

first served".

Now that word of the new regulations has percolated to the universities, the Engineering Board's objective of increasing the amount of postgraduate study seems well on the way to being achieved. The Engineering Board has set itself a target for this year of 435 research studentships and 535 advanced course studentships, and gives the impression of being prepared to spend more in future years if only it can attract suitable applicants.

In science subjects, where the rules are unchanged, the target for the award-making season is virtually the same as last year — 769 research studentships and 435 advanced course studentships. These awards are made on the nomination of university and polytechnic departments on the basis of quota allocations by the various subject committees of the Science Research Council. Even so, there is some evidence that the volume of applications is greater than in 1979.

The parallel operation of these two systems is likely to throw an interesting light on the workings of the quota system. Although (outside engineering) the quotas are fixed by the SRC subject committees after a necessarily subjective estimate of the capacity of individual departments to provide training in research, many of those who wish to see a further concentration of research support on departments with high reputations have regarded the quota system as an impediment to change. Would-be engineering research students are in the circumstances more free to decide where to settle, for which reason a comparison of the distribution of research students in science and engineering will be of some interest when the award-making process is over.

Applications for postgraduate awards have also increased under the SRC's scheme for Cooperative Awards for Science and Engineering (CASE) although a relaxation of the rules may again have helped. CASE studentships involve research projects worked out in partnership by a university department and an industrial company, which in previous years have had to be approved by the SRC before a student award can be made. For the first time this year, university departments have been allowed to nominate a student while seeking approval for a project, although an award remains conditional on the students' performance in the degree examinations.

The target for CASE studentships this year is 760, but clearly the SRC would again spend more if there were a sustained demand. It is, however, something of a surprise that the council has been able to build up to 700 awards a year in less than a decade of CASE studentships.

The apparent buoyancy of demand for postgraduate awards is somewhat at odds with reports that many new graduates are this year more anxious to find permanent

jobs than to remain in research. By the end of the summer, it is also possible that much of the demand may have melted away. One of the hazards of the process is that awards offered are not always taken up, sometimes because applications are made in duplicate. The SRC's record of this kind is that of a husband and wife who each made sixteen separate applications.

NPT review conference

Smooth start

The Second Review Conference of the Non-Proliferation Treaty (NPT) got off to a smooth and predictable start in Geneva last week. From the opening declarations which delegates to the conference were making in the first six working days, it is plain that the non-nuclear weapons states which are parties to the treaty will be urging that the nuclear powers have made too little progress too slowly towards strategic disarmament, and that the restrictions imposed on trade in nuclear materials in recent years are both a violation of the treaty and discriminatory against developing countries.

Delegates from nuclear weapons states are however heartened that these protests have been couched in moderate language. For their part, the nuclear weapons states (the Soviet Union, the United Kingdom and the United States) have been making much of the report on the comprehensive test-ban negotiations submitted to the Committee on Disarmament at the end of July and of the Committee on Assurance of Supply set up under the International Atomic Energy Agency and due to hold its first meeting at the end of September.

Procedural matters appear to have caused so far the few anxieties that have flitted across delegates' minds at Geneva. As planned by the preparatory conferences, however, the Iraqi delegate was in the end appointed chairman of the conference. It has been agreed that most of the work will be done by two committees which met for the first time on Tuesday and which are concerned respectively with progress towards disarmament and security of supply.

Work on the drafting of the conference report will begin next week, and although everybody seems reconciled to the notion that the report will refer to the discontents of the non-nuclear powers, it was hoped last week that a consensus document would be agreed.

For the most part the nuclear powers presented a united front in their formal speeches, drawing attention to the need to strengthen the NPT system and to the detailed character of the report on the comprehensive test-ban negotiations. At one point, however, the Soviet delegate did seek to embarrass the United States by pointing out that Salt II would by now have been ratified had it not been for the United States Congress.

The discontents of the non-nuclear powers, expressed in several of the formal statements, were eloquently put by Mr Domingo Siazon, the leader of the Philippine delegation, who argued forcefully that restrictions on the supply of nuclear materials devised in the past few years by nuclear suppliers were a violation of the NPT, and that signatories of the treaty such as the Philippines, having signed in good faith, had every reason to expect that the nuclear powers would honour their undertaking to provide nuclear materials, fuel and equipment, without discrimination.

It is planned that the review conference will end on 5 September.

Windmill power

UK gets wind

Windmills seem to be on the march in Britain. Officials at the Central Electricity Generating Board (CEGB) will embark this summer on the choice of a site for a large windmill which the board plans to order in 1983 and commission by 1985.

The decision to buy a windmill, announced last week, seems to indicate that the board has decided to take wind power seriously. It is the first piece of alternative energy technology to be bought by the board, Britain's sole electricity utility, on a commercial basis. The early announcement of the plan is intended to stimulate British industry to develop an improved machine by 1983.

The CEGB's plan is to choose a site where other windmills could be built later to assess the characteristics of windmill arrays. It is prepared to spend about £10 million on building ten 1-MW machines. The first windmill will be a 1-MW machine, probably of horizontal axis, with a blade span of no less than 200 ft suspended 150 ft above ground. While industry is busy working on new designs to compete for the order, the CEGB will be gaining operating experience on a smaller 100-kW machine which it hopes to buy as soon as possible.

The apparent sudden interest in wind power has been stimulated by recent developments in the United States. Hamilton Standard, an American company which has pioneered wind-turbine technology, has recently claimed to have designed a windmill which could bring down the cost of wind-generated electricity to as little as 1–2 pence per kWh. Previous best estimates of cost have been about 3–4 pence per kWh.

Undoubtedly, these low estimated costs have stimulated interest in wind power within the CEGB. It is too soon to know what part windmills will eventually play in the pattern of the CEGB's electricity generation. Intermittent generation is an obvious problem unless pumped storage is available. The CEGB says that the chief contribution will be in saving fuel.

Costs of generating electricity from

power stations now being built range from 2.28 pence per kWh (nuclear) to 3.59 pence per kWh (coal). If, because of intermittent generation, windmills do not reduce the total need for installed capacity, however, the cost of wind-generated power should be compared with the costs of fuel in conventional stations, 0.61 pence per kWh (nuclear) and 2.30 pence per kWh (coal).

Hamilton Standard claims to have applied some of the principles involved in building helicopters to the design of a flexible windmill capable of bending in the

wind and responding to wind coming from different directions. Until now, most windmill designs have assumed the need for a large rigid structure capable of standing up in gales and for very strong rigid sails to withstand opposing gravitational forces. Hamilton Standard is now saying that a bendy windmill can withstand considerable forces and can be built more cheaply because less material is needed.

A cheaper windmill could also operate economically in wind speeds of only 6 m s^{-1} to operate effectively. The ability to

respond more sensitively to variations in wind direction also suggests that a flexible design of windmill might be successful in relatively low wind speeds.

In the light of these considerations, the CEBG says that it will be looking at flat inland sites, probably in the east of England, as well as hilltop sites for its first big windmills. A low inland site would have the added advantage of causing less environmental trouble than a hilltop in the rural areas of Scotland or Wales.

Judy Redfearn

Nuclear generation costs compared

The report of the Central Electricity Generating Board (CEGB) for the year to the end of March 1980 includes a detailed analysis of the costs of generating electricity from power stations of different types which is likely to be much quoted in the months ahead, when plans are being laid for the further development of the British nuclear power programme. The figures now published represent a departure from previous practice in that the assumptions on which they are based are stated more explicitly than in the past, with allowance being made for elements of cost such as the interest paid during the period of construction and the cost of decommissioning the stations concerned.

During the past year, the cost of nuclear power generated from the first generation of British "Magnox" stations was less than that of electricity from coal or oil. The costs for the past year are shown in the accompanying Table 1.

Part of the reason why the nuclear costs turn out to be so advantageous is that the initial capital costs of the Magnox stations, built between the late 1950s and the late 1960s, are much lower than present-day replacement costs would be. Although the same is true of the capital costs of conventional power stations, the fact that nuclear capital costs represent a greater proportion of the total implies that the figures are not a reliable guide to the costs of building new power stations of the same types.

One surprising feature of the CEBG's operations during 1979-80 is that the load factors of the nuclear stations were more or less the same as those of conventional stations. Electricity generated by the nuclear plant amounted to 70 per cent

of net capacity, compared with 69 per cent for coal-fired stations and 77 per cent for oil-fired stations. Originally, it was intended that the nuclear plant in the British generating system should be run at virtually full capacity; the board says that the lower load factors now being obtained from the nuclear power stations reflect their increased age. The costs of electricity generation are obtained by dividing the total cost of operation by the amount of electricity generated and thus increase as load factors decline.

Table 2 Costs for Hinkley B (AGR) and Drax (coal-fired)

| | Hinkley Point B p/kWh | Drax first half p/kWh |
|---|--------------------------|--------------------------|
| Capital charges and provision for decommissioning | 0.37 | 0.12 |
| Interest during construction | 0.18 | 0.04 |
| Inclusive fuel costs | 0.55 | 1.25 |
| Other costs of operation | 0.16 | 0.09 |
| Research | 0.07 | 0.01 |
| Training | 0.02 | 0.01 |
| Total | 1.35 | 1.52 |

The CEBG's annual report also provides costs on a comparable basis for two of its newest power stations — the Advanced Gas-Cooled Reactor station (the first of its type to be commissioned) and the newly-completed Drax coal-fired power station. The figures are shown in Table 2. The load factors for the AGR station (Hinkley Point B) and Drax were 55 per cent and 74 per cent respectively. The poor availability of the AGR reflects the difficulties in bringing this station into operation. It may seem remarkable that, in the circumstances, the cost of electricity generated is not much greater than that from the older Magnox station.

Mainly because of inflation, the CEBG

expects nuclear costs to rise. The net cost of electricity from the three AGR stations soon to be commissioned (Dungeness B, Hartlepool and Heysham I) are estimated at 2.62 pence per kWh, 2.28 pence per kWh and 2.31 pence per kWh respectively. The increase is largely attributable to increased capital costs, three times as great as those for Hinkley Point B. At the same time, the board estimates that the cost of conventional electricity will have increased still further, with oil-fired plant producing electricity at a cost of more than 6 pence per kWh and the second half of the coal-fired Drax station producing electricity at 3.59 pence per kWh.

For the first time, the CEBG also provides figures to show the basis on which future investment decisions are being made. The principle is that of discounted cash flow in which future costs are represented by a present cost using a discount rate of 5 per cent per annum. The board also makes the assumption that the price of coal will increase at an average rate of 2 per cent a year at least until the end of the century and notes that the cost of building generating plants of all

Table 3 Overall comparison of costs for nuclear and coal-fired stations

| | Nuclear p/kWh | Coal-fired p/kWh |
|---|------------------|---------------------|
| Capital charges at station and provision for decommissioning* | 1.39 | 0.76 |
| Interest during construction* | | |
| Inclusive fuel costs | 0.61 | 2.38 |
| Other costs of operation | 0.22 | 0.21 |
| Generation costs | 2.22 | 3.35 |
| Less fuel saving from displacing less efficient plant | 2.68 | 3.02 |
| | -0.46 | +0.33 |

kinds has recently been increasing faster than inflation. The calculations now published, and summarized in Table 3, show that a nuclear generating plant has potential advantages over a coal-fired plant both in generating electricity more cheaply and in its effect on the economics of the generating systems as a whole — assuming that nuclear plants would displace less efficient plants, the Net Effective Cost of nuclear generating capacity becomes negative, implying a net saving for each power station built.

Table 1 Costs of power generation by Magnox, coal-fired and oil-fired stations in 1979-80

| | Nuclear (Magnox) p/kWh | Coal-fired p/kWh | Oil-fired p/kWh |
|---|---------------------------|---------------------|--------------------|
| Capital charges and provision for decommissioning | 0.34 | 0.09 | 0.14 |
| Interest during construction | 0.06 | 0.02 | 0.02 |
| Inclusive fuel costs | 0.60 | 1.29 | 1.61 |
| Other costs of operation | 0.26 | 0.14 | 0.14 |
| Research | 0.03 | 0.01 | 0.01 |
| Training | 0.01 | 0.01 | 0.01 |
| Total | 1.30 | 1.56 | 1.93 |