CORRESPONDENCE

Geothermal electricity

SIR,— Richardson and White[1] have raised the interesting possibility that electricity generation from geothermal aquifers in the UK might be an economic proposition. It is unfortunate, however, that they have supported their proposal with spurious comparisons; for example, comparing the performance of purpose-built (and as yet undeveloped) organic Rankine cycle generating plant with conventional unadapted district heating systems.

They state that district heating ". . .has dominated official thinking for several years. . ." and cite[2] Energy Paper No 9. I would not in general wish to defend that development, which is now outdated, but it actually says (p.51): ". . .it seems that district heating would be economic only if higher temperatures or higher housing density were to become available".

Current thinking is that the major market for heat from geothermal aquifers in the UK (as in France) will indeed be for space heating, but at the group rather than district level. Heating of only a few large buildings from each pair of wells (doublet) is envisaged, which would be located as close to the buildings as possible. Few aquifers in the UK seem likely to yield temperatures in excess of 80°C, so it will be necessary to instal heating equipment capable of (1) operating at temperatures lower than those used in conventional systems and (2) extracting as much heat as possible from the geothermal fluid. These conditions have already been met in France, and suitable equipment is available. In particular, rejection temperatures can be nearer 25°C than the 60°C envisaged in ref. 1.

In the operation of a resource with a high capital cost and a low running cost resource such as geothermal energy, there is a powerful incentive to maximize the load factor. In the French installation a conventional boiler plant is used in parallel with the primary geothermal circuit, allowing geothermal to meet the "base" heating load while peak demands are met by fossil fuel. In this way, a geothermal doublet designed to meet 40% of the peak demand can typically supply 70% of the buildings' annual energy needs while achieving a load factor of 60% or more[3]. The relative capacities of geothermal and conventional plant will be determined by local conditions — including cost of conventional fuel at the site; analysis of the heat demand curve for similar buildings in the UK[4] suggests that comparable figures for a UK geothermal scheme would be about 50%, 89%, and 74% respectively.

In comparing the two modes of use, we recognize that in the UK, calculations must be based on estimates and will be of value only in assessing relative rather than absolute performance. For consistency, the approach adopted by Richardson and White[1] has been used to calculate the relative performance of electricity generation and group heating for a range of probable UK aquifer temperatures and attainable flow rates. The capital cost of the doublet (£1m) and the pumping power required (250 kWe) have been assumed constant for all cases. For group heating, the geothermal system is assumed to meet 50% of the buildings' needs with the remainder supplied by conventional boilers. The size of the heat load ("equivalent dwellings" at a density in excess of 100/hectare for a mixture of commercial and residential property) is allowed to vary according to the output of the geothermal well. Capital costs for distribution mains, building internals and boiler plant are calculated according to refs 1 and 5. The rejection temperature is taken as 30°C, distribution and heat exchange losses as 10°C, the load factor as 70%, and the heat is assumed to be sold at £2.0 per GJ. For electricity generation, the conditions given in ref. 1 have been used, while the capital cost of turbogenerator plant is assumed to be proportional to (gross output)$^{1/2}$ with the £748,000 for a 1 MWe plant of ref. 1 used as a baseline.

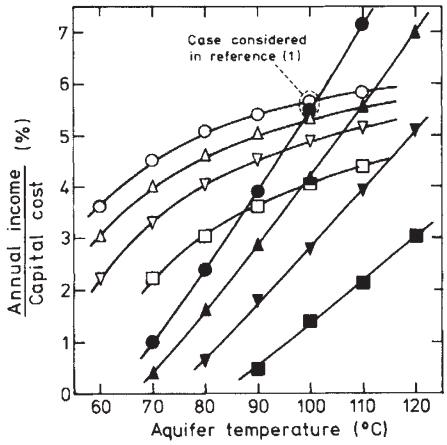

Fig.1 The effect of temperature and flow rate on the relative merits of group heating and electricity generation from geothermal aquifer sources in the UK.

Solid symbols, electricity generation; open symbols, group heating. Flow rates: ■ □, 20; ▼ ▽, 10; ▲ △, 40; ● ○, 50 kgs^{-1}.

The results are given in the figure. As might be expected, electricity generation becomes more attractive as temperature and flow rate increases but the return on capital is very sensitive to both parameters. Group heating is apparently less sensitive but this may be due to the method used for calculating capital costs. Comparing the data with those from French installations, capital costs derived from ref.5 seem very high, particularly for the larger schemes. Note also that the selling price of gas, in practice, varies from £2.03 per GJ (domestic user) to £2.47 per GJ (large industrial user). The cost of useful heat, even from gas, is thus nearer £2.90 per GJ than the £1.95 per GJ quoted in ref. 1, and the cost of heat from oil would be almost double. By contrast, the selling price of electricity is fixed (at 2.2 p/kWh); this calculation might then underestimate the relative advantage of direct heat uses over power generation.

Hence the advantages of electricity generation from low-enthalpy geothermal sources are not as clear-cut as Richardson and White[1] suggest. Until a borehole is drilled at any particular site, uncertainties will exist — particularly as regards flow rate.

However, such demand for heat will occur only in the larger towns, while many of the deep aquifers in the UK underlie rural areas where group heating would not be an option. If electricity production can be shown to be an economic proposition, then the contribution of geothermal sources to UK energy supply would be greatly increased.

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Banking DNA sequences

SIR, — We were glad to see your article "Banking DNA Sequences" (8 May) 1980, in which you make a persuasive case that there should be such a computerized data bank. We fully agree. In fact, we already have compiled such a computerized DNA sequence bank, which now considerably exceeds the 100-kilobase figure mentioned in your article. Our DNA data bank is a natural adjunct to our Protein Sequence Reference Data Collection[1] that has been supported for the past 15 years mainly by the Institute for General Medical Sciences of the US National Institutes of Health and by the National Aeronautics and Space Administration.

Many people are aware of our facilities and we do various searches and computer studies each week for people all over the world. Our computer system includes a large number of programs especially designed for analysing such collections of data. The most frequently used capability is a search of the amino acid and nucleotide sequences for segments that match a given segment. Sequences can be retrieved quickly and compared, and statistical assessments of similarity can also be made.

Our DNA Reference Data Bank is growing continually, despite the fact that the collection of these data is aggravated by the nonavailability of material in computer-readable form (as are, for instance, the protein crystallography data). The sequences are not even in clearly readable form in some journals. We would be happy to receive sequence data in computer-readable form to add to the collection when this information is published in journals. The sequence in this additional format would then be available to others.

You also entertain the notion that it matters little by whom or where a bank is started and that a successful operation could be a depository run by a keyboard operator who sent out tapes. Based on our years of experience, we must emphatically disagree. There have been many attempts to start data collections but few have continued in operation, mainly due to greatly underestimating the amount of effort and training required for such an undertaking. Will the users be satisfied to say, in their papers, "I looked over a few sequences and reached the conclusion that . . ." or would they prefer to say, with confidence, "I looked over all of the sequences so far elucidated . . ."? Who will find corrections that have been made to the old data? Will the users want the corrected sequence in the collection? Will they want other information, such as which portions of the nucleic acid sequence code for proteins? Also, who will solicit the new material? It doesn't just drift into a depository. If the users have questions about the collection, do they want to be able to communicate with someone and expect answers? Do the users want the data center to be delicately attuned to their needs?

We feel that making the data base intellectually accessible requires a considerable amount of effort and that such an effort is warranted by the central importance of nucleic acid sequence data to many fields including medicine, genetics, and biochemistry.

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