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PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A
MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

General Discussion

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General discussion

P. T. Landsberg (*University of Southampton*). I should like to draw attention to the importance of inflation in estimating the economic viability of solar collectors. Figure 1 is due to D. J. Toop of B.S.I. and myself (I.E.E. 1979). Plotted vertically is the maximum cost of collectors in £/m² for economic viability. The future rate of inflation of fuel prices, i_x, is plotted horizontally. The curves rise since fuel price inflation allows one to spend more on the installation without being out of pocket (other things being equal). The money saved, however, loses its purchasing power owing to general inflation, i_g, and this has to be taken into account. The higher this is, the more the curves are depressed, and the graph therefore illustrates the effects of differential inflation. Energy is a commodity that will probably suffer rather high differential inflation, since more expensive energy resources have to be exploited as the cheaper ones are depleted.

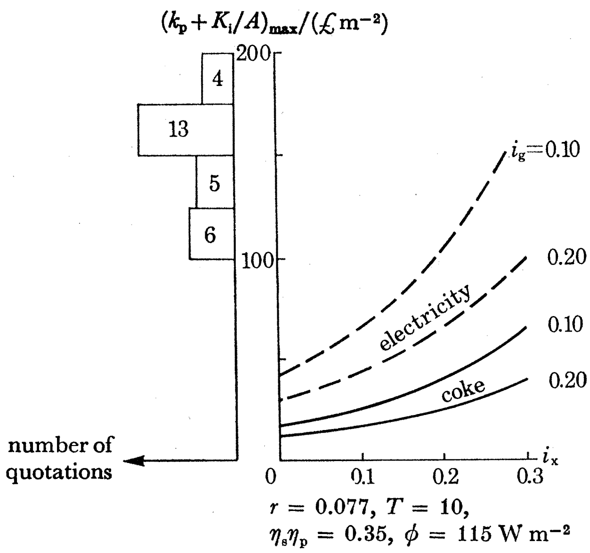

Figure 1

The ordinates at £66/m² (electricity) and £25/m² (coke) represent uniform inflation ($i_x = i_g$). Put differently, the inflation rate 'in real terms' reduces to zero. Note incidentally: (1) that the expression $r-(i_x-i_g)$ often used to arrive at discount rates in real terms is merely an approximation of a slightly more complicated expression, and leads to serious error when any of the terms exceeds 1 or 2%; (2) inflation actually cancels out the calculation for uniform inflation. This is expected, since uniform inflation is equivalent to a change in money unit.

Finally, the histogram gives 1977 prices of solar collectors available in the U.K. In order to determine whether any of these collectors are economically viable today, the potential investor, as in any investment decision, must make his personal forecast of future economic parameters. Thus if he thinks that r (the interest rate net of tax) will average 0.007, i_x will average 0.2, and i_g will average 0.1, all over a useful life of ten years, then one can see that the cheapest collectors are just economically viable where electricity is displaced, but not for any other fuel.

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The values of the other parameters used in the calculation are as follows: insolation 115 W/m² (U.K. average), storage efficiency unity, electricity cost 2.75p/kWh, unit conversion efficiency, coke cost 6.36p/kg, 65 % combustion efficiency.

Reference

IEE 1979 The economic assessment of future energy schemes. *IEE Conference publication no.* 171, January 1979.

H. Tabor (*The Scientific Research Foundation, P.O.B.* 3745 *Jerusalem, Israel*). I would like to draw attention to the over-sophistication of many solar installations. While collector manufacturers are trying very hard to reduce the cost of the collectors, the systems people then treble the total cost, rendering the system totally uneconomic. Thus at a recent Canadian solar meeting, we were told that system costs for house heating were $40 or more per square foot (about three to four times the collector cost) and the annual useful yield of the collectors was 60000 Btu/ft², worth – at present fuel prices – about 20¢! (Admittedly, using a collector for house heating in the Canadian climate is an extreme example, but the situation would not be very different in the U.K.)

Our education of engineers working in this field must include an awareness that, unlike other areas, a compromise must be made between sophistication and cost because the primary energy source is so diffuse. Any trained engineer can draw an idealized block diagram of a system, forgetting that each block represents both cost and possible maintenance problems: the goal should be to reduce the diagram to a minimum. The classical example is the thermosyphon solar water heater that has no pumps, valves or controls and operates for the lifetime of the collector (or tank) without maintenance. Another example is the manual control of indoor climate by the operation of shutters and curtains. Were this automated, the extra capital cost of the building would be greatly increased.

F. E. Rogers (66 *Knowsley Way, Hildenborough, Kent, U.K.*). I am an electrical engineer, not involved professionally in energy technology, but nevertheless deeply concerned about it. I have two points to make.

The first point relates to thermal losses and storage. The equations for heat transmission through a thermal circuit under the hypothetical constraints of perfect insulation and freedom from radiation are analogous to the equations for an electric circuit. However, while the electric circuit in practice can be insulated almost perfectly, and is normally free from significant radiation at power frequencies, the practical thermal circuit is, by comparison, very imperfect in these and other respects. I draw attention to the analogy and to the practical departures from it, because analogy can often stimulate new ideas. Perfection in insulation and freedom from radiation seem to me to be of paramount importance in the design of thermal storage devices, especially when heat retention for a long period is required, as from summer to winter. I ask, therefore, if work has been done on the development of a thermal storage tank having very low conduction, convection and radiation losses. Such a tank might borrow principles from the Dewar flask, and be minimally supported within an outer container that is continuously evacuated and internally faced with a suitable reflecting surface to suppress radiation.

The second point relates to the economic comparisons made by the first contributor to the discussion. In my opinion it is not valid to draw comparisons, in conventional economic terms, between solar energy devices and devices using traditional fuels; for on the one hand the energy

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source may last for the span of the human race, while on the other, it is certain to be exhausted within a period that is minute in the perspective of that span. Recent predictions for North Sea oil are very discouraging, and predictions for the overall duration of oil and gas range between 20 and 40 years. The precise figure, even if it extends to a hundred years or so, is irrelevant: mankind is now thought to have existed, I think, for about four million years.

J. W. Jeffery (*Birkbeck College, Malet Street, London W.C., U.K.*). The Rt Hon. Tony Benn remarked at the Royal Institution Conference last year that it would be foolish to base energy policy for the future on what the Treasury thought was the right interest rate that morning. It is also foolish to make 'economic' assessments on the basis of present energy prices for developments in the heating of buildings over the next 50 years. We should at least take for such an assessment the doubled energy prices that the Department of Energy envisages for A.D. 2000. In that case, many things that are now 'uneconomic' become very desirable, including 100% house and hot water heating by means of solar collectors, with seasonal storage.

As far as national policy is concerned we should be looking to the future and finding ways of encouraging now the developments which will be required by A.D. 2000, if we are not to find ourselves facing even higher energy costs. Since housing is a long term development, the sooner we start the better.

B. J. Brinkworth. On the points raised by Mr Rogers, I am not aware of any work on thermal storage in vessels with evacuated walls. A solution of this kind would be technically complicated and expensive and is unlikely to be practicable at a time when the only acceptable solutions have to be simple and cheap. There are schemes in hand in which advantages are claimed for storage on a large scale, by using conventional insulation for the walls of the storage chamber. While it is true that the losses become smaller in relation to the thermal energy stored as the size of the chamber increases, it is worth remembering that the absolute rate of heat loss increases with size, so that novel methods of insulation might still have a place.

The second question on economic comparisons, echoed by Professor Jeffery, reflects the difficulties of evaluating new sources of energy at a time when energy from conventional sources is still a very cheap and abundant commodity. In anticipation of a change in that situation very soon, we need certain information urgently if alternative sources are to be properly evaluated and are to win acceptance by potential users. For solar heating systems, we shall soon know enough about performance for this, although our understanding of factors affecting operating lifetimes of systems is still lacking. We also need to know more about manufacturing costs in large-scale production. It is interesting that this is recognized for photovoltaic devices, and much effort has gone into predicting future manufacturing costs for these, while most studies of the economics of heating systems are based on existing costs, which are virtually those for hand-made prototypes.