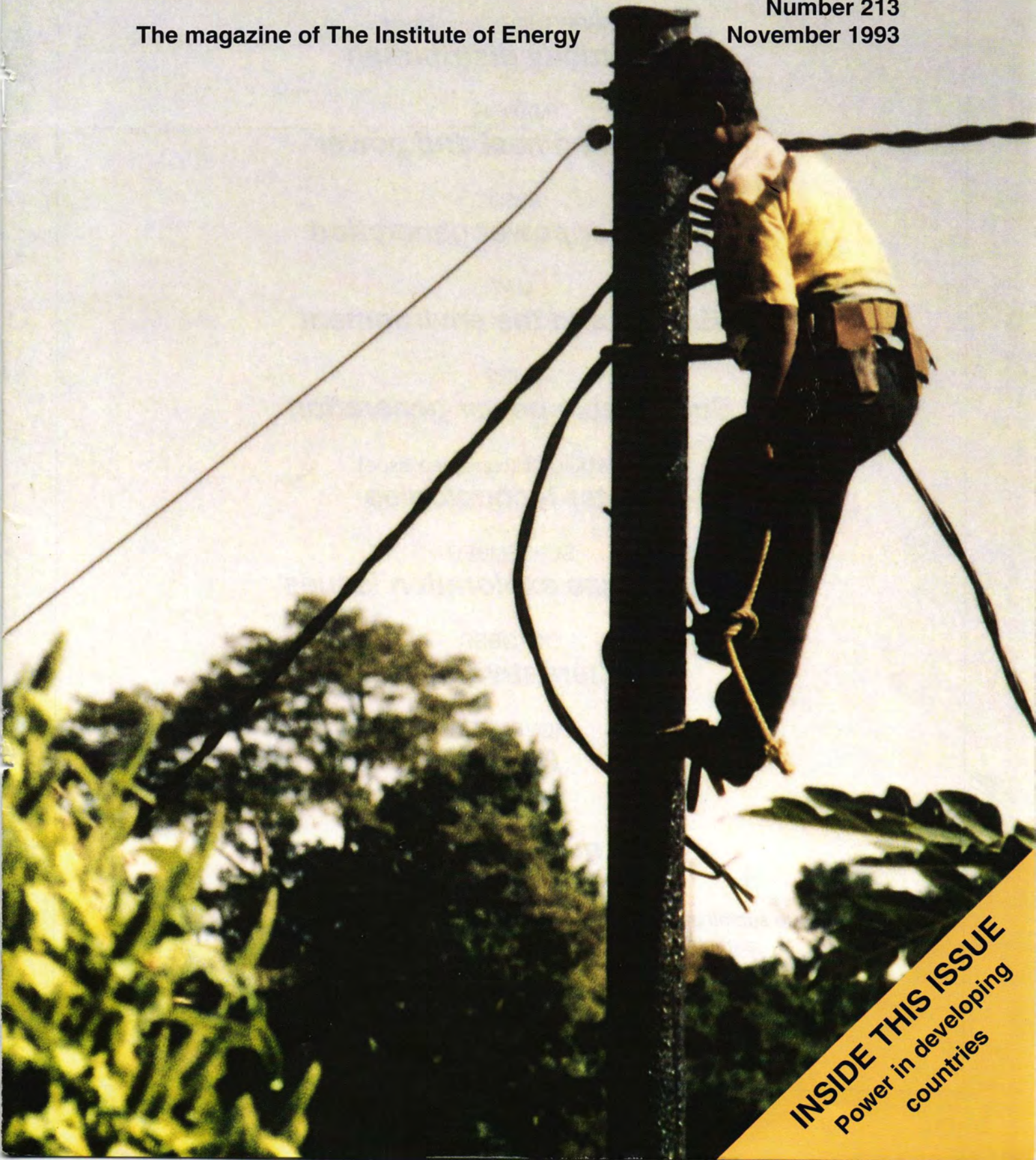


ENERGY WORLD



The magazine of The Institute of Energy

Number 213
November 1993



INSIDE THIS ISSUE
Power in developing
countries

ENERGY WORLD

The magazine of The Institute of Energy

The following feature topics are planned for 1994

JANUARY/FEBRUARY (combined issue)

Electricity distribution

MARCH

Combined heat and power

APRIL

Fuels for power generation

MAY

Energy and the environment

JUNE

Sustainable power generation

JULY/AUGUST (combined issue)

Water technologies

SEPTEMBER

Oil and gas exploration issues

OCTOBER

Alternative fuels

NOVEMBER

Boilers

DECEMBER

UK nuclear industry

If you wish to submit an article on any of the above topics, or if you wish to support a particular issue with an advertisement, please contact:

**The Editor/Advertising Manager, Energy World, H Howland Associates
The Martins, East Street, Harrietsham, Kent ME17 1HH.
Tel/fax: 0622 850100**

SWIRLING VORTEX FLOWS AND COMBUSTION SEMINAR

Organised by the Combustion Institute
Co-sponsors - Institute of Energy
Combustion Physics Group

Date: 6th January 1994

Venue: Trevithick Building, School of Engineering, University of Wales College of
Cardiff, Newport Road, Cardiff, Wales

Swirling, vortex, cyclonic flows are widely used to stabilise flames from a wide variety of different fuels, gaseous, liquid or solid and although much progress has been made on understanding the complex interaction between such flows and combustion processes there still appear to be many areas where further progress is needed and where benefit can accrue by interaction between the major groups working in this area. The UK is fortunate in having many active groups working in this area both in academia and industry thus giving the possibility of a very lively meeting. Dr Roman Weber of the IFRF will give an opening keynote address entitled "The Role of the Reverse Flow Zone in Combustion Processes".

Participants will be encouraged to bring Posters describing latest developments in this and related fields for sessions which will cover the lunch period and some of the afternoon. A buffet lunch will be served in the Common Room where the Posters are displayed to facilitate discussion of/interaction with the Poster participants. A large area will be available for Poster displays. Persons not wishing to bring posters are still encouraged to describe work in progress in the five minute afternoon session.

I wish to attend the Swirling Vortex Flows and Combustion Seminar on 6th January 1994 (Please tick appropriate box)

		<u>Cost</u>
Member of Combustion Institute	<input type="checkbox"/>	£30
Member of Institute of Energy	<input type="checkbox"/>	£30
Member of Combustion Physics Group	<input type="checkbox"/>	£30
Student/retired person	<input type="checkbox"/>	£15
Others	<input type="checkbox"/>	£36

Name:

(In Block Capitals)

Address:

.....

I enclose a cheque for £..... Please invoice me

Cheques to be made payable to UWCC and returned to Professor N Syred, School of Engineering, UWCC, P O Box 925, Newport Road, Cardiff CF2 1YF

I intend to bring a Poster for Display

I wish to make a 5 minute presentation

TIMETABLE FOR SWIRLING VORTEX FLOWS AND COMBUSTION SEMINAR

Trevithick Building, UWCC, Cardiff - 6th January 1994

- | | |
|------------|---|
| 9.30-10.20 | Registration - Coffee - Provision for mounting Posters in Common Room |
| 10.20 | Opening Remarks - Professor N Syred |
| 10.25 | Dr R Weber, IFRF, The Netherlands - "The Role of the Reverse Flow Zone in Combustion Processes" |
| 10.55 | Discussion |
| 11.00 | Prof F Lockwood, ICST - "Studies of Flame Stability and Blow Off" |
| 11.20 | Discussion |
| 11.25 | Prof J Swithenbank, Sheffield University - "Acoustic Streaming and the Travelling Tangential Wave" |
| 11.45 | Discussion |
| 11.50 | John Fuell, PowerGen - "Prediction of Swirl Burner Flows in Multiple Burner Units" |
| 12.10 | Discussion |
| 12.15 | Dr C Pridden, Rolls Royce - "Swirl Flows in Gas Turbine Combustor" |
| 12.35 | Discussion |
| 12.40 | Prof N Syred, UWCC - "Coherent Structures in Swirling and Vortex Flows and their Influence on the Combustion Process" |
| 1.00 | Discussion of all morning's papers |
| 1.10 | Lunch and Poster Display. Authors are requested to consume their Buffet Lunch and Wine next to their Posters |
| 2.30 | Five minute presentations of work reported in Posters plus other contributions |
| 3.30 | Discussion of five minute presentations |
| 4.00 | Tea and end of meeting |

ENERGY WORLD



NOVEMBER 1993

Number 213

The magazine of The Institute of Energy

Published by H Howland Associates, The Martins, East Street, Harrietsham, Kent ME17 1HH, on behalf of The Institute of Energy, 18 Devonshire Street, London W1N 2AU.
Editorial tel/fax: 0622 850100
Conferences: 071-580 0008
Administration: 071-580 7124
Membership, Education and Journal subscriptions: 071-580 0077 Fax: 071-580 4420

Editor
Johanna Fender

Advertisement sales
Harris Howland, tel: 0622 850100

Printed by Headley Brothers Ltd
The Invicta Press, Ashford, Kent

THE INSTITUTE OF ENERGY

Patron
Her Majesty The Queen

Copyright The Institute of Energy. Opinions expressed in *Energy World* are those of the authors individually and do not necessarily express the views of The Institute of Energy as a corporate body.

TERMS OF CONTROL

Energy World is circulated free of charge to all paid up members of The Institute of Energy. To libraries, organisations and persons not in membership it is available on a single subscription of £60 (UK), £70 (overseas) for 10 issues.

ISSN 0307-7942

November 1993

CONTENTS

Viewpoint 2

NEWS

International News 3
Home News 4
Commercial News 5
Institute News 20

FEATURES

Technology transfer to developing countries 6
Jyrki Antikainen

Cleaner and more efficient use of low-grade coal 10
Eur Ing H B Locke

Mongolia: renewable energy in a transitional economy 13
Anthony Derrick

Biogas: an energetic fuel for rural areas 16
Ismat Ali

The Indo-British Partnership 19
Johanna Fender

REGULARS

Book Reviews 21
Readers' Letters 22
Engineering Profession 23

DIARY

Events 24
Conferences Outside back cover

COVER

The Finnish company, IVO International, was a consultant on the Pokhara rural electrification project in Nepal. In addition the company has been selected as the consultant for the Kali Gandaki 90 MW hydropower project, also in Nepal. The company is to provide power transmission system design and consultancy services. The project involves the installation of two 50 km-long 130 kV power lines.

The Kali Gandaki project is being financed by the Asian Development Bank. For more on IVO's work in developing countries, turn to pages 6-9 of this issue.



Energy and quality of life

FOR 200 years the Industrial Revolution has been based on 'the Rights of Man'. It has been assumed that every individual has a right to all the electricity, heat and machine power that he/she can afford to live a good life with minimum physical effort.

However it is now clear that this concept of rights without duties is leading towards various troubles, because it implies that the only value system by which success in life is judged is 'the bottom line': profit, wealth and consumption.

The potentially disastrous troubles are numerous, among them a collapsing economic system as the rich get richer and the poor, poorer; and rising employment in both the rich countries and the 'less developed' countries, as machines replace humans and the resulting overproduction cannot be absorbed. These problems in turn lead to an increase in stress, nervous breakdowns, psychosomatic illnesses, alcoholism, drug taking, family break ups, stomach ulcers and heart troubles, particularly among the unemployed. Violence and war are due largely to envy of the rich and a lack of worthwhile life activities. On top of all this is the increasing destruction of the ecosphere, which will be uninhabitable in a few decades at the present rate of decline.

The only hope that our descendants in the second half of the 21st century will have a decent life is if we, the rich, can get away from our grossly extravagant habits and help the poor to have the opportunity to earn by their own efforts the essential benefits of the Industrial Revolution. Only when all parents have a decent education and security in old age can the population expansion in developing countries be halted without disaster.

We engineers have so shrunk the world that it is certain that our descendants cannot live a decent life in a fortress isolated from the less developed continents.

We can call the engineering necessary to ensure a decent life for our descendants in permanent equilibrium with the environment 'equilibrium engineering'. It has three essential conditions:

- no damaging pollutants put into the ecosphere;
- roughly equal consumption of resources by all people;
- jobs, education and healthy surroundings available for all.

What do these conditions imply as regards fuel and energy?

In 1989 the world total use of fossil carbon was about 7200 million tonnes of oil equivalent per annum (mtoe/a). It is reasonable to suppose that if mankind is to reach stable equilibrium with the ecosphere this figure must be reduced to one third, ie 2400 mtoe/a. Let us also suppose that the world population has risen by the year 2050 to 10 000 million, and that everyone has a right to an equal share of fossil fuel, to eliminate the tensions between rich and poor. This then means that each person has a right to about one quarter toe/ca. The quantity will vary a

little between cold and hot climates to allow for winter heating in the former. To this can be added as much renewable energy as can be harnessed, including any fuels grown on a sustainable basis because this makes no net contribution to CO₂. This implies that we have a duty to regard a large fraction of the fossil fuel we consume as capital which must be invested in renewable energy systems, and that the amount of fossil fuel energy available per person will be less than one tenth of that used in Europe now, with an even greater reduction in North America.

It is now quite clear that neither nuclear fission nor fusion can be used in a system which would enable humanity to live for hundreds of years in stable equilibrium with the ecosphere. They imply the accusation of huge derelict power stations, a vastly expensive distribution system which can only be justified if those few people to whom it is connected use far more than their share of electricity, and the putting into the ecosphere of radioactive isotopes which do not occur naturally, and which lodge in the human body, some of which will remain dangerously radioactive for thousands of years. *Pu* is a particularly lethal legacy to our descendants, because if a tiny particle gets into the lungs, it will eventually cause cancer. Walls contaminated with *Pu* 'become more difficult to clean over time because decay of *Pu* to Americium results in increasingly dangerous levels of gamma radiation' (*New Scientist* 11.9.93 p52).

If any politicians offered such a drastic policy of energy reduction they would lose their deposits, so we will inevitably continue towards a disastrous future until we are almost over the precipice. Only if people who see clearly the danger can spread widely the message of the one step essential to avoid the precipice, can we hope that humanity will not go right over it some time in the next century.

This one step is a restoration of a value system that judges success in life by quality rather than quantity: by creative self-fulfillment rather than energy consumption. Quality of life is indicated by one's fundamental gut feeling that one is repaying, to some limited extent, the enormous debt one has for the blessing of life. If we ignore totally this message from our conscience we have the basic guilt feeling that is the cause of all our ills.

There is much statistical evidence that the average quality of life of a group of people is related to their consumption of energy and other resources by a curve, which at first rises as they get enough for a healthy life, and then falls right down as they become besotted with affluence.

My calculations indicate that all the benefits of the industrial revolution which are essential to a life of self-fulfillment can be obtained with this ration of fossil fuel, so that it is possible for humanity to reach a long-lasting equilibrium with the ecosphere.

All that is needed is to replace the demand for human rights by the slogan 'No rights without duties'. We must return to the acceptance of responsibility for our remote descendants.

Prof M W Thring ScD FEng SFInstE



Swedish plant wins 'power station of the year' award

IN COMPETITION with nuclear power stations across the world, Sweden's Forsmark nuclear power station has won the 1993 Power Plant Award.

Forsmark is the most recent nuclear power station in Sweden. It consists of three state of the art boiling-water reactors, and was built by ASEA/ATOM. Total output is 3100MW.

The award was granted for 'years of superior availability and

safety at a nuclear station and for operation of a low-level radioactive waste storage facility.' Another decisive element was Forsmark's basic design and the low radiation exposure to personnel and the surrounding neighbourhood.

The Swedish nuclear power programme consists of twelve reactors, which between them generate 50% of Sweden's electricity.

Miskar inauguration

THE INAUGURATION of the Miskar gas field project in Tunisia took place in October at Sfax.

The development of the field is one of the largest international projects undertaken by British Gas' exploration and production division.

The ceremony was carried out by Tunisia's Minister of National Economy, Sadok Rabah and chairman of British Gas, Robert Evans.

The Miskar field was discovered in 1975, and the project's completion should enable Tunisia to become self-sufficient in the supply of natural gas. Initial production will be from a 12-well, three-platform complex, which will be connected to a processing plant by way of a subsea pipeline.

Gas from the field will be sold to the Tunisian electric power and gas distribution company, STEG.

Correction

SINCE last month's report on the 11-month study into prospects for renewables in the Commonwealth of Independent States (CIS), we have learned that a further two UK companies: Energy for Sustained Development (ESD) and Energy Resource Management (ERM) are also involved in the study.

Georgian oil venture

A JOINT venture company is to form between J P Kenny Exploration and Production (JPK Expro) and the Georgian state oil company, Gruzneft, making JPK Expro one of the most significant acreage holders in the Black Sea area.

The joint venture, the Georgian British Oil Company, will explore for and produce oil and gas in several areas of Georgia. The main exploration areas are: the majority of the off-shore Georgian area of the Black Sea, which shows good potential for oil and gas; the adjacent coastal area, which also contains several discoveries; and the 'Kartli Depression', an area to the west of the Georgian capital, Tbilisi.

Chairman of the Georgian State Committee for Foreign Economic Relations, Tengiz Gelishvili, stressed the importance of the project in making Georgia truly independent.

JPK Expro began negotiations in Georgia during 1992 and worked together with Gruzneft and the Georgian Ministry of Fuel and Energy to negotiate the terms of the 50:50 joint venture, which was discussed at the highest level in the Georgian government.

JPK Expro has been appointed the UK representative of the Georgian State Committee for Foreign Economic Relations with a view to developing bilateral trade and economic relations.

Improving solar cell efficiency

GETTING maximum efficiency from a solar cell is a key element in making solar energy a competitive major power source for the future.

An Australian university has taken a major step in that quest by creating a solar cell module which registers 20% efficiency — it converts a fifth of the sunlight reaching it into usable power — the best result achieved on a worldwide scale.

The module is the product of the University of New South Wales' (UNSW) Centre for Photovoltaic Devices and Systems, and its efficiency rate has been confirmed in independent tests by Sandia National Laboratories in the United States of America.

The centre's director, Prof Martin Green, said it was the first time the 20% level had been achieved, beating the previous best of 18.2%, also achieved by the centre.

The next step will be the development of commercial modules capable of the same output. Current modules have an efficiency rating of around just 10%.

This astounding result was achieved by 'packing' the module to a density of 98%. This meant only 2% of the module's 28cm x 28cm surface was not covered by active silicon.

Several solar cell manufacturers have licensing agreements with Unisearch, UNSW's marketing branch.

Optimism for fuel cell reliability

FUEL CELLS which can generate electricity more efficiently and cleanly than conventional systems are now showing that they can work reliably as well.

At the third Grove Fuel Cell Symposium in September, it emerged that cost is now the final hurdle. At several times the cost of a conventional system, cells will remain expensive until economies of scale can be applied.

Countries such as Japan and the USA are supporting the commercial introduction of early fuel cell systems by direct government purchase of early high cost units and direct subsidy, enabling production volumes to increase, resulting in reduced costs. Both countries confidently predict that fuel cells will become a worldwide industry before the year 2000.

No government would deny that the environment is now firmly on the agenda, and an item of growing concern. Fuel cells provide the ideal answer, as they do not burn fuel, but rather they work through an electro-chemical reaction, using fuel more efficiently.

Over the last five years, fuel cell development has accelerated to the stage that some 50MW of generating capacity is now in place, and factory capacity exists which will allow the rapid growth of the fuel cell business. Forecasts vary as to how large this business will be in the year 2000, but the most pessimistic estimates predict several hundred MW per year of manufacturing capacity by that time.

Fuel cells were invented in the UK in 1839, and the recent UK White Paper of Science, Technology and Wealth Creation suggested that the UK should be reviewing the subject.

There are many different types of fuel cell, each at a different stage of development, and each suited to a different power generating niche, from small transport applications to multi-megawatt power stations.

The third Grove Fuel Cell symposium was held in the UK in September, and was opened by Rioji Anahara, who outlined clearly how the Japanese government, together with industry, is tackling the problem in establishing a major new industry.



The largest windfarm in Cumbria (above) was opened in October by the Rt Hon Lord Wakeham, former Secretary of State for Energy. Kirkby Moor is the fourth windfarm to be commissioned by National Wind Power, and is capable of generating sufficient power to meet the needs of a community of 5000 people. The windfarm has twelve 400kW turbines. Construction work began in January, and since August the windfarm has been supplying electricity to the local grid.

HSE Sellafield study inconclusive

A REPORT published in October by the Health and Safety Executive could find no single factor capable of explaining the high incidence of leukaemias among Seascale residents.

The study did find that the excess of cancers was mainly confined to Seascale residents, however, and particularly to the

children of fathers who commenced work at Sellafield before 1965.

The investigation also concluded that there is no need for preventative action, beyond the measures already in place, as there has been a significant reduction of dose levels since the 1960s. Report available from HSE Books, on 0787 881165.

Local energy advice centres

THIRTY regional Local Energy Advice Centres are to be set up by the Energy Savings Trust in the form of a pilot scheme.

The centres will aim to give free advice and information on saving energy to householders and small businesses in their area.

Running initially for a three-year period, the pilot scheme was launched to coincide with the Government's 'Helping the Earth Week', which ran from 23-30 October.

The centres will receive 50% of their funding from the Energy Efficiency Office, with most of the additional funding coming from local authorities. Nine or 10 of the LEACs will be directly sponsored by the relevant local authority, with about a third receiving their sponsorship from independent sources.

No support for UK policy

A SIGNIFICANT percentage of the UK population disagree with a number of the key issues in the UK's energy policy, according to a report published in October.

Research carried out by Gallup shows 70% thought the imposition of VAT on domestic fuel was wrong, with only 4% agreeing with the policy. Nor did the Government's claim that it was a 'green' tax hold water: only 12% believed it would reduce consumption, thereby benefiting the environment.

53% opposed the pit closures, with just 3% believing more mines should have closed. Only 16% believed that coal should be privatised to make mines more profitable, reducing the price of coal. While 42% felt that having a strong coal industry was important to the UK economy.

Minister announces Energy Advisory Panel

ENERGY Minister, Tim Eggar, announced the membership of the Government's new Energy Advisory Panel at the end of October.

The panel was set up following the coal review to advise on the information to be contained in the Government's annual Energy Report. The first report is due to be published mid 1994.

Chairman of the panel will be Martin Holdgate, currently director general of the International Union for Conservation of Nature and Natural Resources, and formerly chief environment scientist at the Department of the Environment. He was also recently chairman of the Renewable Energy Advisory Group (REAG).

Members of the new panel are: Dr Mary Archer, chairman of the National Energy Foundation and formerly a member of REAG; and Ron Campbell, former managing director of Babcock Energy and director of the Nuclear Power Group, now a consultant. He was a member of the former Advisory Council on

Energy Research and Development (ACORD) and of the NII's Advisory Council.

Tony Cooper, general secretary of the Engineers' and Managers' Association, and Nigel Evans, managing director of Caminus Energy Ltd and a former member of ACORD will be members, as will David Green, director of the CHPA; Dieter Helm of Oxford Economic Research Association; Peter Ibbotson, Sainsbury's plc; Sam Laidlaw, managing director of Amerada Hess (UK) Ltd; Mike Parker, a consultant and former director of economics with British Coal; Paul Rich, managing director of Allied Steel and Wire; Lynda Rouse, director of the Public Sector Unit of Barclays de Zoete Wedd Ltd; Ann Scully, vice-chairman of the National Consumers Council and chairman of the Domestic Coal Consumers' Council; Anthony White of National Grid Company, and last but by no means least, Professor Alan Williams of University of Leeds, Department of Fuel and Energy.



A half-day seminar organised by BRECSU on 25 October helped to launch the Department of the Environment's 'Helping the Earth begins at Home' campaign. Hosted by BBC's Judith Hann, the seminar was addressed by Minister of State for the Environment, Tim Yeo (pictured above right with John Hobson, director general of the Energy Efficiency Office (EEO)), who attacked those who took an apathetic or ignorant attitude towards energy efficiency. He told the audience that the Government had carried out a successful demonstration scheme for council housing refurbishment, known as the Green House Programme. The lessons learnt are being promoted alongside the Energy Efficiency Office's Best Practice Programme, as the basis for energy efficiency measures in the Housing Investment Programme. The Minister said the Department was working to improve on the thermal insulation standards in Building Regulations by a further 25-35%.



Datum Solutions introduce new bill checking system

A NEW business unit of The National Grid Company, Datum Solutions, has just announced the introduction of its new electricity bill checking software: 'FathoM BCM' — the first module in its bill management system.

FathoM BCM will prove invaluable to energy managers of large power users when, as of 1 April 1994, the second tier contracts come into force.

From 1 April, companies with a power demand in excess of 100kW will be able to negotiate individual contracts with their chosen supplier. FathoM BCM is able to calculate independently electricity bills with up to 48 individual contracts, allowing companies with more than one site to validate bills remotely on a single system at head office.

The system also provides a detailed analysis of the electricity costs at the various contracts, in either graphical or tabular form. These can then be compared with electricity bills to identify any

discrepancies.

The software can run on any 386 or 486 IBM compatible PC. The power usage information can be entered into the system in one of two ways. First, a company can obtain its historic electricity usage information relating to the bill on a floppy disc from their supplier. Second, Datum Solutions can connect the company's electricity meters with the PC running FathoM BCM by using its PCAN data collection system, allowing the information to be received in real time.

Any existing meter providing a pulsed output can be connected to the PCAN remote data collector. Information from the meters is transmitted via the public switched telephone network or private network, to the central data collector.

For further information contact Colin Fisher, Datum Solutions, NGC plc, Technology Services Centre, Littlebrook Manor Way, Dartford, Kent DA1 5PS.

Joint venture to build Moroccan plant

THE NATIONAL electricity companies of Morocco, Spain and France signed a deal in October to create a joint venture electricity production company.

The company will be responsible for the construction of a 400MW combined cycle gas turbine power station at Kenitra, Morocco.

Due to be commissioned in 1997, the plant represents an investment of around 2 billion French francs, and is part of an overall plan to ensure a quality electricity service in Morocco, and eventually to interconnect the electricity networks of Europe and the Magreb.

The agreement was signed by the managing directors of the Moroccan National Office, ENDESA in Spain and Electricite de France.

Malaysia revisited

A TURNKEY gas turbine power plant is being built in Malaysia by Siemens AG. The new plant, with a total capacity of 405 MW is to be erected in Serdang, 50 km south west of Kuala Lumpur.

This represents the second plant order for Siemens from Malaysia.

The new plant will be equipped with three 135 MW gas turbine generators, manufactured by Siemens in Berlin and Mulheim. The order, already placed in the form of a letter of acceptance received from the Malaysian utility Tenaga Nasional Berhad in February 1993 has since been signed.

To meet the rapidly increasing power demand in Malaysia, the first gas turbine generator is to start feeding power into the nation's grid in March 1994. Hand over for the entire plant is scheduled for June 1994.



A 4MW power station has been installed in the Chinese municipality of Baoan in Lung Gang, Guangdong Province to provide essential baseload operation for the region's power supply bureau of local government. The area has been designated an important production area, needing a continuous, reliable power supply — both for existing factories and to attract new businesses.

Diesel-powered baseload power stations have proved popular with the Chinese authorities over recent years, in a region that can experience up to four days of power cuts a week during the summer months. The Lung Gang installation currently operates up to 16 hours a day, six days a week, using five Petbrow generating sets from the UK. As load demand decreases towards the end of each factory shift, sets can be switched manually out of the system and back on to load as demand increases. The sets were commissioned in May 1993.

Two contracts for Kvaerner

CONTRACTS worth a total of US\$28 million have been placed with Norwegian and UK subsidiaries of the Kvaerner group by customers in Uganda and Indonesia.

Kvaerner Energy in Oslo is to deliver two Kaplan turbines to the Uganda Electric Board at Owen Falls, while its UK subsidiary Kvaerner Boving in Doncaster will supply hydro equipment to Sumatra.

A letter of intent has been signed for the Ugandan order, and is due to be finalised this month. Delivery will be financed by Norway's Norad aid agency, via the World Bank, with the administrative support of the Norwegian Trade Council.

Located at the point where Lake Victoria drains into the headwaters of the Nile, the new power station will have a generating capacity of about 380MW, and is due to come on line in November 1997.

The Kvaerner Boving delivery to Kotapanjang is of three 40MW Kaplan turbines.

S Korea goes for natural gas

CONCERN for the environment, along with increasingly stringent fossil fuel emission regulations are encouraging the wider use of natural gas for power generation in developing countries.

The installation of a \$70 million power plant by GE Power Systems of the US at Korea Electric Power Corporation's Pyongtaek plant in central South Korea is a recent example.

The project is being carried out in two phases. The first calls for the plant to operate initially as a simple cycle power plant, with the second phase comprising the upgrading to a combined cycle plant by mid 1994.

The first phase will provide 334MW, while the combined cycle phase, with natural gas as the fuel source, will produce 500MW.

GE Power Systems is responsible for the conceptual plant, design, equipment supply, project management and technical supervisory services, as well as supplying four MS7001 (EA) gas turbines, each rated at 83.5MW.



Technology transfer to developing countries

by Jyrki Antikainen*

FINLAND'S largest supplier of electricity, Imana Voima Oy (IVO), has recently undergone a fundamental restructuring of its core activities. Since it was founded in 1932, IVO has acquired a vast store of experience in many aspects of energy — from power generation to transmission.

As part of the recent restructuring, IVO Energy Ventures was established in May 1992 to undertake projects overseas, a number of which are in developing countries.

A 66 MW hydro electric plant is being built at Pangani Falls in north-east Tanzania, to help meet the country's urgent need for more generating capacity. It is being funded by Finland, Norway and Sweden and will cost around US\$125 million. Construction began in late 1991 and it is scheduled for commissioning in January 1995.

Demand for electricity in Tanzania has been growing by between 6% and 13% annually in recent years, so the Tanzania Electric Supply Company (Tanesco) has adopted a policy of developing the country's hydro resources.

To satisfy the increasing demand, two potential projects were identified: Pangani Falls and Kihansi. A feasibility study carried out by the consultant IVO-Norplan between August 1989 and November 1990 concluded that the development of Pangani Falls was the fastest way to increase hydro capacity.

Pangani Falls will add 66 MW to the country's existing 330 MW of hydro-based generating capacity.

Pangani Falls is located on the Pangani River in north-east Tanzania, about 60 km south west of the coastal town of Tanga. The Pangani River originates from the slopes of Mount Kilimanjaro and Mount Meru. From there it flows south-south-east for about 350 km to Pangani Falls, and then to the

Finnish utility Imana Voima Oy (IVO), which has recently been completed restructured, has in the past few years turned its attention to technology transfer to developing countries. So thorough is the company in its approach that they have produced studies of the social and economic impacts of proposed projects before commencement. The following article describes several of their projects to date.

Indian Ocean.

Tanzania's first hydro electric plant was constructed at Pangani Falls in 1934. Four of its original five GEC units are still operating, generating about 15 MW. Upstream of Pangani Falls there are three further hydro plants: Hale (21 MW, commissioned in 1964); Nyumba ya Mungu (8 MW, 1969) and Kikuletwa (1.2 MW, 1935).

To pay for the new plant, development aid has been made available by Norad, Finnida and Sida, the international development agencies of Norway, Finland and Sweden respectively. Norad is contributing 42% of the cost, Finnida 33% and Sida 25%.

The project includes the construction of a new underground power plant utilising the total available head of 170 m, giving a maximum generating capacity of 66 MW and an average annual output of 367 GWh, of which 313 GWh is expected to be a firm power under drought conditions. It will also include the construction of a new 58 km-long 132 kV transmission line from Hale to Tanga, including extension of the Hale and Tanga substations, and an 8 km-long double-circuit 132 kV line between Pangani Falls and Songa, to connect the new plant to the Hale-Tanga transmission line. The project will require the building of a new 10 km-long access road from Hale to Pangani Falls, and a camp with about 30 houses at Hale to accommodate the expatriate personnel.

The donors attached several preconditions to the financing package, including more effective water management in the Pangani River. Tanesco is to increase tariffs to reflect

the true cost of generating power, and the Tanzanian government is to make foreign currency available for the purchase of spare parts.

IVO-Norplan, the consultancy company that carried out the feasibility study, is a joint venture, formed in 1989 by IVO International and Norplan A/S of Norway. The company has also been appointed as the engineer for the client Tanesco, and is responsible for all aspects of project supervision. Engineering companies from Norway, Finland and Sweden are carrying out most of the work, using local labour where possible.

The estimated cost of the project is \$100 million at June 1991 prices, of which \$90 million is for the power plant; the rest for the transmission line, water management, community development and training projects. A budget of \$125 million has therefore been set, to allow for price escalation during the construction period.

The contracts associated with the power plant are divided between the donors. The civil engineering work, with a contract value of \$35 million, goes to Noremco of Norway, Lemminkainen of Finland and a Swedish contractor. \$26 million of electrical work goes to ABB Power Generation of Sweden, EB Power Generation of Norway and ABB Stromberg Distribution Ltd of Finland. Mechanical equipment will be provided by Kvaerner, Norway.

For the transmission line, Tanesco itself is carrying out the work. The equipment and materials, valued at around \$7.5 million, are being supplied from Finland and the work is being supervised by IVO-Norplan. The IVO-Norplan staff involved in this part of the project are in fact mainly from IVO, as the company has considerable experience of power transmission and its staff have worked on other similar projects in Africa.

Consultancy services for both the power plant and transmission line projects will cost a total of \$16 million and are being provided by IVO-Norplan.

Throughout the project, it is intended that the division of contract values between the three donor countries should be in proportion to their financial contributions.

The plant will feature an earth-fill dam, creating a reservoir with an area of around 800 000 m² and an effective storage capacity

*Communications Manager,
IVO Group



Tanzania: engineering companies from Norway, Finland and Sweden carry out the work using local labour where possible.

of 400 000 m³ between high and low levels. The creation of the reservoir will have very little environmental impact, because most of the area already floods during the rainy season.

From the reservoir, a headrace tunnel will direct water to the underground turbine hall. The tailrace tunnel will then deliver it back to the Pangani River. One effect of the project will be that water flow in the river between the dam and the tailrace tunnel outlet will be reduced to almost nil, except under flood conditions. The old power plant will thus be effectively by-passed, so will only be used when there is sufficient flow.

Water resources have to be carefully managed in Tanzania, because the country depends so heavily on hydro power. In recent years, when low summer rainfall has led to reduced water levels in the reservoirs, considerable load shedding has been necessary. For instance, under normal summer drought conditions, hydro electric capacity would be reduced from 330 MW to 300 MW. However, during 1992 the reservoirs were so low that load shedding of up to 130 MW was imposed.

During the feasibility study, the potential problem of lack of water at Pangani was identified. Thus, as a precondition for financing, the donors stipulated that a water management scheme be introduced.

The Pangani Basin Water Office (PBWO) was therefore established on 1 July 1991, to monitor and regulate water use in the Pangani Basin, which covers an area of about 42 000 km² upstream of Pangani Falls.

In recent years, there has been a steady increase in upstream abstraction. Until 1991, water rights were granted by the authorities in individual regions upstream of Pangani Falls, with no consideration for the downstream

effects.

The officially documented upstream abstractions, of which there are around 750, amount to a total of 20 m³/second. Many of these users draw more water than their permits allow and in addition, there are up to 1500 'traditional furrows', bringing the total abstracted to an estimated 35-40 m³/second. This is around half the total flow into the Pangani Basin.

To achieve the design output of 66 MW from the new power station, a flowrate of 45 m³/second is required, so a water regulation system was needed to ensure that the output of the plant will not be affected by upstream abstractions.

The PBWO will monitor water usage, and wants to introduce a water user fee, to enable it to become self financing. It is planned that any excess revenue will be used to renovate water diversion structures and construct control gates. The experience at Pangani is likely to lead to similar water management schemes being set up elsewhere and Tanesco staff are now looking at the Pangani Basin Water Project to assess its suitability for use at other sites.

A new 58 km-long single-circuit 132 kV line is being built from Hale to Tanga and the substations are being extended. This part of the project comprises 200 galvanised lattice steel towers. Similar towers have been used for the double-circuit 132 kV line from Pangani to Songa.

Expatriate engineers are employed to advise the local staff at Pangani Falls. Part of their role is to train the local staff who will take over plant management after the commissioning period. For operation and maintenance particularly, a number of programmes have been set up to ensure that local staff

acquire the necessary skills.

The project is expected to encourage economic growth and improve industrial productivity in Tanzania, by increasing the amount of reliable power available. In particular it will enable the cement factory in Tanga to increase its output, which will help both the local economy and the construction industry throughout the country.

The total potential of hydro power in Tanzania is estimated at around 4000 MW. In the medium term there are plans to build a hydro plant at Kihansi. This would have a capacity of 165 MW and would be operational by 1998. If it goes ahead, the leading financier for the project will be the World Bank, which will provide around half of the estimated \$200 million needed. Tanesco is currently seeking other participants to provide either bilateral funding or joint funding with the World Bank.

Power lines in Ethiopia

IVO International has carried out several power transmission projects for the Ethiopian Electric Light and Power Authority (EELPA), the country's national power company. The latest is the Wolaita Sodo to Arba Minch 132 kV transmission line.

The projects are extending the country's interconnected power transmission system, enabling expensive and unreliable diesel generating capacity to be replaced by indigenous hydro power. As well as providing a more reliable supply, this is helping to reduce Ethiopia's dependence on imported oil.

Since 1985, over 400 km of 132 kV lines have been erected, complete with joining transformer stations. This work was carried out in phases, and included lines from Alaba to Gilgel Gibe via Hosaina, Gilgel Gibe to Agaro via Jimma, Agaro to Bedele, and now Wolaita Sodo to Arba Minch.

In each case, EELPA bore the main responsibility for all the site works, inland transportation and import procedures for the materials and equipment, while IVO was responsible for detailed design of the installations, foreign material and equipment procurement, site supervision, commissioning and overall project management.

IVO also helped finance the project by arranging concessional financing for EELPA. The money was loaned by Finnish Export Credit Ltd, with the interest covered by the Finnish International Development agency.

The Wolaita Sodo to Arba Minch project included installation of a 109 km-long, 132 kV line. This replaced an existing 66 kV line that couldn't supply sufficient power to meet the estimated needs of a new textile factory at Arba Minch.

The factory will employ 1500 people and process around 4000 tonnes of cotton per year, about a third of which will come from



the Arba Minch area. A reliable power supply is vital because the factory will make an important economic contribution to the whole Arba Minch area. The new line has been supplying power to the site during construction of the factory, and consumption will be around 6 MW when the factory is fully operational.

The route of the new line is in the Rift Valley region, around 400 km south of Addis Ababa, the Ethiopian capital. The terrain in the area is mostly rolling hills with some small forests, and ranges from 1100 to 2000 metres above sea level. The route crosses a mountain ridge and the Amessa river, and it was decided that the power line would follow an existing road to allow easier access for traffic, both during construction and for maintenance in the future.

The site survey was carried out in December 1988 by an IVO expert, working with an EELPA survey team. The line was designed on site, so that any checks could be made easily, and the drawings were subsequently finalised in Addis Ababa. The tower lists were completed in May 1989 and sent to IVO's head office in Finland, where the electrical and mechanical components were designed.

Load studies were performed on a computer to determine the optimum conductor size. In this case a single-phase 'Ostrich' steel-reinforced aluminium conductor was chosen, with a 50 mm² steel earth wire.

Guyed towers were chosen to support the conductor because IVO has used them successfully on many other projects in Finland and Ethiopia. Previously, eucalyptus poles have been used for power lines in Ethiopia, but galvanised tubular steel was chosen this time because sufficiently large eucalyptus poles were not available. The towers are the two-legged type, with a steel cross-arm.

The guyed tower is a particularly versatile type of support, so only two special lattice steel towers were needed along the whole length of the line, while 376 guyed towers were used. Their average height is 17 metres, and the average span between them is 288 metres.

A separate project has now been started, to ensure that EELPA has sufficient wooden poles for future power line projects. This project includes the establishment of eucalyptus plantations.

A range of IVO-developed computer programs were used to perform strength calculations for the power line's foundations, towers and conductors. The results of these calculations were transferred to a computer-aided design (CAD) system, which produced the final drawings. The design work was finished in January 1990.

Much of the material and equipment needed for the project was procured by IVO on behalf of EELPA, from suppliers around the

world. IVO also undertook supervision of manufacturing, factory tests and shipment to the port of Asseb.

At Asseb EELPA took over and dealt with all the import formalities and inland transportation. The poor state of the Ethiopian roads made transportation difficult, particularly since the project site was 1300 km from Asseb. However, EELPA's familiarity with the local conditions enabled everything to be delivered on time.

A depot was set up at Arba Minch in early 1990, comprising a labour camp, site stores, a vehicle maintenance shop, a crushing plant and a workshop to manufacture the steel reinforced precast concrete foundations for the towers.

Construction work started in June 1990, when substation excavation work commenced, and the first precast foundations were manufactured. The size of the workforce varied with each phase of the work, but on average there were 70 skilled workers, plus around 200 unskilled labourers.

In Ethiopia, manual labour is used in preference to machinery. This labour-intensive approach is possible because of the comparatively large size of the workforce.

Foundation work on the power line towers started in August 1990, and was finished quickly, because precast elements were used. This is another advantage of guyed towers, because they don't require the heavy reinforced concrete foundations needed for free-standing towers.

The use of lighter-weight precast foundations saves time, because they can be made in a manufacturing plant instead of on site. Material is saved too, because better quality control means that a large safety factor does not have to be included in the design.

Assembly and erection of the towers, and stringing of the conductors, was carried out by EELPA, with supervision from four IVO staff.

To ensure that the project proceeded according to plan, there were regular site meetings with the senior project managers from IVO and EELPA. Everyday operational matters were dealt with by the site staff.

So successful was the cooperation between IVO and EELPA that the project was completed more than four months before its contractual deadline.

The Wolaita Sodo to Arba Minch 132 kV line is now providing a reliable supply to power to the textile factory, helping to increase the prosperity of the whole area by ensuring that the factory achieves maximum production capacity.

Electrification in Ghana

IVO International Ltd and its Swedish subsidiary Transelectric Ab are to install

electricity distribution networks. The turnkey project is worth approximately \$12 million. The order has been placed by the country's Energy Minister. Work on both projects commenced in August 1993 and is scheduled for completion in September 1995.

IVO International's contract comprises the construction of five separate distribution networks. The turnkey project is worth approximately \$12 million and is mainly being funded by Finnish Export Credit Ltd, with the Ghanaians contributing 15% of the financing.

The district of Ashanti in central Ghana is the site for IVO International's project, which comprises technical design, the supply equipment, construction and training. The project includes a 178 km-long 33 kV medium-voltage power line, 69 distribution transformers, a 116 km-long AMKA-type cable for the low voltage networks and 2000 consumer connections together with kWh meters.

Transelectric's contract covers the construction of an electricity distribution network in the Eastern district equivalent to the one being installed by IVO International. This project is worth approximately \$7 million and will be financed with Swedish funds for development projects.

The project includes a 173 km-long 33 kV distribution line, a 4 km-long sea cable, 29 pole transformers and 2355 consumer connections.

Uganda's power network

IVO International is investigating the potential for basic improvements in the Ugandan electricity network.

They have been analysing, assessing the power distribution networks in three major Ugandan cities, and suggesting improvements. The project has included training Ugandan experts in the planning and operation of distribution networks.

The project was commissioned by the Ugandan Electricity Board (UEB) and financed by the African Development Bank. It covers the 33 kV, 11 kV and 415 kV distribution networks in the cities of Kampala, Jinja and Tororo respectively.

The biggest problems in the Ugandan electricity network are the extensive losses, unauthorised use of electricity, defective meters and inefficient invoicing.

Based on the figures for 1990, of the 736 GWh generated at Owen Falls, Uganda's main power station, 167 GWh was sold to Kenya. Of the remaining 569 GWh, 359 GWh was billed, so the loss was 210 GWh, or about 37% of Ugandan consumption.

IVO has put forward plans for economically feasible projects that could be put in place to modernise Uganda's partly obsolete electricity network, with the aim of reducing these losses. They have also trained operating staff and supplied Uganda with a micro computer-



based program to help with distribution network planning.

The computer program has been developed by IVO specifically to help with the planning of distribution networks in developing countries.

UEB is responsible for all aspects of electric power generation and distribution in Uganda. The company carries out substation and distribution line construction work, while power plants and 132 kV transmission lines are built by outside contractors.

The main power station is the Owen Falls hydro plant at the mouth of the Victoria Nile, adjacent to Jinja. The other power plants are eight diesel and a 1 MW mini-hydro station at Kabale.

The total installed capacity in Uganda is 154 MW, of which 150 MW is at Owen Falls. However this has been reduced to 110 MW, while rehabilitation work is carried out. Rehabilitation and uprating should be completed by 1995, and the country's total installed capacity will then be 180 MW.

The transmission system comprises 132 kV, 66 kV and 33 kV networks. The 132 kV national grid extends westwards from Owen Falls via Kampala and Kabulasoke to Nkenda in the west and Masaka in the south west. Eastwards it extends from Owen Falls via Tororo, to Lira in the north and to Kenya. Its total length is 1009 km.

The 66 kV line is 80 km long and was used before the 132 kV system was built. It feeds Kampala from Owen Falls via Lugazi and Mukono.

The 33 kV system is 2200 km long and supplies the remote rural areas, from substations in Kampala, Masaka, Nkenda, Jinja, Tororo, Mbale, Soroti and Lira.

The 33 kV, 11 kV and 415 kV networks are used for power distribution. Most lines are overhead, with some underground in Kampala City.

The total length of 11 kV lines is around 4000 km and the 415 kV network is about 2400 km long.

Domestic customers have a single-phase supply. Many have no meters because of lack of availability, so they are charged a fixed sum for the power they use. Peak demand is limited only by UEB's line protection fuses, which are rated at 60A, which restricts power consumption to around 14 kW.

Of the domestic meters that are installed, many run slowly through lack of maintenance, and others have been damaged by consumers. Also, it is estimated that in Kampala alone there may be around 7000 illegal tapings from the supply.

Industrial consumers are equipped with maximum demand kVA meters and kWh meters, on which billing is based.

IVO's work is helping to solve many of the Ugandan power system's problems. New cost-effective distribution network standards



In Ethiopia, manual labour is preferred to machinery: an approach made possible by a large available workforce.

are being introduced, covering overhead lines and underground cables, distribution substations and consumer services.

Throughout the project, UEB staff have been closely involved with the work, to ensure effective technology transfer. This will enable UEB to carry out similar studies of its own in other areas of the country.

District heating in China

A district heating system has been installed by IVO International in the city of Mudanjiang in northern China.

The system, which is a Finnish type, uses a coal-fired cogeneration plant with three peak load boilers. Its maximum output is 181.6 MW of heat and 147.8 t/h steam, which is supplied to 200 heat consumers and 13 industrial steam users. Its area of coverage is 9.1 km², and a total floor area of 2 million m² is supplied with heat.

The indirect connection method uses an individual heat exchanger in each house to transfer heat from the district heating system to an independent heating circuit.

The contract to supply the plant was placed with IVO in 1988 by the City of Muanjiang Heating Office (MDHO). Most components for the system were manufactured in China. The main items supplied from overseas were the heat exchangers, which came from LP Metali Oy, and the automation system, supplied by ABB Stromberg Power Oy.

IVO started working on the project in collaboration with MDHO and the China National Import and Export Corporation (CNTIEC), in April 1988. Commissioning of the system started in October 1991.

Mudanjiang is a medium-sized industrial city in Heilongjiang province in northern China. It has a population of around 650 000 and in winter the temperature falls to as low as -30°C. Much of the heating used in the city is coal fired, which has resulted in heavy air pollution in the winter months.

IVO's responsibilities were: basic design of the system; consultancy in overall project management; training design staff; training operators; training construction, installation

and maintenance staff; delivery of key components from overseas, such as heat exchangers; advice on the choice of local components; supervision of detail design work carried out by Chinese institutes; general supervision of construction, installation and commissioning.

MDHO, using local contractors, was responsible for overall project management, delivery of local components, detail design, construction, commissioning and operation of the system.

At all stages of the project, technology transfer to China has taken place through training of staff and close local cooperation. The outcome of this has been so encouraging that similar working practices will be part of future Chinese projects.

IVO International Ltd is to deliver a comprehensive control system for power transmission to Mindanao, the largest island in the Philippines. The contract will include the supply of a SCADA/EMS operation control system, which uses DEC-ALPHA processors and is considered to be the most effective system of its type.

The project has been commissioned by National Power Corporation, the Philippine's electricity utility. It is the biggest project of its kind in the country and is valued at over \$15 million. It is also one of the largest Finnish projects to be financed by the Asian Development Bank, and the contract to carry it out was won by IVO International against tough competition.

IVO International will supply state-of-the-art energy management systems as well as modern communications systems. The main subcontractors are Nokia of Finland for communications equipment, and Landis & Gyr of the USA for the energy management system. The Finnish content of the project corresponds to around 40%.

IVO International will also work with the customer and the main sub-supplier to develop software and measuring systems for waterway calculations and hydro power optimisation.

Work began on the project at the end of 1992 and it is due for completion at the end of 1995.

At peak periods, Mindanao's electricity demand is around 900 MW, mainly supplied by hydro-based generating capacity. Following completion of the project, the efficiency of energy management on the island will improve considerably, which is of particular importance to the steel, cement and food industries there.

IVO International's comprehensive approach has made them an appropriate choice for many power projects in developing countries, an area of their business in which they hope to expand their activities over the coming years. □



Cleaner and more efficient use of low-grade coal

by Eur Ing H B Locke FCGI CEng FIChemE FInstE FIGasE
and I G Thomson MA PhD CEng FIEE MInstP

THE INSTITUTE OF ENERGY has for many years been concerned that its activities should cover the wider implications of energy developments, as well as the developments themselves. The UNIDO/Institute Workshop on *Cleaner Use of Lower Grade Coal* was an enterprise to fulfill that concern. It followed the very successful workshop on *Biomass Thermal Energy Projects*, sponsored jointly by UNIDO and the Institute of Energy in 1990². The aim was to discuss issues and promote a series of worthwhile projects for the use of low-grade coal in ten developing countries. Individual delegates from each of these countries drew up proposals in a standard UNDP/UNIDO format, satisfying widely recognised UN criteria for considering project funding. A key point was that each of the proposals had originated within the country concerned and had gained support locally before emerging in the workshop forum, so the proposals reflected real local needs and circumstances.

The opportunity was provided for each delegate to discuss the ideas with other delegates as well as with a number of international experts during the proceedings.

British Coal were the principal hosts for the workshop at their Stoke Orchard Coal Research Establishment. It followed the World Coal Institute (WCI) international conference, which the delegates had attended, along with a reception and address by Dr J R Williams of Shell Coal International. After the workshop, delegates visited British Coal's liquefaction project at Point of Ayr, the British Gas coal gasification site at Westfield and the Babcock Energy Technology Centre and boiler factory in Renfrew.

Following the success of their biomass thermal processing project in 1990, UNIDO and the Institute of Energy joined forces again, this time for a low-grade coal workshop.

The activities were coordinated by Eur Ing Brian Locke of Cadogan Consultants (who also wrote the formal report) in close association with Douglas Willis, past president of the Institute of Energy.

Costs were covered jointly by the British industry hosts and by UNIDO, under the authority of the Overseas Development Administration (ODA).

Addressing the WCI conference, Mr Domingo L Siazon Jr, director general of UNIDO, set the scene by explaining that UNIDO sought to accelerate industrial development and promote industrial cooperation

throughout the world. Its budget was about \$160 million, promoting well over half a billion dollars a year of industrial investment. World primary energy consumption was expected to rise over the next 30 years, by some 50-70%, though not uniformly across the world.

Energy issues played a crucial role in the industrialisation of developing countries. Over the previous twenty years, the industrial countries had been able to achieve a 30% increase in GDP while their consumption of energy had levelled off. In the developing countries, demand for energy tended to rise in proportion to economic and population growth and in the previous ten years, energy consumption had risen by 3.5% per annum.

Some additional 105 000 MW coal-based electricity generation plant was predicted to be required in non-OECD countries, much of it in Asia. In China and India for instance, coal was the dominant source of energy for industry. According to UNEP, total world

Table 1: Proposed projects by country at UNIDO workshop.

Bulgaria	Improvement & development of low-rank coal utilisation power systems
Chile	Briquetting of bituminous coal fines
China	Development of FBB for cement manufacture using low-grade coal
India (A)	Development of CFBC technology for high-ash (60%) Indian coal
India (B)	Dry beneficiation of high-ash coals
Indonesia	Coke-making from non-coking coal
Korea	Scale up of FBC boiler using low-grade Korean anthracite
Mozambique	Development & introduction of cooking stoves to burn indigenous (moatize) coal
Poland	Upgrading low-quality power coal using Iarcodems (large coal dense medium separator) technology
Vietnam	Improvement & eventual mechanisation of 'bee nest' briquette process
Former Yugoslavia	Reduction of particulate emissions from low-grade coal combustion (Kosovan lignite)
UK (via UNIDO)	Database of low-grade coal statistics, conversion technologies and environmental impacts of their utilisation worldwide



consumption of coal was likely to increase by some 70% by 2000 compared with 1980.

Coal is naturally abundant in most of the developing countries. Many authorities considered that coal reserves could last another 200 to 260 years, compared with forecasts of 30 to 40 years for oil and 50 to 60 years for gas. Sustainable industrial development must therefore involve a significant shift to coal and ever more intensive use of coal was indeed anticipated. Increased efficiency will be a critical factor, and underpricing of power was not an answer.

An important challenge was to ensure that maximum exploitation was not allowed to damage the environment. Coal can have a high sulphur content, and inefficient combustion can generate nitrogen oxides. Furthermore, low-grade coal can have a highly abrasive ash content that leads to high maintenance costs on crushing and grinding equipment. Of more far-reaching significance was the possibility of climate change, global warming and acid rain. The proper response was to increase efficiency and install appropriate technology for the local situation. This begged the question of who should pay: developing countries should not be burdened with additional capital investment and

resources commitments. Mobilisation of international funds and effort was needed.

UNIDO's medium-term plan emphasised energy issues. Moreover, energy intensive industries such as steel, fertiliser, cement and glass also received special consideration. One third of UNIDO's energy programme was also devoted to the use of new and renewable sources of energy where much of the rural population's energy needs were derived from biomass. Coal remained a major component however. Many millions of dollars worth of coal-utilising projects had been supported in China, Africa, Poland, Bulgaria and the former Yugoslavia for over ten years. There was also a major initiative on monitoring and reducing pollution from coal combustion. UNIDO had been instrumental in transferring technology for the most recent developments in gasification, fluidised bed combustion and direct liquefaction as means of minimising the environmental impact of lower quality fuels.

UNIDO's aims were therefore strongly reflected in the objectives of the conference and the workshop: energy management, improved efficiency and conservation; support of new and renewable sources of energy, and the introduction of cleaner technologies.

At the appropriate place in the proceedings, Patrica M Hillebrandt offered special insight into the resource planning that lay behind the implementation of the sorts of schemes proposed at the workshop, even though the projects all concerned previously researched and developed technologies for use in locally-needed demonstration schemes. The workshop aimed at deriving practicable demonstration projects, serving local needs, not at initiating research or new developments. It was considered important that the projects should be applicable elsewhere, potentially in other countries, not just the initial host country. Another concern was that individuals, organisations and national bodies connected with UNIDO should cooperate in promoting UNIDO's objectives of achieving greater technological and economic success, in the context of combining more efficient use of energy with reduction in environmental pollution, using indigenous natural resources and improved technology.

James Harrison, Director of the Coal Research Establishment, summarised British Coal's interests and activities in the field. Dr R O Williams of UNIDO outlined their detailed ways of working, and described some of the projects in Korea, the

Table 2: Some UNIDO concerns addressed by the proposed projects

Country of proposed project	Improvement of industrial energy efficiency	Improvement of power generation efficiency	Provision of domestic fuel	Women in development
Bulgaria	●	●		
Chile			●	●
China	●	●		
India (A)	●	●		
India (B)	●	●		
Indonesia	●		●	
Korea	●	●		
Mozambique			●	●
Poland	●	●		
Vietnam			●	●
Former Yugoslavia	●	●		
UK (via UNIDO)	●	●	●	●



Table 2 (cont): Some UNIDO concerns addressed by the proposed projects.

Country of proposed project	Reduction of deforestation	Reduction of imported fuel	Reduction of local pollution	Reduction of large-scale pollution	Possibility of inter-country cooperation
Bulgaria		●	●	●	●
Chile	●	●			●
China		●	●	●	●
India (A)		●		●	●
India (B)	●	●		●	●
Indonesia	●	●	●		●
Korea		●		●	●
Mozambique	●		●		●
Poland		●		●	●
Vietnam	●	●	●		●
Former Yugoslavia		●		●	●
UK (via UNIDO)		●	●	●	●

Philippines, India, Poland, China, the former Yugoslavia, Bulgaria and Chile. This helped put the delegates' presentations into perspective.

The detailed objectives of the workshop can be summarised as follows:

- to review opportunities for the adaptation of available clean-coal technologies for use with low grade coals, of which many developing countries have abundant resources;
- to evaluate the potential of these low-grade coals to contribute to energy supplies with minimum pollution;
- to set out the framework for appropriate projects worthy of support in these technologies.

Bulgaria, Chile, China, India, Indonesia, Korea, Mozambique, Poland, Vietnam, and the former Yugoslavia were all represented. The delegates were well qualified in industry and officialdom, with the responsibility at policy-making and decision-making levels, to develop and promote coal technologies; and they brought with them ideas for projects for discussion.

Each delegate was asked to provide a CV and also a 'country paper', to set the social, cultural, economic and technology scene into which the projects would fit. These papers also explained the general energy backgrounds of the countries, especially regarding coal supplies and use, and the local environmental considerations.

After plenary sessions and discussion of the special needs of each country, delegates split

into five working groups, each responsible for an aspect of cleaner use of low-grade coals, so as to address the specific concepts worthy of technical assistance. They were able to take advantage of the presence of leading experts in the fields. Participants each contributed from his or her own experience to at least two working groups. Group A dealt with coal preparation, drying, briquetting and transport; group B, combustion for power and heat; group C, with carbonisation (coking); group D, with gasification, and group E dealt with uses for power and heat, in both the industrial and domestic sectors.

Delegates then prepared fully written-up and justified 'project formulation frameworks' (PFFs), suitable for seeking funding support at the highest level. These PFFs took account not only of the best available experience, current national energy policies, recent technology developments and international agreements on pollution control and the environment, but they also included assessments of problems and risks, and summarised the cost components of their proposed projects (listed in Table 1).

All of the proposed projects had been conceived and had gained support locally before emerging as the UNIDO/Institute of Energy workshop, where they received further exposure. This way it was ensured that the processes and plant would meet real needs and be of benefit to the developing countries concerned and interested in the outcome.

The PFFs were in the appropriate format

for governments to seek funding from bodies such as UNDP for UNIDO to put into practice, and provide the opportunity to involve institutional and industrial funding for expenditures in excess of budgets set aside by the UN organisations or national governments for the purpose.

Preceding the workshop itself, the developing country delegates had also been given the unique opportunity to attend (free of charge) the WCI international conference and exhibition *Coal in the Environment*. This important forum covered problems, solutions and opportunities worldwide, and into the future. The delegates were able to discuss their own technical, economic and environmental problems affecting coal use with others in similar positions, international specialists, equipment manufacturers, process developers and users, coal supplies and shippers.

Table 2 shows some of the special concerns of UNIDO. It can be seen that all satisfied a range of criteria, sociological and economic, as well as technological and practical.

Eleven very worthwhile project proposals were prepared, one for each country that took part (two for India). Each promoted the cleaner, more efficient use of low-grade coal. They all used commercially-proven technology, already demonstrated elsewhere to meet specific and general local needs. All eleven are drafted in standard UNDP/UNIDO format (PFFs), suitable for application for support from international funding bodies, banks and national governments.



In addition all the projects met the requirements of UNIDO's strategic objectives, and because of their local origin and relevance, each should be of practical economic and technological benefit to the countries concerned.

This workshop was as useful in its way as that held on *Biomass Thermal Processing Projects* in 1990. That one set the scene for this approach to setting up socially/economically/technologically/environmentally useful projects for eventual UNDP/UNIDO funding. Lessons learnt in that first workshop were applied in this one.

The types of project were markedly different, however, as these projects were necessarily located where coal was needed and available, being less ubiquitous than agricultural biomass. Nevertheless, several of the projects were concerned with small-scale local applications, of benefit to women in developing countries and aimed to reduce deforestation too. Naturally other projects concerned industry directly, and also large-scale central power generation — to improve thermal efficiency and reduce pollution over large areas.

The delegates were to pass their completed PFFs through their own governments and keep Brian Locke and Robert Williams informed of their progress.

It was recommended that UNIDO should

maintain a half-yearly progressing system, and draw up calendars for targeting outcomes and monitoring progress.

A further recommendation was that UNIDO should circulate the report to appropriate regional representatives and governments for information, and to facilitate local coordination of the progress.

It was also recommended that this technique of deriving worthwhile projects targeted to real local needs should be developed further.

In addition, the need for a worthwhile comprehensive database of low-grade coal statistics, conversion technologies and environmental impacts of their worldwide use, was clear. Such a database need not begin from nothing, as worthwhile databases already existed and would be useful constituents to be linked (and lacunae filled) by the proposed new UNIDO database. Examples included the World Energy Council, IEA Coal Research, Babcock Energy, UNIDO and many other component sources. IEA Coal Research would be well placed to coordinate and add what was needed and to be the central input/output location if suitable resources became available. This proposal is the final listing in Tables 1 and 2.

Some projects derived from the workshop would involve some expenditures larger than

previously in some fields. Accordingly there would be opportunity to invoke and involve the UNIDO initiative of bringing together industrial and other types of financing — where the UNIDO funding could act as the fulcrum to institutional/industrial financial leverage. That way the effect of the UNIDO work would be multiplied to commercial benefit in the countries concerned. □

References

- 1 UNIDO/Institute of Energy Workshop on *Cleaner Use of Lower Grade Coal*, Ed Eur Ing Brian Locke, published by British Coal. ISBN 0 902597 45 0, 3—13 April 1991, Coal Research Establishment, Stoke Orchard, Glos. Vol 1 — Proceedings; Vol 2 — Visits and Technology Papers.
 - 2 UNIDO/Institute of Energy Workshop on *Biomass Thermal Processing Projects* Ed Eur Ing Brian Locke, published by Shell Research, ISBN 0 902597 44 2, 1-5 October 1990, Shell Centre, London. Vol 1 — Proceedings; Vol 2 — Papers
- *Very limited numbers of copies of both publications are available from Dr R O Williams, UNIDO, Vienna, or from Eur Ing Brian Locke, Cadogan Consultants, Bisley, Glos GL6 7AT.*

Mongolia

renewable energy in a transitional economy

by Anthony Derrick*

MONGOLIA is a land-locked country of approximately 1.6 million square kilometres sandwiched between Russia and China. Although Mongolia covers a land area more than six times that of the UK the population is only 2.2 million, of which half live in rural areas and are mainly nomadic livestock herders. The livestock population is more than 25 million, comprised of mainly horses, cattle, yaks, sheep, goats and in the south, camels.

Mongolia achieved independence in 1921, and went on to adopt a socialist model of development. The country was,

UK consultants IT Power Ltd have undertaken a market assessment study in Mongolia, which is in the throes of conversion from a socialist to a market-based economy. Tony Derrick tell of their findings.

until 1990, known as the Mongolian People's Republic (MPR), although often referred to as Outer Mongolia, to differentiate it from Inner Mongolia — the autonomous region of China. (Only one third of Mongols live in Mongolia, the remainder live in Inner Mongolia — 3.4 million — and the former republics of the Soviet Union — 0.4 million). Mongolian affairs were dominated by the Soviet Union following the signing

of a 10-year treaty between the USSR and Mongolia in 1946, and renewed thereafter. The UK was the first Western country to establish diplomatic relations with Mongolia in 1963, as well as an embassy in the capital Ulaanbaatar (known as Ulan Bator prior to 1990). This early establishment of diplomatic relations has been the cornerstone of excellent relations between Mongolia and the UK and between their peoples.

The process of economic reform started in 1986 and as growing disenchantment with the socialist model became evident in other countries, the momentum of reform in Mongolia became unstoppable. In July 1990 the first multi-party elections took place. The transition to a market economy has been difficult, particularly in the energy sector, following the breakdown of fuel supply arrangements with the Soviet Union in

*Director, IT Power Ltd



August 1990. The requirement that fuel supplies and also imported electricity have to be paid for in hard currency has been a serious problem for an economy in transition.

The energy sector in Mongolia is an interesting mix of traditional resources (animal dung in rural areas), indigenous coal (used for electricity production and district heating) and oil fuel (for transportation and electricity production). Electricity is also imported from Russia.

Coal production peaked at 8.6 million tonnes in 1989, but has declined since then due to production equipment related problems. Production is expected to increase however as more coalfields are being opened as a result of the market economy. Reserves are estimated at 20 billion tonnes.

In considering electricity supply it is useful to note the administrative set up of Mongolia. The country is divided into 18 provinces, known as 'aimaks', which are subdivided into a total of more than 300 'soms' (referred to as 'somens' prior to 1990). Under the centrally planned economy, the soms were also subdivided into 'brigad' centres, which were headquarters for the livestock herders cooperatives. Following the breakdown of the cooperatives, the soms are subdivided into 'bags'. The government is supporting the strengthening of bags centres as focal points for communications, rural health services and livestock services.

Towns in only six of the 18 aimaks are connected to an integrated electricity grid. The remaining aimaks (accounting for 50% of the population) rely on diesel-fuelled generators to feed stand-alone distribution systems. Since 1990 availability of diesel in these



The family owning this 204 W (peak) solar PV home power system proudly pose for photographs in front of the modules.

regions has become problematic, particularly in the more remote regions of the Gobi aimaks. This situation is particularly serious in winter, because electricity is required to power the distribution pumps of the district heating systems. In the winters of 1990/1 and 1992/3 diesel shortages caused the curtailment of education and hospital services. At a meeting of donor countries to Mongolia, held in Tokyo in 1993 the energy sector was identified as a priority area for assistance. The US

Agency for International Development (USAID) is already assisting in the rehabilitation of power stations, Denmark has granted emergency funds for fuel supplies and has supported investigations into the rural energy problems and potential solutions of the Gobi region.

The electricity and other problems in the towns not connected to the central utility has resulted in a recent reversal of urbanisation as many Mongolians are finding it more attractive (comfort wise and financially) to revert to their traditional nomadic livestock herding existence, living in very comfortable round felt tents known as 'gers' (or 'yurts') which are heated by stoves fuelled by animal dung. The attraction of livestock herding has been enhanced since the end of the centrally planned economy because families are now able to keep many types of animals, as opposed to only one type under the cooperative systems.

However, the main problem with the Nomadic livestock herding way of life is lack of access to electricity. It is in this area that renewable energy is particularly attractive.

Around 130 000 Mongolian families in rural areas rely on animal husbandry for their living, making this the major sector in the Mongolian economy. More than 80 000 of these families are essentially nomadic, moving their gers up to thirty times a year, often covering distances of 200-300 km.

Three-quarters of Mongolians are under 35, and although the flow of population to the towns has slowed, and even reversed in some areas, it is considered that migration to towns

The author

Anthony Derrick is a director of IT Power Ltd, a UK consulting firm specialising in the application of renewable energy. He has worked in Mongolia on renewable energy projects for UNDP and Danida, and has visited the country under the centrally-planned economy in 1987, during the transition in 1990 and recently in September 1993. IT Power is presently drafting a major report on photovoltaics for the Asian Development Bank, which accepted Mongolia as a member in February 1991.

Mr Derrick is a member of the Institute of Energy, and was a committee member for the Institute of Energy workshop on Sustainable Energy, organised for the 1993 DTI global technology partnership initiative.



Anthony Derrick



will restart as availability of electricity and other living conditions start improving again in the towns. It is therefore necessary to improve living conditions in rural areas also, and the provision of electricity to the livestock herders is considered a priority.

Obviously for nomadic people grid extension is not a sensible option so the choices on the options are limited to small petrol engines, battery charging wind generators and solar photovoltaic battery chargers.

Traditionally, Mongolia was known as the Land of the Clear Blue Sky. Not surprisingly, then, solar power is proving particularly successful. A typical family in a ger would like electricity for lighting (5 hours per day), monochrome television (4 hours per day) and radio (15 hours per day), equating to a daily energy requirement of only 150-200 Wh. A single solar photovoltaic (PV) module of 40-60 W is sufficient to meet this.

The lowest solar irradiation in Mongolia occurs in December and January, but this is compensated to some extent by low ambient temperatures of between -15°C and -30°C . (PV cell modules are more efficient the lower the temperature). Reflectance from the snow is also picked up by modules in their winter settings (facing more to the horizon as the sun is lower in the winter). The result is satisfaction for photovoltaic engineers, who have a rare opportunity to experience modules sometimes performing above their rated power.

More than 3000 PV systems have now been installed in Mongolian households. These range from almost 3000 small 10 Wp systems solely for lighting, imported from China by the government in 1990 to more than 100 larger 204 Wp systems with inverters imported under a Japanese-Mongolian cooperative research programme. These larger systems allow the use of colour TV, as well as more lights and other appliances, such as radios/cassettes. The principal market is however believed to be for systems of 40-60 Wp for lighting, radio and black and white TV.

Commercial photovoltaic activities in Mongolia are still limited, however, despite the large potential market identified. One Belgian company (Soltech) has established a joint venture for the manufacture of modules, although production has not commenced as yet. The Institute of Physics and Technology, meanwhile, has pursued a PV research programme. PV cells on monocrystalline silicon wafers have been produced and then assembled into modules. The United Nations Development Programme (UNDP) has supported this activity, which included a market assessment undertaken by IT Power Ltd of the UK. The lack of commercial activities in Mongolia with PV has resulted in a commercialisation and market development project being proposed by the Danish cooperation agency, Danida, during an energy mission in



An 11 W peak, Chinese manufactured solar PV module and lighting system being installed on a nomad's tent (ger). Total installation time was a mere 90 seconds!

September. The project, in cooperation with the Institute of Renewable Energy in Mongolia, is presently under consideration.

The purchasing power of the Nomadic families is significant. Many have bought motorcycles and small petrol-fuelled generator sets (although the present shortages of fuel are making both difficult to use). A family may have a herd of over 100 horses and cattle plus

additional sheep and goats, and a small PV system can be bought for the equivalent of 5-10 horses or good cattle.

Solar energy is also used for water heating. About 2000m² of solar collectors supply water to rest houses, hotels and children's 'pioneer camps', which are mostly occupied in the summer months. The Institute of Renewable Energy has also developed large volume solar water heaters specifically for the warming of drinking water (from snow or ice) for livestock, to help these animals survive the harsh Mongolian winters. (Some 2.6 million livestock died in the winter of 1977).

In addition to solar power, the household electrical requirements of Mongolia's rural herdspeople can be met by wind generators. UNDP-supported trials of a one metre diameter 50W machine, manufactured by Marlec Engineering of the UK in the late 1970s met with good user acceptance. These machines can be installed or taken down in a few minutes. In 1989, following the trials, the Research and Production Corporation of the Ministry of Energy (now the Institute of Renewable Energy) formed a joint venture with Marlec for the manufacture and assembly of 50W and 250W wind generators. This was the first joint venture to be signed by the Mongolian Government with a non-communist country. The company was privatised after the 1990 transition to a market economy, and is now known as Monmar. More than 1000 of the 50W units are reported to have been manufactured in Mongolia by Monmar. The present selling price of the battery charging wind generator system to a



A 50 W battery charging wind-generator manufactured in Mongolia by the UK-Mongolian joint venture Monmar (UK partner: Marlec Ltd of Corby).



Nomadic family is approximately 20 kg of Cashmere.

Traders from Inner Mongolia in China are also selling larger 100W wind generators (for approximately 3 head of cattle/horse per unit). Larger 1-5kW wind generator systems are also being proposed for stationary applications at the bag centres, although none have yet been installed. Although a reasonable wind regime exists in the Gobi area, the use of commercial-sized large wind generators feeding into the diesel-powered small local grids is generally not feasible, because of the small demand on these isolated grids, and problems with keeping the diesel engines operative.

Because of the vast numbers of animals that were kept on state farms and by nomadic herders, biogas represented an obvious option for Mongolia. Portable small-scale digesters to produce biogas from animal waste have been proposed. So too were large-scale digesters for use on state farms, where the gas could either be cleaned, compressed and

bottled for distribution or harnessed to generate electricity for on-site use. A 150m³ digester has been built and is being evaluated. Problems with low temperatures and the distribution of the bottled gas or electricity, though, are hindering commercialisation, but now the collapse of the state farm system appears to have shelved such systems for the near term.

International support for the pioneering work in renewable energy undertaken by the Ministry of Renewable Energy's Research and Production Centre came initially from the UNDP, with UK companies playing a key role in providing technical assistance. A significant successful result was the establishment of the joint venture with Marlec of the UK for the manufacture of wind generators in Mongolia. IT Power assisted the UNDP and the Mongolian Ministry of Energy to formulate present activities and, since then, has been providing a variety of technical support. The University of Wales College of Cardiff has assisted in solar collector testing, and Mongolian scientists have undertaken train-

ing and research in renewable energy at UK universities.

The EC has recently assisted the joint venture activities on PV module production under a technology transfer project. Danida has been particularly active recently in connection with appraising the possibility of the application of renewable energy in the Gobi region, and the Japanese in support of a PV research and demonstration project in the central aimaks.

Mongolia has undertaken pioneering work in the application of renewable energy technology under the direction of the Institute of Renewable Energy. This work is directly benefiting the nomadic livestock herding families and will ensure the continuation of the animal husbandry industry.

Renewable energy, then, has a sunny future in the Land of the Blue Sky, and the transition to the market economy is highlighting the benefits of autonomous, non-fossil fuel energy sources for rural populations. □

THE OBVIOUS solution to the migration of rural populations to urban areas is the supply of modern comforts to the people in remote areas. Without this there will soon be a serious shortage of agricultural produce due to the shifting of manpower from villages to cities. This could be the second greatest problem after environmental pollution.

A major requirement of rural areas in developing countries is the supply of an inexpensive, reliable, convenient, energetic and environmentally safe fuel for cooking, heating and lighting purposes. Natural gas and electricity are beyond the means of villagers, who constitute between 70 and 80% of the population in developing countries. At the moment they meet their fuel requirements by utilising kerosene, wood, charcoal and dried cake of animal dung. In burning dried dung, land is deprived of its manural value. Its use can be attributed to the shortage of fuel resources resulting from widespread deforestation and the indiscriminate use of village trees.

Biogas: an energetic fuel for rural areas

by *Ismat Ali**

Biogas is an ideal and energetic fuel for the population of remote areas of developing countries. Production cost is in the range of \$1 to \$1.50 per GJ, which compares very favourably with existing fuel prices. The technology is simple and straightforward compared to pyrolysis or hydrogasification of biomass, and no technical skill is needed to run a biogas plant. In the past few biogas plants have been discussed along with the biogasification reactions. The author feels more studies are called for in order to reduce plant cost by increasing the rate of gas generation, making biogas a feasible alternative to wood, charcoal and kerosene.

Wood, charcoal and kerosene are costly, and moreover the resources are limited. Kerosene is not locally produced in many developing countries: it is imported at the cost of hard-earned foreign exchange, which is very precious and limited for countries such as Pakistan, India and Sri Lanka.

Keeping these facts in mind I shall examine

the feasibility of generating a combustible gas suitable for cooking, heating and lighting from animal excreta using the process of anaerobic digestion. This gas can be produced at a cost of US\$1 to \$1.50 per GJ, which compares favourably with existing fuel prices. It is estimated that the initial capital outlay for a small family-sized plant of 100 MJ per day is around US\$350.



Gas obtained from anaerobic digestion of organic wastes or animal excreta is known as biogas. The process of digestion of organic wastes for the production of a combustible gas is a century-old technology, but since oil, wood, coal and other combustible matter were then cheap, no attention was paid to the production of biogas to use as a combustible gas for cooking and heating.

Among the organic wastes, cow dung is an ideal raw material for gas generation as it needs no pretreatment or addition of any chemicals, apart from water. It has the capability to adjust to favourable conditions such as pH or temperature as the process is slightly exothermic.

Biogas contains a fair proportion of combustible gas (50-60% methane) which has a heating value of 22.3 to 23.4 MJ per cubic metre, which is fairly good for a domestic fuel. No other synthetic fuel gas is as energetic as biogas. It is a clean, smokeless and environmentally benign fuel for combustion purposes. It will burn in a natural gas burner/stove with a light blue flame.

A further by-product: slurry waste from the digester, contains a fair proportion of nitrogen-rich manure which, as a result of chemical changes that occur in the digestion process, is more readily taken up by the soil than the original material — cow dung. So a resource that is currently being used as fuel alone can be converted to both a fuel and a fertiliser, making anaerobic digestion for the production of biogas a very attractive economic proposition.

The conversion of organic wastes to methane-rich combustible gas has been practiced on both large and small scales in many developing countries. There are over seven million biogas plants in China and 0.14 million plants have been installed in India. South Korea has over 2400 and Pakistan over 5000. The plants vary in design, but the basic principle is the same: anaerobic digestion of animal excreta.

Table 1: Cost comparison of various fuels in developing countries

Fuel	Estimated cost per GJ (US\$)
Kerosene	3 — 3.50
Charcoal	3 — 3.50
Wood	2.50 — 3
Mineral coal	1.50 — 2
Biogas	1 — 1.50



An Indian design of biogas plant.

Three possible processes have been developed so far for the production of a combustible gas from biomass or organic wastes. These are: hydrogasification, pyrolysis and biogasification.

Hydrogasification is the reaction of hydrogen with carbon-bearing materials to produce methane-rich combustible gases. Further, gas cleaning and processing are

needed to complete the process. This is only possible with large-scale production, making this method unsuitable for small-scale production in rural areas with unskilled operators.

Pyrolysis. Alternatively solid wastes may be pyrolysed to produce methane-rich gases, but the process is highly complicated and requires gas purification, making it impractical again on a small scale. Once again the technology of pyrolysis of organic wastes rules it out for small-scale use in rural areas.

Biogasification. Anaerobic digestion of organic wastes, on the other hand, does have an immediate technical appeal. Operating conditions are mild (like most biochemical reactions) with a temperature range 30-37°C, and requiring no technical skill. Choice of construction materials is wider and control and operation of the process is straightforward. There are also a large number of biogas plant design currently in use. The raw material is abundantly available in the villages themselves, with the added advantage of being inexhaustible. These factors combine to make biogasification the ideal process for the production of a combustible gas for meeting fuel requirements of rural areas in developing countries on any scale, from small to large, without the need for gas purification.

Biogasification reactions can be sum-

Table 2: Biogasification parameters for the digestion of organic wastes.

Parameters	Range
Total solid in slurry	7—9%
total volatile solid	70—80% of total solid
pH of slurry	6.8—7.4
carbon/nitrogen ratio	25—30 by weight
temperature	27-71°C
pressure*	atmospheric

*biogas can be produced at any pressure as established in case of high-pressure biogas plant — a Pakistan design

**Fuel Research Centre,
Pakistan Council of Scientific
Research, Karachi*



marised thus:

$C_6H_{12}O_6$ (carbohydrate from the digestion of organic wastes) $\rightarrow 3CH_3COOH$

$3CH_3COOH \rightarrow 3CH_4 + 3CO_2$

The route of this reaction may be suggested thus:

$C_6H_{12}O_6$ (Carbohydrate from the digestion of organic wastes)

$\rightarrow 2C_2H_5OH + 2CO_2$

$2C_2H_5OH + 2CO_2 \rightarrow 3CH_3COOH$

$3CH_3COOH \rightarrow 3CH_4 + 3CO_2$

In the above reactions, first step is the decomposition of solid to liquid, known as the liquefaction phase, and then the liquid, i.e. acetic acid is converted to gases known as the biogasification phase. In the above reactions, it is quite obvious that the final products — methane and carbon dioxide — are in equal proportion, i.e. 1:1.

Biogas is an ideal fuel for remote areas of developing countries where cow dung is abundantly available either free or at a nominal cost. At the moment dung is dried under the Sun and used as fuel, depriving the land

of its manure. With biogasification the left-over slurry forms a nitrogen-rich manure, and consequently around 5000 biogas plants of capacities ranging from three to 30 cubic metres have been installed so far in Pakistan. Most of these are based on an Indian design, consisting of a concrete well (digestion chamber) in the ground and a metallic gas holder inverted over the slurry of the well for gas collection. The well is connected through RCC pipes as inlet and outlet for slurry. There is a gas delivery tube on the top of the gas holder.

The Chinese design is a concrete air tight chamber in the ground with inlet and outlet for slurry. Gas is collected over the slurry in the same chamber. It is then transmitted to the point of consumption through a pipe on the top of the chamber. Pakistani plant design is a sealed metallic cylindrical vessel with inlet and outlet for slurry, and the gas is collected in the same metallic chamber. The gas can be transmitted to point of consumption with any desired pressure from the top of the vessel.

The basic principle in these designs is the same. An equal amount of water and animal excreta are confined in the digester, ensuring 10% solid concentration in the slurry. It should be pointed out here that generally fresh dung contains 80% water. A com-

bustible gas can be obtained within a week, provided favourable parameters are established.

The only drawback of this process is the very low rate of biogas generation. 0.5 unit of gas is produced per unit of slurry in a temperature range of 25—37°C per day. This means retaining the slurry in the digestion chamber for around 100 days, too long and inconvenient a period. Increasing the plant size could hold the answer, but loses the advantages to rural communities of small-scale plant. Rate of biogas generation could also be increased by warming the slurry, but this is not thermodynamically feasible. These are some of the reasons for the unpopularity of biogas plants.

However, if the rate of gas generation is enhanced, plant size can then be reduced accordingly, which in turn reduces costs, making the plant more acceptable to rural village communities. A Pakistani design of high-pressure biogas plant reduces the size by around 10%, but the rate of gas generation still needs to be increased. A number of organic and inorganic compounds have been tested, but so far the results have not proved encouraging. Biochemical and engineering studies in Pakistan are now concentrating on enhancing the rate of biogas generation so that in the future rural communities in developing countries will be able to take advantage of the full benefits of this form of gas. □



A Pakistani design of biogas plant



The Indo-British Partnership Initiative

by Johanna Fender

IN JANUARY of this year John Major, accompanied by seventeen of the UK's leading business leaders, led by Howard Davies, director general of the CBI, touched down in Delhi for India's Republic Day celebrations.

The UK Premier's presence heralded the relaunch of a special trade relationship with India, and so the Indo-British Partnership (IBPI) was born. The Initiative was backed by India's Prime Minister Narasimha Rao, and has won the support of all India's major business organisations — the CII, FICCI and ASSOCHAM.

In the UK British Gas chairman, and Institute of Energy past president, Robert Evans was invited by John Major to head the British side of the initiative for its first vital year. Mr Evans accepted and work began immediately to promote links between the two countries. Within six weeks the first British ministerial follow-up visit took place, when the then Environment Minister, Michael Howard, met his opposite number, Kamal Nath, in Delhi together with a number of top Indian industrialists. Mr Howard's message was that India could learn from the environmental mistakes made by the UK during its industrial development. He went on to assure Mr Nath that help, via the IBPI, would be forthcoming to ensure the right kind of rapid technology transfer.

This initiative, along with global partnership conferences in Birmingham in March, and in Manchester in September, was a direct result of the Rio Summit, at which it was finally recognised that we all inhabit the same planet, and the well-being of the developed world is at least partially dependent on the success of the developing world. This view was put in a UK perspective by Robert Evans at a seminar held in London in May of this year. Speaking to a 200-strong audience, he said: "We may be emerging from recession, with low interest rates, low inflation and a favourable exchange rate to reinforce our

The beginning of 1993 saw the relaunch, under very different circumstances, of a preferential trade agreement between the UK and India. Trade figures show that in the period January to May 1993, exports from the UK to India increased by 17%, while imports from India to the UK rose by 24%. The initiative appears to be having some impact.

export drive, but most of our European partners seem to be sinking further into recession.

"This is the time to look around for healthier, hungrier markets, where the economy is strong and growing, and demand is high and rising. For many British companies, that market could well be India."

He went on to elaborate, saying the partnership initiative would concentrate on specific opportunities steered by individual sector steering groups for power generation, oil and gas, petrochemicals, transport, telecommunications, food processing, financial services, printing and packaging, manufacturing technologies and infrastructure development.

Also present to address the gathering was UK President of the Board of Trade, Michael Heseltine. He played down the government's role in the initiative, stating "business listens to business". However, he also pointed out that his department was active in identifying and eliminating remaining barriers to trade between the two countries, and welcomed the "imaginative and courageous liberalisation programmes which are being introduced by the Indian Government".

In an optimistic address by the managing director of Tata Steel in India, Dr Jamshed Irani, forecast a bright economic future for his country, with double-figure growth in 1994-95. He stressed that India would not simply become a ready-made market for exploitation by overseas companies: "We want to develop our own industrial base, our own technologies".

Robert Evans has expressed his desire to get things moving in the first year, so that the momentum may be maintained. In an inter-

view for *Partnership*, the bulletin of the IBPI, he spoke of the situation in India's energy sector. "India is woefully short of power and that provides opportunities for many British companies. Our project in India is quite small, but if you were to look at the totality of opportunities in the gas sector alone, it would be in the order of £2 billion."

In a call to bury past differences, Mr Evans pointed out that America, France and Germany were all well established in India, but historical differences had kept the UK and India apart; now that "India has the pick of the world, British companies will be picked on merit" he predicted confidently.

Among UK patrons of the IBPI are Douglas Gadd, chairman of GEC Alsthom, Graham Hadley, executive director of National Power and Philip Daubeney, director of ICI. Indian patrons include Dr Jamshed Irani, Vijay Kirloskar, vice chairman and managing director of Kirloskar Electric Co and Rajive Kaul, chairman of NICCO Corporation.

A series of one-day workshops targeted exclusively at private sector power project interests took place in October. Representatives of 25 UK companies met specially invited senior officials from the relevant Indian Ministries, central electricity boards, private power companies and entrepreneurs with projects or industries which require captive power generation and transmission facilities.

In addition the workshops were attended by Mr N K P Salve, India's Minister for Power, along with Sir Nicholas Fenn KCMG, British High Commissioner for India. The UK group comprised the most senior representatives from the generating utilities — as potential investors and advisers; financial institutions; lawyers; consultants, suppliers and manufacturers. The one thing they all had in common was a committed interest in the Indian private sector power market.

If you would like to follow the progress of the IBPI, *Partnership* is to be published every two months as a supplement to *Business Eye* magazine. For further information please contact IBPI Secretariat, DTI, Bay 818, Kingsgate House, 66-74 Victoria Street, London SW1E 6SW. □



Midland Branch programme

All meetings will be held at the University of Aston in Birmingham, Senior Common Room at 7 pm, unless otherwise noted.

Friday 19 November

Annual Dinner Dance at the Belfry Hotel, Wishaw, Near Sutton Coalfield. Tickets available from Mr M Round, 'Branksome', Kent Road, Halesowen, West Midlands, B62 8PQ. Tel: 021 422 5311.

Thursday 2 December

'The Optimisation of Process Heating' by Dr P J Mullinger

Thursday 6 January

'The Gasification of Industrial Waste for Power and Heat Generation' by Mr N Abrahams

Thursday 3 February

'Energy Efficient Lighting for Industry and Commerce' by Mr I F Maclean. Joint meeting with CIBSE.

Thursday 3 March

'Pumps and Motors — Energy Experience from the Water Industry' by Mr R Gregory

Thursday 14 April

'Modern Coal Firing Technology for Industry' by Mr A J Minchener

April 1994

The Ellis Memorial Lecture (date and venue to be announced).

May 1994

Works visit and Annual General Meeting.

Discussion will be invited on each paper.

Visitors are welcome to attend all technical meetings: personal introduction by a member is not necessary.

Market forces not given a proper chance

FORMER Conservative MP, and now Chairman of the Major Energy Users' Council, Peter Rost, was the guest speaker at the London and Home Counties branch of the Institute of Energy on 7 October.

Entitled *A critique of the Government's energy policy*, Mr Rost's paper suggested that the Government's critics may be "shooting at the wrong target". Rather than criticise government policy, Mr Rost sought to highlight their failure to implement their declared policy of achieving greater efficiency, security and diversity of supply through the mechanism of market forces.

Mr Rost laid the blame for this failure at the door of the Government for not freeing market forces sufficiently to prove their power: "we neither have the economic

dynamism in the energy sector, nor do we have a strategic policy framework to guide market-led decisions."

The Government has failed to do this, he argued, "because Governments operate in pigeon holes", and ignore expert advice. He called for the energy 'think tank' promised in the White Paper to be set up as soon as possible — he was speaking a fortnight or so before the advisory committee was announced.

Fettered market forces were also to blame for the coal debacle, said Mr Rost, when the review failed to recognise the reason why demand for coal has slumped — not because of an uncompetitive UK coal industry, but because of the rigged electricity generation market.

Project managers' award launched

More than £250 billion is spent in the UK every year on projects, but nearly half fail. In response the Association of Project Managers have launched a £4500 award, sponsored by IBM and The Observer, to find the most successful projects.

The Sir Monty Finniston Award for Project Management aims to encourage better business practice by promoting the concept and discipline of project management.

Entries are invited from all areas of UK industry, including energy.

For information and an entry form, write to: The Sir Monty Finniston Award, The Association of Project Managers, 85 Oxford Road, High Wycombe, Bucks HP11 2PX.

Call for papers

THE BRITISH Nuclear Energy Society has issued the first announcement and call for papers for their *International Conference on Fuel Management and Handling*, to be held at Heriot-Watt University in Edinburgh on 20-22 March 1995.

The scope of the conference will allow papers on specific topics such as: licensing; quality assurance and control; lifting and handling equipment; fuel cycles; equipment maintenance and decontamination; fuel handling faults and protection systems; operational experience; component reliability; storage; remote assembly and dismantling; case histories; and human factors in design.

Further details from The Secretariat, BNES, 1 Great George Street, London SW1P 3AA.

Special book offer

IN SEPTEMBER this year the Institute held its *First International Conference on Combustion and Emissions Control* at the University of Wales, College of Cardiff.

For those members who were not able to attend, we are pleased to offer the proceedings at the special price of £30 (inc p&p, UK) or £35 (inc p&p, elsewhere). Presenting some of the latest developments, *Combustion and Emissions Control* will be invaluable to engineers, manufacturers and other professionals working in this field. The volume contains chapters on: waste utilisation, emissions reduction — gas and oil systems, emissions reduction — solid fuels, boilers and furnaces and combined cycle power generation.

To obtain your copy/copies, please send your remittance, made payable to 'The Institute of Energy' to: Louise Evans, Conference Department, Institute of Energy, 18 Devonshire Street, London W1N 2AU.

For a contents list please telephone Louise Evans on 071 580 0008 or fax: 071 580 4420.

ISBN 0 902 597 434, paperback (430 pp).

Your ideas on energy storage, please

WE mentioned in the last issue of *Energy World* that we would be grateful for the advice of readers on the subject of energy storage, with the view determining whether this would be a suitable subject for a future conference.

Some of the issues which might be considered are:

energy storage

- for efficient use of energy;
- to increase attractiveness of renewable sources;
- to increase flexibility of energy usage;
- new technology and improvements to existing technology: mechanical, chemical, thermal or electrical storage;

implications:

- for energy supply/supply management;
- transport.

Your suggestions would be gratefully received, by Judith Higgins, Conference Manager at the Institute's headquarters. Telephone 071 580 0008 or fax: 071 580 4420.



Astute timing

'British Coal: Prospecting for privatisation' by Charles Kernot

Published by Woodhead Publishing Ltd, Cambridge, September 1993, 248 pp, £35.00.

SERENDIPITY — making happy or unexpected discoveries by accident — played absolutely no part in the timing of Charles Kernot's book.

This thoughtful, carefully researched work has appeared at precisely the right moment to make a valuable contribution to what promises to be one of the most heated debates of the Parliamentary session when the Government's Coal Privatisation Bill makes its stormy passage through the Commons and Lords.

Coal has always been an emotional topic, often generating more heat than light, and Kernot has clearly seen the danger that without a cool appraisal of where the coal industry in Britain stands today and how it got there, bad decisions can still be arrived at for apparently good reasons.

His credentials are impeccable. A degree in mining geology at the Royal School of Mines, followed by a stint as a mining analyst for Kitcat and Aitken and now at Credit Lyonnais Laing, have given him the insight necessary for a clear analysis of the kind essential to anyone contemplating investment in coal at privatisation.

In order to understand exactly how coal reached its present impasse it is necessary to grasp the social, economic and political ramifications of its history. Kernot devotes the first part of his book to a survey of coal's turbulent times from its role as power house for the industrial revolution and the roller-coaster fortunes in the 20th century, to its perilous position today which could, if mishandled, be the beginning of its final demise.

As coal has become more and more embroiled with politics it has become increasingly subjected to wayward pressures driving it ever farther away from the possibility of sensible commercial decision making. As a result it finds itself in situations for which it is not responsible, yet from which it is expected to extricate itself with little or no real aid.

Kernot cites as a recent example of major government error the termination of all coal's electricity industry contracts on the same day, which lies at the heart of the industry's present problems. 'No one but the most foolhardy business executive would risk all of a company on a single contract with no guarantee of renewal; but such was the contract forced on British Coal,' he says.

Part II of the book is devoted to a short but pithy analysis of the world coal scene, in which he concludes that the long-term price of coal will rise, and that only those electricity generators which have ensured their supplies

on long-term contracts will be able to continue to purchase coal effectively and economically.

In the final part, Kernot examines the physical state of British Coal in the run-up to privatisation. In a careful analysis of assets, reserves and potential earnings he compares the Corporation with other coal mining companies which have changed hands recently, particularly in the US and Australia. Assuming that the mines for disposal have around 40 years of reserves at the stable production forecasts for 1994/5, the price that British Coal mining operations will fetch at the privatisation sale will be in the region £500-£600 million, while the value of assets in the form of non-operational freehold property interests could be between £300 million and £1000 million, depending on whether they were made a forced sale or were disposed of in an orderly fashion. He points out that the Corporation is worth much less than the sum of redundancy payments and other Government subsidies accrued in the past 14 years.

Kernot comments on the closure of the 12 pits which were originally reprieved in March as a result of the White Paper. It is a direct result, he says, of the mistaken way in which privatisation is proceeding. 'Both the Government and British Coal can clearly be seen to be protecting their own market at the expense of allowing other willing participants to buy into the industry. This is shown by the Government's failure to remove the restrictions on other operators, which prevent them producing coal on the same terms allowed to British Coal: more rather than fewer jobs will be lost and in 1995/6 greater demand for electricity will force buyers to use more gas or import coal, at the expense of the locally produced coal that would otherwise be available,' he concludes. A sentiment being borne out already by the latest news of British Coal entering the importing business.

Peter Heap

Not a technical book

'The Struggle over North Sea Oil and Gas' by S S Anderson

Published by Scandinavian University Press, 204 pp.

THE AUTHOR, from the Norwegian School of Management, has surveyed the political background and decision making for the three major countries in the North Sea oil and gas bonanza, right from the early days when it was not known whether the resources were there or economically viable, through the oil price rises of the 1970s and falls of the 1980s to the present day.

The main theme is the completely different

approaches of the three countries to the way the resource should be managed. The book was completed in November 1992, so is as up to date as any hard-back publication can be.

The book is completely non-technical and for an energy engineer it is useful to realise that even in technically important and complex fields, such as North Sea energy, the politics behind the decisions setting out the organisations can influence the scale of the operation and the way technology develops. Of the three countries involved, Norway has the greatest control, insisting that their Government agency and nationals control output and the technology. In spite of political changes and swings in oil price, the Norwegian policy of maximum Government involvement has survived.

In Britain there was involvement of the international oil companies from the beginning, but the role of the Government has changed with the political party in power. It is clear that in energy, whatever else may be right or wrong about changes in recent years, Britain comes closest to the free market and transparent pricing favoured by the EC. Even so, Norwegian gas is piped to Germany rather than Britain as a result of the British Government's policy.

The Danish programme, with what is undoubtedly the smallest resource of the three countries has been arguably the least successful, with an arrangement confined to a single Danish company.

The authors shows that throughout the period each country maintained its own individual approach. The author reviews the factors influencing the North Sea resource in the future and how the three countries are likely to be affected.

The book is not easy to read, and is in places repetitive. However, the North Sea is important, both to Britain and Europe and the analysis in this book is therefore valuable. Although these are available elsewhere, the book would benefit from the inclusion of maps (perhaps giving exploration areas at various dates) and tables of data. But then this is **not** a technical book!

N G Worley

Recently published

'District Heating in Denmark: research and technological development' Ed by Fleming Oster.

Published by the Ministry of Energy, Danish Energy Agency, 1993, 56 pp, US\$10, from Danish Board of District Heating, Jernbanevej 65, DK-5210, Odense NV, Denmark.



Not so friendly

I WAS disturbed to see in the article on the Quebec energy policy (*Energy World*, July/August 1993) a reference to Quebec's massive hydro programme as 'environmentally friendly'. The scheme has in fact caused severe and irreversible environmental and social disruption.

While the generation of hydro power does reduce unwanted emissions such as carbon dioxide associated with combustion of fossil fuels, hydro power inevitably devastates landscapes and ecosystems. This is especially the case for projects such as those in Quebec because the landforms are very shallow, necessitating the flooding of huge areas per MW generated.

The land flooded at James Bay included forest used for 5000 years by the indigenous Cree people for hunting and fishing; their rights to this land have been overridden. Cree chief Bill Namagoose has pointed out that the valley bottoms were most valued by his people, as they had the highest concentration of wildlife (*Panascope* magazine, July 1993).

Hydro Quebec has argued that the area flooded is not as great as claimed, because

some of the area in the reservoirs was underwater already, as lakes and rivers. This shows a disturbing level of environmental naivety on the part of Hydro Quebec. The wildlife value of a water/land ecosystem is highly concentrated at the margins: these margins have, of course, been lost.

Even more serious ecologically, submergence of the vegetation under the reservoirs without first clearing the area has led to acidification of the water, which in turn has caused leaching of toxic mercury from the soils. This has caused severe damage to wildlife and, further, the fish that remain are so contaminated with mercury that they are unfit for human consumption.

A document on hydropower published by the World Bank (*The World Bank's new policy on Environmental Aspects of Dam and River Projects*, by R Goodland) in fact ranks hydropower as the fourth most environmentally unfriendly of the 10 major power sources, with only oil/gas, coal and nuclear as presenting worse environmental hazards, with conservation, solar, wind and wave, geothermal and biomass energy all considered to be less environmentally damaging than hydro.

The Bank recognises that hydro is not truly renewable and sustainable, because construction always destroys some land, and with it terrestrial and aquatic ecosystems and fish migrations; water quality can be reduced because of increased standing water relative to flow; downstream floodplains and water tables are altered. And dams always silt up in the end: when this happens the energy source has vanished, but the landscape with its associated ecological, agricultural and social value cannot be replaced.

It is almost inevitable that energy generation on the scale of the Hydro Quebec projects, where the aim is to exploit the natural environment to generate revenue by selling power to industrial projects such as aluminium smelting (in fact, the scheme may not in the end have turned out to be a profitable venture for Quebec, but that is another story) will entail environmental destruction. Whether that destruction is the price worth paying for the associated gains in revenue is a separate question; but first of all, we must not fool ourselves into thinking that hydro power is environmentally friendly.

Kate de Selincourt
London

The case for Magnox

THE CALL by the Coalfields Communities Campaign for a Monopolies and Mergers Commission inquiry into Nuclear Electric's Magnox stations (*Energy World*, October 1993) perpetuates many misunderstandings about the economics of those stations.

I would like to take the opportunity to correct just a few.

First, the treatment of most of the Magnox fuel costs as unavoidable reflects the nature of the work to be done, not just the form of contractual arrangements between BNFL and ourselves. Even if the Magnox stations were to be closed immediately, BNFL's reprocessing facilities would still need to run for a

number of years to handle the final reactor cores and the fuel already discharged. And, because reprocessing is a capital intensive activity, most of BNFL's charges to us for that work reflect money already spent.

Second, BNFL's chief executive did not say to the Select Committee that £2 billion in Magnox fuel fabrication and reprocessing costs could be avoidable if all Magnox stations were closed immediately. What he actually said was: "Off the cuff I would say that something *in excess of* £3 billion of that £5 billion *would still be required* to deal with irradiated fuel". BNFL's written reply equates this to approximately 0.4 p/kWh which is entirely consistent with the figures we put forward.

Last, and most importantly, a thorough review of Magnox economics has already been carried out by Government and the Select Committee. Information on the BNFL contracts was supplied in confidence to both and the independent consultants' report to Government, which was also made available in full to the Select Committee, confirmed the validity of the Magnox figures we put forward.

A further inquiry will not change the truth, which is, that closing the Magnox stations does not make economic sense.

Stephen Ogle
Financial Control Director,
Nuclear Electric

Energy World — helping to get your message across

An advertisement in *Energy World* is seen by the professionals who really matter in the energy industries. For friendly advice on our entire range of advertising and promotional services, contact:

Harris Howland on tel/fax: 0622 850100



Chartered engineer wins top prize

THE ENGINEERING profession's top environment award has been won by a consultant chartered engineer for the development of a machine to recycle waste concrete from readymix lorries and on-site concrete mixers.

The Engineering Council's 1993 Environment Award for Engineers, sponsored by British Gas, was presented to Anthony Convery of Cookstown, Co Tyrone, in October, at a ceremony at the RSA, London.

Mr Convery, who received £3000 and a specially commissioned trophy, developed and produced a working prototype of a machine that processes waste readymix concrete by separating sand, aggregate, cement and liquid, enabling the materials to be reused in future mixes.

The invention is now selling worldwide to the concrete and construction industries.

Second prize in the competition was won by a team of engineers from Simon Holder Ltd of Bury, Lancashire. Brian Pearson, Andrew Tomlinson CEng, Leonard Lawrie and John Bamber have successfully converted a linearboard mill in Florida to the manufacture of completely recycled board.

The team conceived, designed and constructed a recycled fibre plant for the Seminole Kraft Corporation to replace equipment producing linerboard from virgin pulp. The mill is now the largest in the US, produced 100% recycled products.

Third prize, of £1000, went to a five-man team from Grant Instruments (Cambridge) Ltd. They were responsible for a project to develop a water quality logging system for the National Rivers Authority.

Said Professor Michael Burdekin of UMIST, chairman of the judging panel: "The engineers' skill in matching environmental requirements with the commercial reality of achieving improvements in efficiency and cost saving are clearly demonstrated by the innovative projects competing for the award."

"Products and processes are not only contributing to solving today's environmental problems, but will lessen future environmental damage."

The competition was open to individuals registered with the Engineering Council — chartered and incorporated engineers or engineering technicians — and to teams of engineers and technicians which included at least one member who is registered. Entrants had to have had responsibility for the design, manufacture or construction of an engineering project or process which provides an engineering solution to an environmental problem.

Among the judges were Roger Jump of PowerGen plc, Sir John Mason of the Centre for Environmental Technology and Pat Weatherill of British Gas.

Winning inventions improve the environment

ATMOSPHERIC pollution in Europe and the Far East, and the quality of drinking water in south east England and southern Africa are benefiting from inventions recognised in the two previous years of the Engineering Council's Environment Award for Engineers.

The 1991 winner of the award was a team from Babcock Energy Ltd, who had developed a fuel system burner, capable to reducing NOx emissions from coal-fired power stations by 55%. Now marketed as the Babcock Low-NOx Axial Swirl burner, the device has been installed in power stations in the UK, Italy, France, Denmark, Finland, Poland, Hong Kong and China.

Altogether 528 units have been ordered worldwide, with another 344 on order and options on a further 144. Last year the company also won the Queen's Award for Technological Achievement for the design, development and application of the device.

But perhaps the most significant statistic is that the units in operation so far are estimated to have reduced NOx emissions at the power stations concerned by a total of

280 000 tonnes per annum.

The second-placed project in 1991 involved a team from the Department of Engineering at the University of Leicester, who developed a low-tech water purification system for use in developing countries.

The system uses the crushed seeds of the moringa oleifera plant as the coagulant necessary to remove suspended material, including bacteria, from river water, rendering it suitable for human consumption. A pilot plant in Malawi has proven the system, and full implementation is expected in early 1994.

The winner of the 1992 competition was a team from GEC of Urmston, Manchester. The team had developed high-efficiency fixed blades for use in the latter stages of low pressure steam turbines. These blades substantially reduce CO₂ and SO_x emissions from coal-fired power stations.

Second place in 1992 went to a team from Thames Water responsible for developing an advanced water treatment process that will be applied to all of London's drinking water.

Environmental code of practice launched

A CODE of professional practice on engineers and the environment was launched by the Engineering Council in October.

The nine-point code comes into effect on 1 March 1994, and aims to encourage greater awareness, understanding and effective management of environmental issues among its chartered engineers, incorporated engineers and engineering technicians. Production has been jointly sponsored by Lloyd's Register and the Department of the Environment.

The code urges engineers to work to enhance the quality of the environment, whilst maintaining a balanced discipline and a comprehensive approach. It also calls upon them to make systematic reviews on environmental issues, and to seek environmentally cost-effective solutions, as well as encouraging management to follow positive environmental policies.

The proposed code also encourages engineers to act in accordance with the codes of conduct of their professional disciplines; to ensure they comply with legal requirements; update their knowledge, understanding and skills of environmental review techniques; and encourage public understanding of environmental issues.

The code was launched at the RSA in London, and marks a step towards closer collaboration between the RSA and the Engineering Council on environmental issues.

Support guidelines will be available in 1994.

Funds required for school technology

NEW proposals were issued in October by the National Curriculum Council on the teaching of technology in schools.

The revised proposals are simplified and better define subject boundaries. The Engineering Council has welcomed the introduction of a new area in the technology curriculum, which looks at products and their applications. Denis Filer of the Council described the recommendation as a major victory for commonsense, but he went on to stress that the changes required underpinning by extensive in-service teacher training and provision of adequate resources for materials and equipment.

Welcoming the new proposals, Mr Filer said: "The revised proposals will make the subject of technology much easier to teach. It will also help prevent the possibility of another catastrophic dilution through misinterpretation, which happened when the subject was initially introduced, resulting in 'Mickey Mouse' technology, and instances of children designing but not making anything. The Council would expect the Government to ensure that subjects combined with core technology were relevant. A proliferation of different GCSE examinations under the heading 'technology' would create problems in managing the delivery in schools. This would result in confusion among parents and employers as to what had actually been studied."



November 1993

Making energy privatisation work: the future of regulation

Conference, 17 November, London. Details from Institute of Energy, Conference Department, 18 Devonshire Street, London W1N 2AU. Tel: 071 580 0008; fax: 071 580 4420.

Practical implementation of EC gasoline vapour emission control directives

Conference, 25 November, London. Details from Caroline Little, Conference Officer, The Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR.

Sub-Saharan oil & minerals

Conference, 29-30 November, Cape Town. Details from Europe Energy Environment Ltd, 071 493 4918; fax: 071 355 1415.

Environmental monitoring for land, air & water

Short course, 30 November — 2 December, University of Sunderland. Details from Dr Salam, School of the Environment, Benedict Building, St Georges Way, Sunderland SR2 7BW. Tel: 091 515 2711; fax: 091 515 2741.

December 1993

Low-cost energy savings

One-day seminar, 2 December, London. Details from The School of Business and Industrial Management, Caxton House, Wellesley Road, Ashford, Kent TN24 8ET. Tel: 0233 622101; fax: 0233 611771.

Electricity — getting the best deal after 1994

Seminar, 3 December, London. Details from Mrs Ann Chapman, Course Secretary, Mid Career College, PO Box 20, Cambridge CB1 5DG. Tel: 0223 880016; fax: 0223 881604.

Geographical information systems (GIS) and the environment

Course, 6—7 December, Leeds.

Details from Miss Julie Charlton, Department of Fuel and Energy, University of Leeds, Leeds LS2 9JT. Tel: 0532 332494; fax: 0532 332511/440572.

UK & European gas price, supply & demand

Conference, 6—7 December, London. Details from Maura Fay, IBC Financial Focus Ltd, 57/61 Mortimer Street, London W1N 7TD. Tel: 071 637 4383; fax: 071 323 4298.

Environmental impact assessment & management — BS7750

Conference, 7 December, London. Details from Mrs Ann Chapman, Courses Secretary, Mid Career College, PO Box 20, Cambridge CB1 5DG. Tel: 0223 880016; fax: 0223 881604.

NEMEX '93

Conference & exhibition, 7—8 December, Birmingham. Details from ESTA, PO Box 16, Stroud, Gloucestershire GL5 5EB. Tel: 0453 873568.

Advances in water and effluent treatment

International conference, 8—10 December, Cumbria, UK. Details from Mrs Kristine Stones (Kit), Conference Organiser, BHR Group Ltd, Cranfield, Bedford MK43 0AJ. Tel: 0234 750422; fax: 0234 750074.

Life management of power plants

International conference, 12-14 December, Edinburgh. Details from Sheila Griffiths, Conference Services, IEE, Savoy Place, London WC2R 0BL.

Application of robotics for the nuclear industry

Conference, 13—14 December, London. Details from Liz Hide, IBC Technical Services, tel: 071 637 4383; fax: 071 631 3214.

The outlook for natural gas in the 1990s and beyond

Conference, 13—14 December, Vienna. Details from Financial Times Conference Organisation, 102—108 Clerkenwell Road,

London EC1M 5SA. Tel: 071 814 9770; fax: 071 873 3975/3969.

Non-CO₂ greenhouse gases. Why and how to control?

International symposium, 13—15 December, Maastricht, The Netherlands. Details from the symposium secretariat, Vereniging LUCHT, PO Box 6013, NL-2600 JA Delft. Tel: +31 15 69 68 84; fax: +31 15 61 31 86.

Energy and society: what legitimacy for energy systems in the 21st century

International symposium, 13-17 December, Paris. Details from Pierre Bauby EDF, Bureau 5/622, 2 rue Louis Murat, 75384 Paris Cedex 08, France. Tel (33-1) 40 42 68 05; fax: (33-1) 40 42 13 78.

Safety and risks in the energy industries

Seminar, 16 December, London. Details from Katie Rayner, tel: 071 9773 1312.

January 1994

Combined cycle power generation

International conference, January, Calcutta, India. Details from Prof Prabir Basu, Dept of Mechanical Engineering, Technical University of Nova Scotia, PO Box 1000, 1360 Barrington Street, Halifax, NS, Canada B3J 2X4. Tel: 902 420 7531; fax: 902 420 7640.

Applied rheology

Course, 10-13 January, Stevenage. Details from Miss S Gartside, Warren Spring Laboratory, Gunners Wood Road, Stevenage, Herts SG1 2BX. Tel: 0438 741122 next 2366; fax: 0438 360858.

Neutral computing applications

Conference, 12-13 January, London. Details from Ila Patel, tel: 0932 821947; or Howard James, tel: 0705 843151/268668.

The future of the nuclear industry

Conference, 18—19 January, London. Details from Liz Hide, IBC Technical Services Ltd; tel: 071 637 4383; fax: 071 631 3214

Middle East Electricity '94

Exhibition, 23-26 January, Dubai. Details from Yvonne Kemp, Project Manager, Middle East Electricity '94, Suite 12, Accurist House, 44 Baker Street, London W1M 1DH. Tel: 071 935 8537; fax: 071 935 8161.

Coalbed methane extraction

Conference, 24—25 January, London. Details from Richard Keown, IBC Technical Services, Gilmoora House, 57-61 Mortimer Street, London W1N 7TD. Tel: 071 637 4383; fax: 071 637 3214.

Mediterranean oil & gas exhibition and conference

25-27 January, Naxxar, Malta. Details from Spearhead Exhibitions Ltd, Rowe House, 55-59 Fife Road, Kingston upon Thames, Surrey KT1 1TA. Tel: 081 549 5831; fax: 081 541 5657/5016, 081 547 2807.

Combustion instrumentation and control

Course, 31 January — 2 February, Leeds. Details from Miss Julie Charlton, Dept of Fuel & Energy, University of Leeds, Leeds LS2 9JT. Tel: 0532 332494; fax: 0532 332511/440572.

February 1994

Fire engineering strategies for complex buildings

Seminar, 17 February, Manchester. Details from Mid Career College, PO Box 20, Cambridge CB1 5DG. Tel: 0223 880016; fax: 0223 881604.

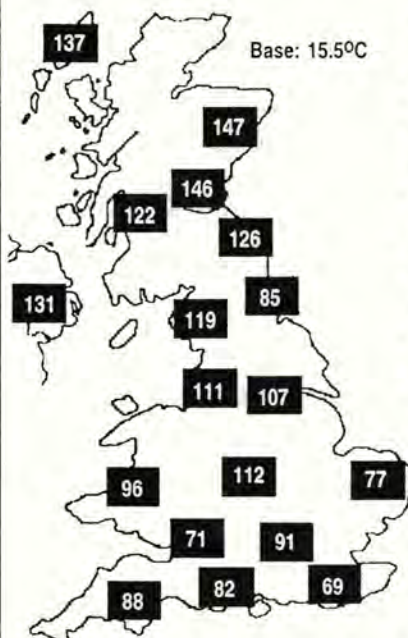
March 1994

Advances in turbo-engineering

Conference, 2/3 March, Aachen, Germany. Details from VDI-GET PO Box 10 11 39, W-4000 Dusseldorf 1 Germany.

DEGREE DAYS: SEPTEMBER 1993

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)

© Vilnis Vesma, 1993. Because different observing stations are used, the figures given here will not necessarily agree exactly with those from other information providers.

The City Council wants to employ more disabled people, therefore applications for the following post will only be accepted from people with disabilities.

Applicants who would like further information or help in completing the application form are very welcome to use the Joblink service by contacting Sylvia Coles. Phone 483500 ext. 4516.

THIS POST IS RESERVED FOR DISABLED APPLICANTS ONLY

Assistant Engineer

Energy Management

Scale SO1 £15,669 - £16,710 pa

An experienced electrical/mechanical engineer who is a member of an appropriate professional institute and has a practical knowledge of working on site is required to assist the Energy Management Service Manager in the monitoring of day to day fuel usage and in the implementation of energy management policies throughout the Authority.

Previous experience in conducting energy surveys is essential. A knowledge of computerised energy information systems and electrical/mechanical design is desirable.

It should, however, be noted that Lawrence House, where the post will be based, has no wheel chair access.

Applications are particularly welcome from women, Asians and African Caribbeans as they are currently under represented among our employees.

Application forms and further details available from the Personnel Manager, Chief Executive's Department, The Guildhall, Nottingham NG1 4BT. Tel: (0602) 350700. Minicom service office hours only. Answerphone after office hours. Please note that CVs cannot be accepted. **Please quote ref. DP/0597** on all correspondence and enquiries.

Closing date: Noon, 29 November 1993.



An Equal Opportunity Employer



City of

NOTTINGHAM

INSTITUTE OF ENERGY PUBLICATIONS

The Institute of Energy publishes a variety of books each year in the form of conference proceedings. Many of these are available to you.

Combustion & Emissions Control, Cardiff, 1993	£30	Fuels For Power Generation	£17
		London, 1993	
Energy in the Single Market	£7	CHP: Creating Higher Profits	£7
London, 1992		London, 1991	
Fire & Explosion Hazards: Energy Utilisation, 1991	£12	Challenges in Energy Statistics	£7
		London, 1991	

If you would like to receive a full publications list or further information, please contact **Louise Evans** at the **Institute of Energy Conferences Dept, 18 Devonshire Street, London W1N 2AU**, Tel: (+44) 71 580 0008 or fax (+44) 71 580 4420.

INSTITUTE OF ENERGY CONFERENCES

Please note that the conference programmes are subject to modification. For the latest information please telephone Judith Higgins on 071 580 0008.
The Institute of Energy, 18 Devonshire Street, London W1N 2AU, UK.

Modernising Central Europe's Energy Opportunities & Experience

Organised in association with the Parliamentary Group for Energy Studies

9 March 1994, London

The Church House Conference Centre, London SW1

Senior figures have been invited to address financial and political aspects of the subject, issues such as: options for institutional/structural change, the role of financial and technical assistance and its effectiveness. The afternoon session will focus on the opportunities and experience of major players in the UK. The areas covered include: Power Generation — international ventures the theoretical opportunities and practical solutions; Networks on upgrading and expansion; and opportunities for British Expertise with observations on the opportunities available and those presently being missed.

2nd International Conference on Ceramics in Energy Applications 20-21 April 1994, Regent's College, London W1

Pre-conference reception evening 19 April.

This two-day conference will consider material solutions to new and existing applications of interest to energy suppliers and users. Important aspects of materials innovation in energy saving will be explored. Sessions will cover the following areas: New Developments & Applications; Energy Saving & Heat Transfer; Evaluation & Performance; Power Generation; Sensors & Catalysts and Energy Efficiency.

Autumn 1994

Internationalisation of the Energy Business

Winter 1994

Energy From Waste

Preliminary Ideas for 1995

- Performance of Large Gas Turbines — technical conference
- Air Pollution — achievements and experiences considering: authorisation, monitoring & compliance
- Energy labelling
- Demand Side Management

Preliminary Ideas for 1996

- Storage of energy
- Combustion and Emissions Control/2
- Security of Gas Supply
- Effective Energy from the Energy Supply/Supply Management
- Modernising Energy in Developing Countries

Events Co-Sponsored by The Institute of Energy

8 December 1993

Process Controls For Boilers & Furnaces

General Enquiries should be directed to:
David Suthers, Combustion Engineering Association,
PO Box 15, Farm Road, Aberaman, Aberdare,
Mid Glamorgan CF44 6YZ. Tel: 0685 879119

January 1994, Calcutta, India
First International Conference on

Combined Cycle Power Generation

General Enquiries should be directed to:
Professor Prabir Basu, Technical University of Nova
Scotia, PO Box 1000, Halifax,
Nova Scotia, Canada B3J 2X4, Tel: 1-902-420 7531