would be another source of ready power. A pumped-storage station — the largest in Europe — was under construction at Dinorwig in Snowdonia. This would be able to provide 1,300MW of power within 10 seconds and its full output (1,800MW) in less than two minutes. It would prove a major help in operating a system that was getting still more complex.

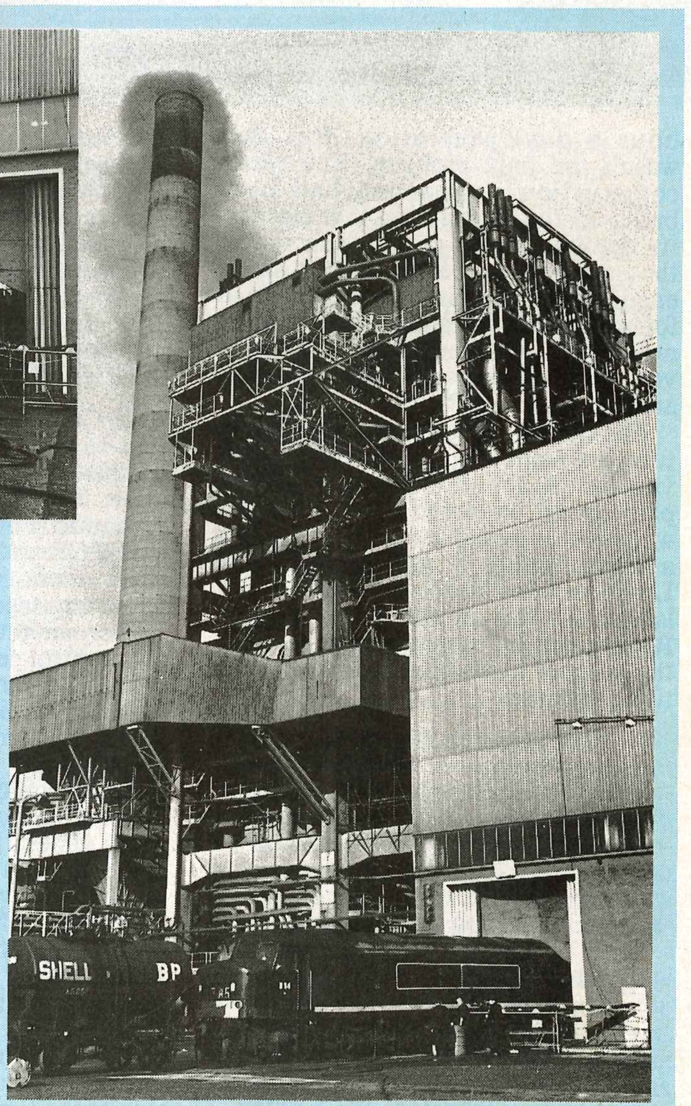
But the aim stayed the same — to give the cheapest supplies possible. If the South of Scotland Electricity Board had surplus generation available at the right price, supplies could be imported through the supergrid links. And Scotland wasn't the only country from which the CEGB could buy supplies. There had been a link with France ever since 1961. It didn't carry much current — just 160MW — and the cable was often damaged by ships' anchors and trawls. Even so it proved it worth. Because peak demands in the two countries came at different times, both countries could get the benefit of cheaper generation "from across the Channel".

With the benefit of that experience, a new 2,000MW link was planned in the 1970s.

John Yates of the Transmission Division managed the project, and it was a major job:

"This time we were going to bury the cables in the sea bed — which meant carrying out the most detailed hydrographic survey ever undertaken of that bit of the Channel. The machines developed for digging the trenches and laying the cables put Britain among world leaders in underwater technology. But now the link can delivery as much power to either country as one of Kent's largest stations . . . enough to supply the needs of over half Kent. Yet the whole project was only half the cost of a new power station — and even that was shared with the French."

The eventual result hasn't been quite the same. The availability of cheap French nuclear power has made the link something of a one-way system, but that hasn't lessened its usefulness.



The train now standing

WHAT are nice trains like you doing in stations like these? That question could be prompted by both these photographs.

The trains, or to be precise the diesel electric locos, are pictured running fast but standing still in a power station.

They were an innovative temporary solution to a rare but often time-consuming technical fault on a generator-exciter failure. The exciter provides the current for a main generator's field coils. Without the current there is no output from the generator.

The idea was demonstrated at Willington power station in 1968 when the armature on one of B station's 200MW units failed. While repairs were completed, the station hired a loco whose electric output was just what the generator wanted. the loco ran for 300 hours and the unit maintained full output.

Other power stations tried the same solution when they faced an exciter problem.

Probe in hand an acid-rain researcher works inside a climate-controlled "solar dome" greenhouse at the Central Electricity Research Laboratories at Leatherhead.

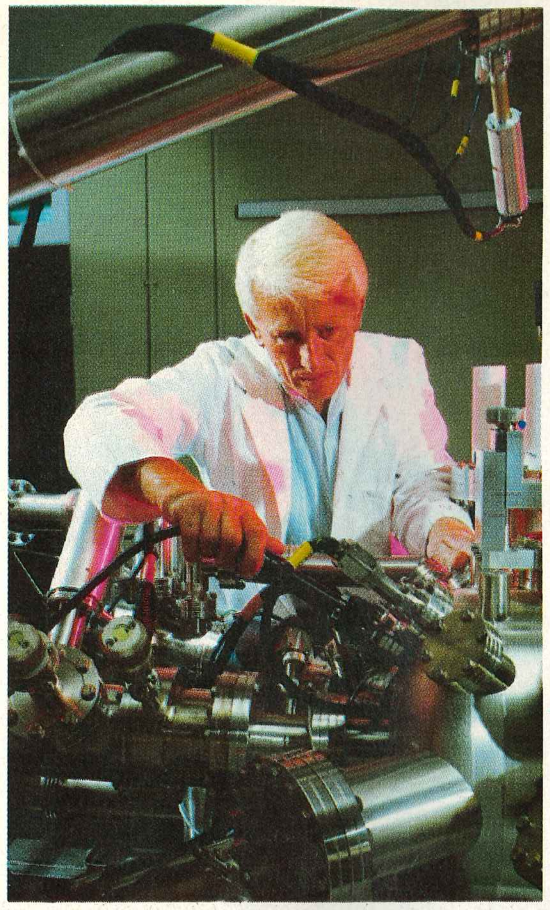
From 'pea soup' to marine biology

"THERE'S a war on — we've no time for research now." That was said by the CEB's Chief Engineer on the day war was declared in 1939. It was a natural reaction, but it doesn't reflect the part that research has played in the industry since the 1930s.

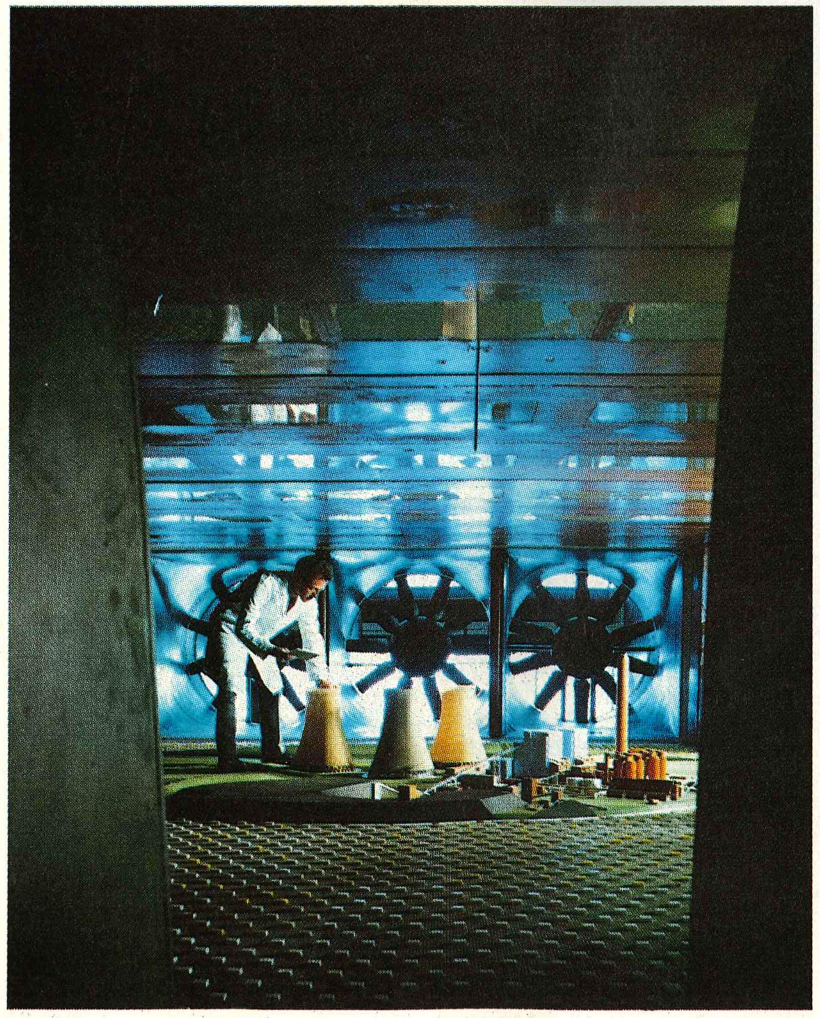
One of the big problems at that time was the effect that "pea-soup fogs" had on insulators, causing flashovers. Dr J S Forrest, in charge of research, said later: "My staff never numbered more than five but, in spite of the limited resources, useful work was done. We found the best type of insulator to withstand foggy polluted atmosphere by a method that has stood the test of time and which has been adopted in many countries."

That, plus techniques developed later for washing insulators on live lines and substation plant, was of vital importance in the 1950s. It was one of the major factors in deciding that a supergrid could be built and operated without hazarding the reliability of electricity supplies.

In the earlier days research was limited to the transmission field. This too developed, with investigations into the additional problems that the use of higher voltages would bring. But while the industry relied on manufacturers to develop plant design both in generation and transmission, Dr Forrest had already seen the need for a multi-discipline research laboratory capable of tackling much more —



Research was always the hidden side of the electricity supply industry. At peak the CEGB had up to 3,000 staff working on a bewildering variety of issues from nuclear physics to fish populations, reaction kinetics of burning coal to aerodynamics.



from boiler corrosion and the electrical science of machines to marine biology.

Some of that work was carried out in a collection of surplus US army huts at Teddington until a research laboratory was built at Leatherhead in 1950. But research requirements were growing rapidly, especially as the first nuclear programme was started. Leatherhead was extended and new laboratories were built at Marchwood and Berkeley.

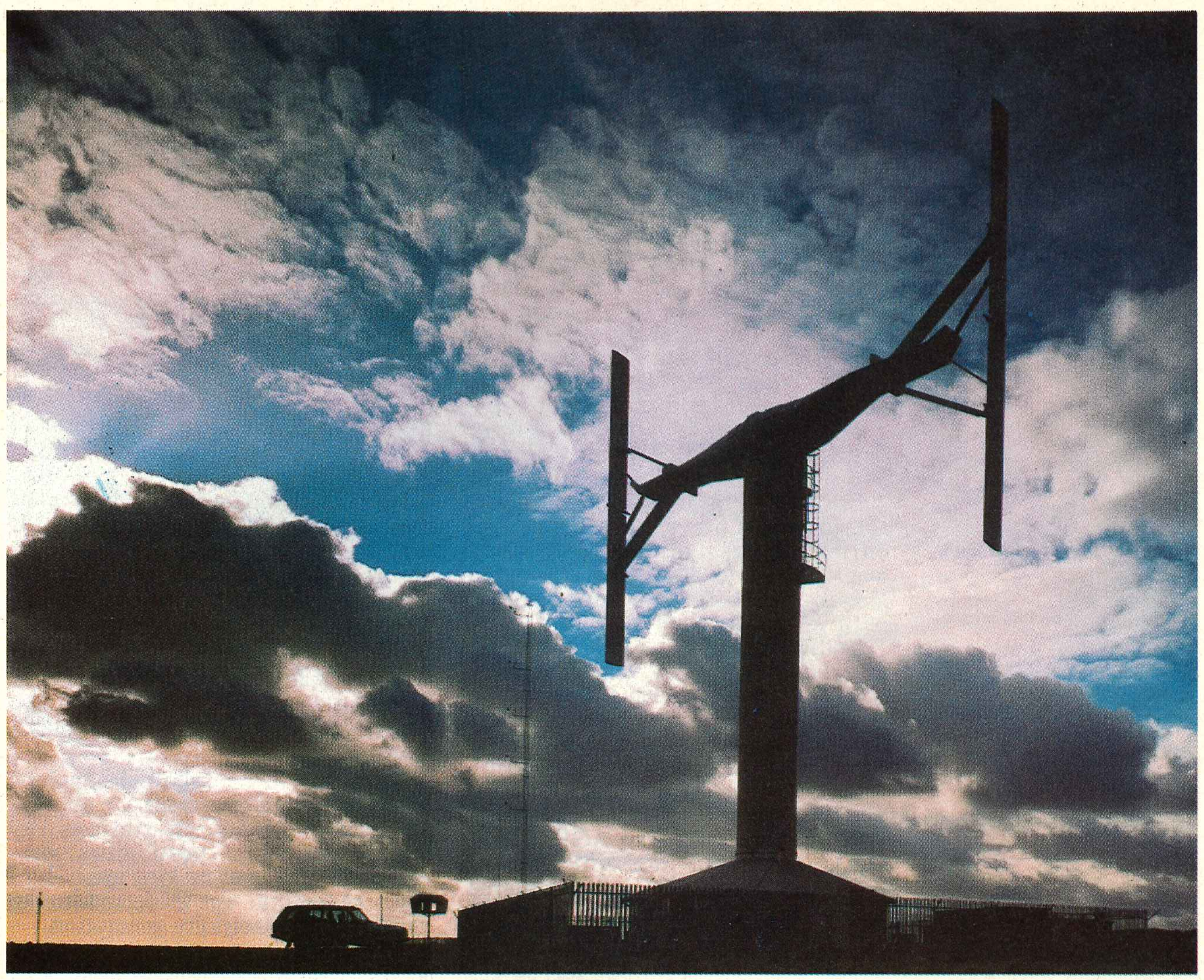
The range and extent of work was enormous. On the nuclear side alone, the Berkeley laboratories were dealing with a massive programme including work on corrosion inside reactors. Simulators were developed to enable nuclear station staff to be trained in normal operation and dealing with emergencies. Other major work was being done at Marchwood to enable repair and inspection to be carried out inside reactors using robot equipment.

There were difficulties involving other plant, including those thrown up by the early 500MW sets. But there has been a lot of work in a very different and fascinating field.

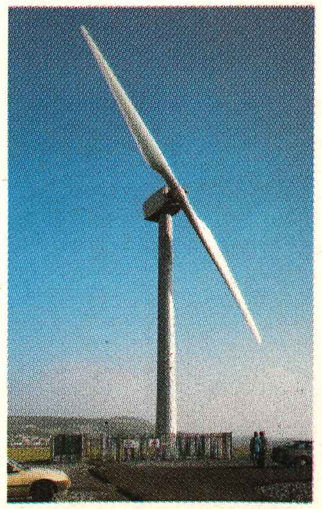
Since 1954 research staff have been involved in a very large environmental programme. Again the range of activities has varied greatly. One problem coal-fired stations faced was the disposal of pulverised fuel ash. Development work has enabled PFA to be used in building materials. Crops have been grown in areas filled with the ash. Marine and freshwater biology have played a considerable part — from preventing mussels fouling the pipes supplying coastal stations with cooling water to the culture of fish in the warm water outflows.

More recently acid rain has been featured in the press and on television. It has been blamed for the loss of freshwater fish in Scandinavia and Scotland, and damage to forests in other parts of Europe. It has been argued that air pollution is a major cause — especially chimney emissions of sulphur dioxide gases from power stations. The CEGB has questioned how far this is the case. [Plant in new stations is being designed to limit emissions which might be harmful. But the cost of modifying existing plant would be very high]. So it has been carrying out its own investigations and funding independent research to help establish the true causes.

From the small beginnings with only a handful of staff, research grew until at its peak almost 3,000 people were involved. It has been just another part of the work needed to ensure that supplies of electricity can be delivered reliably to the customer — without harming the environment.



The energy crises of the 70s raised interest in renewable energy sources such as wind, waves and tides. Interest was heightened in the 80s with growing public concern over environmental matters.



Keeping the lights burning

THE late seventies brought fresh problems. As a worldwide depression hit this country the CEGB was faced with an unprecedented situation. The demand for electricity fell — and it was to stay below the 1978 level for another six years.

Ironically this was at a time when the problems with the 500MW sets were coming towards an end, and the effects were evident. The Midlands Region even started a "Ten Billion Club" for stations which generated 10,000 million units a year.

CEGB planners were confident that demand would pick up again and that new stations would still be needed, even if not for the time being. But not everyone shared that view. Environmental pressure groups were arguing that energy conservation could meet all future requirements — or alternatively that use should be made of "renewable resources" like wind power.

The Chairman, Glyn England, had visited the United States to see what was being done in that field.

"I found that President Carter's people heading the alternative energy project were being very heavily funded by British standards, and came back with the clear view that we ought to be doing more in terms of practical experiments. As a direct result, the first wind machine was built at Carmarthen Bay, and I put

Power News

COAL: 'NOT OUR DISPUTE'

The teenage ice king

The main headline in Power News caught the flavour of the Board's response to the miners' strike. The CEGB's job was to keep the lights on, not to take sides in the dispute

British manufacturers on notice that, if it was successful, we would be in the market for wind turbines."

The CEGB's first wind turbine, installed in 1982 at Carmarthen Bay, in South Wales, had an output of 200 kilowatts, enough for a small village. Later other, larger, machines were tested on the site.

A much larger, one MW turbine, was commissioned at Richborough in Kent in 1989. Application was made for a wind park at Capel Cynon in Dyfed, Wales, with 25 wind turbines each with an output of 300 kilowatts. Two other sites with potential as wind parks were identified — in Cornwall and the North Pennines.

But useful as alternative energy sources might prove, in the latter seventies it was believed that they wouldn't be enough to meet a resumed growth in electricity demand and the need to replace older stations.

By the turn of the century the first generation of nuclear (magnox) stations would be shutting down. The Board was convinced that proposals for future stations should include a sizeable proportion of nuclear plant.

Early experience with the AGR programme hadn't been encouraging. Construction of the first AGR station at Dungeness ran into difficulties of the worst kind. Design problems meant that work started had to be redone. That was made worse by contractual difficulties on site.

Although the station had been intended to come into service in 1970 it was nowhere near completion — in fact the first reactor wasn't commissioned until 1985 — 15 years late. Hinkley Point B had fared better and started operating in 1976, thanks to a concerted effort by designers, the CEGB's nuclear specialists and station staff. The Hunterston B station in Scotland was also in service. But although those were given greater confidence in the AGR system, it was still too soon to judge its success. The CEGB needed an alternative.

Some years earlier, the Government had initiated a review of future possibilities and decided to adopt a programme with Steam Heavy Generating Water Reactors. The CEGB would have preferred the Pressurised Water Reactor system and Donald Clark, by then a Board Member, resigned in protest. Later studies showed the Board's view had been right. So when, in 1978, they put forward positive proposals, the Labour Government agreed there was a need to "develop the option of adopting the PWR system in the early 1980s" by ordering a first station.

The Conservative Government which followed was even more committed to nuclear power. In 1982 they appointed Walter Marshall, then Chairman of the Atomic Energy Authority, as the new Chairman of the CEGB. But the Board knew they would have a hard fight on their hands before they got final approval to build Sizewell B.

The public's attitude towards nuclear power was changing. In spite of the good safety record of the CEGB's nuclear stations, fears about the possible risks had increased — especially after the 1979 PWR accident at Three Mile Island in the United States.

The Sizewell B public inquiry was the longest ever held. But in 1987 approval was obtained and construction work started.

Already the Board had announced which sites were being considered for additional PWR stations, and within the next couple of years approval was sought to build another three.

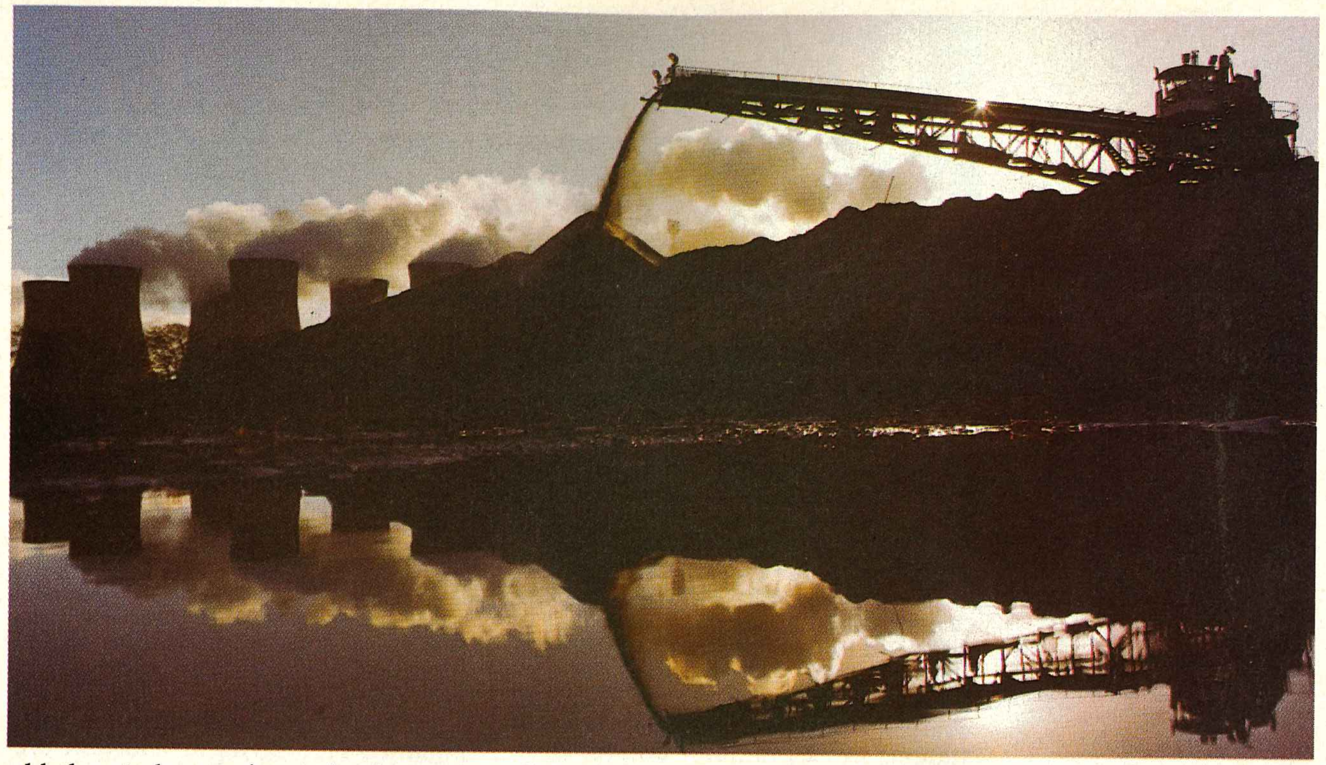
But other energy sources hadn't been ignored. In the late 1970s the CEGB had gone ahead with the second stage of Drax, making it the biggest coal-fired station in Western Europe.

That was to be followed some 10 years later with proposals for another three large coal-fired stations, by which time other possibilities were opening up, such as making use of supplies of natural gas expected to be available for electricity generation.

But in the meanwhile, March, 1984, had brought a major threat to existing electricity supplies — another miners' strike. This time there was a major difference. The Board had large stocks of coal at power stations — some 28 million tons, enough to last six months. But they still had to make a vital policy decision. Walter Marshall put it in a nutshell:

"If we thought the strike was going to be a short one, then the thing to do was to burn the mountains of coal we had. But if it was going to be a very long one, then we should switch electricity production to oil immediately to preserve coal. We knew that would be a very expensive policy. In six weeks we would be in the red by hundreds of millions of pounds, and it could soon mount up to a billion. In the end the overwhelming thing that mattered was to keep the lights on, and the decision was made to burn oil."

In fact the strike lasted 12 months. Fortunately, the Nottinghamshire miners had stayed at work and some coal supplies were coming through. But as the Chairman added: "It was only absolute determination throughout the entire organisation that en-



Silhouetted against the night sky even an ash conveyor can acquire a certain beauty . . . as this plant at Drax demonstrates.

abled us to keep going — by the most remarkable means."

System Operations used computer simulations to guide the operation of plant and get every last ounce of benefit from the fuel supplies available. Oil supplies were purchased on a vast scale in a way intended to minimise the visibility of the operation from price escalation and other factors. It entailed bringing oil in from different parts of the world by ships of many nationalities so as not to risk price rises if the extent of purchases became known.

In the Midlands Region, coal and oil were transported by road in a bigger operation than had ever been attempted — 500,000 tons of coal and 25,000 lorry movements a week, despite road-routing problems and the need to maintain good relations with communities affected.

The Regions changed from coal to oil burning on an unprecedented scale, with plant not yet fully commissioned being run at high loads.

All in all, it involved the most highly co-ordinated management exercise in the CEGB's history — with the whole operation having to be carried out in a way that wouldn't create political and industrial relations problems. The strike cost the CEGB £2,000 million. But the lights had stayed on, and during that winter the highest-ever maximum demand was met without load shedding. As Frank Ledger commented, it showed the CEGB at its best.

The strike wasn't the only thing concerning many staff at that time. Once again they were being faced with another reorganisation.

As far back as 1976 a Labour Government committee had recommended changes in the structure of the industry. During the next couple of years there was speculation that all-purpose power boards would be set up, responsible for both generation and distribution as in Scotland. When a Conservative Government followed, no-one knew what might happen.

The Generating Board already had its own views of what was needed. There had been some changes since the major reorganisation of the early sixties. A Generation and Construction Division had been created, based at Barnwood, matched by a Transmission Design and Construction Division at Guildford. But the number of power stations the CEGB inherited had dropped from 253 to 131 without any major change in the way the organisational side was managed. This was about to alter and Gil Blackman, them a Board Member, had firm ideas.

'We didn't bring in consultants. We realised we had the knowledge and certainly the talent to do it ourselves. So we set up an organisational development unit which looked at the industry and asked what it was doing and why. The answer gave us the four main elements of production.

"The first was generation, and that could easily be handled as a single management unit. So could transmission. That left the overall job of operating the system and the engineering side — looking after the plant when it was built. That was the bible on which we were proceeding and everything was well under way when suddenly we were told we were going to be privatised."