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DISCUSSION ON PAPER 8653

The renewable sources of energy in the United Kingdom

J. K. Dawson

Mr A. C. J. Baker, Binnie & Partners

The ETSU study has shown that tidal power is first in the ranking of resources, but since the Bondi Committee was wound up after its report was submitted in 1981, tidal power has gone into the background. Was this because ETSU's report went to the Advisory Council on Research and Development (ACORD) whereas this work was the concern of the Interdepartmental Committee on the Severn Barrage? Is any work going on, or about to go on, in connection with tidal power as far as the Author knows? Does the Committee still exist and is it making recommendations to the Government in the same way as ACORD have been making representations to Government?

Mr K. F. Scott, Sir Alexander Gibb & Partners

It appears that there must be an export potential for renewable resources. The Author mentions solar power, but did not say anything about photo-voltaic cells. Has ETSU any brief on their export potential, and is there an intention to carry out any research and development on photo-voltaic cells?

Mr A. C. Paterson, Bullen and Partners

Regarding export potential, one of the greatest problems overseas is not the large installation but the small energy requirements of peasants in the villages, and I recall that, particularly before the Second World War, in Scotland most farms had windmills on steel structures which were used for pumping water and generating electricity for lighting. Is anything being done to improve the efficiency of small windmills, in addition to the work that is going on in 3 MW structures?

Dr E. C. Hambly, Consulting Engineer

Could the Author say why he is not involved now in active heating? How far has he progressed on the economic studies on passive heating? I have got the impression with some old people's homes with which I am involved that it is always 'jam tomorrow'. Whenever I ask for estimates of costs the answer seems to be that it is not the right time to ask the question. Recently I read that British Petroleum are planning a solar power station project; could the Author expand on this?

Mr W. G. N. Geddes, Babtie Shaw & Morton

I presume that during his investigations the Author looked at the Rance Barrage

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which has now been operating for many years? Could he give an idea of the cost-effectiveness of this full-scale experiment?

Mr T. G. Hammond, Binnie & Partners

Could the Author expand on geothermal hot rock which was a long shot but which appears now to have come good? Putting money into a long shot is something which everyone appreciates and it is nice to see this money well spent. Are there any other long shots which might come good in the future?

Mr Scott

What about the possibility of collecting solar energy and beaming it down to the earth? Is that too long a shot even to consider?

Mr R. H. Allen, Cement and Concrete Association

In Table 1 the ratio of energy per annum to installed capacity for the Morecambe Bay scheme is greater than that shown for the Severn Estuary, yet we have not heard very much about it. Does this mean that it is on too small a scale to be really worthwhile?

74. A year or two ago we in the UK were the forerunners in wave energy research along with the Japanese. Are the Japanese still pursuing it or have they abandoned it on economic grounds?

Miss D. Schumacher

Regarding the time scale, we seem to be in a very strange situation in the UK. It is forecast that we may have the best energy mix in Europe, and we may even have a surplus of energy by 1990 if we carry on the way we are going, but it is not going to last for ever, and it seems that when the Government is allocating money for renewable energy resources, it does not take into account the time scale, because every government can only look to the end of its political regime. What is going to happen beyond that, say in 30 years' time? It seems that the lead time necessary for investment in renewable resources is something like 20–30 years.

Mr J. A. Derrington, Sir Robert McAlpine & Sons Ltd

Does the Author feel that the heat has disappeared from the energy discussion, and is there a reason for it? My own reason is that it seems to have proved that small is beautiful. These vast schemes are not wanted because people are either frightened of going into them, or virtue is found in every man doing his own thing. As civil engineers, we are interested in major schemes which will change the economics of the country, open up vast export markets, etc. Can the Author say how the search is going for these schemes?

Mr D. G. M. Roberts, John Taylor & Sons

Regarding biofuels, the Author concentrates on the potential of waste material. Has research been undertaken into growing crops with high calorific or energy content, either in the UK or overseas?

78. A constantly increasing problem facing the UK is the disposal of sewage sludge, especially as many of our large conurbations dump their sludge at sea. The European Community is, however, now talking of directives to prohibit such

marine dumping. Should this come about, the only currently feasible alternatives open to such cities (land disposal, incineration or composting) would be even more difficult and expensive. Are any investigations being carried out to minimize the water content of sludge so as to reduce the heat required to incinerate it, and ultimately to enable the dried sludge to be used as a fuel in biomass generating processes?

Mr F. F. Poskitt, Ferguson & McIlveen

The Author described a number of renewable energy resources, and I think it is accepted that the greatest environmental impact is that of the estuarial barrage. In that case, while I take his point that the scale is different between one scheme and another, and that a pilot scheme does not benefit greatly engineering studies of a different-scale scheme, is there not something to be said for the pilot scheme itself from the point of view of environmental impact? It could be that the studies required to look into those factors affecting the environment would require a longer time and prove more difficult than some of the engineering elements in the scheme itself.

Mr K. R. Lawrence, Property Services Agency

One aspect of energy is energy conservation; to what extent can one see combined heat and power schemes and low-energy houses significantly affecting the balance of energy demands in the future?

Mr N. J. Widgery, Sir Alexander Gibb & Partners

The Author's review of renewable energy sources in the UK does not mention hydro-electricity, which is clearly a renewable source, and it is one that has been demonstrated and proven over a long period.

82. It seems that the problem here is not so much a technical one, and I wish to quote Professor Wilson of the University of Salford: 'If the large number of small hydro sites in this country are to be developed, there needs to be a much greater awareness of the inhibiting factors and a much more positive lead from the Department of the Environment and a more enlightened attitude in the majority of Electricity Boards'. Is anything being done on these institutional problems to make this resource more attractive to eventual investors?

83. As a separate point, and particularly with a view to export potential, what progress is there on the development of modern electronic control systems for small-scale hydro schemes?

Mr G. F. J. White

It is unfortunate that energy conservation (efficiency in use) was excluded from the Paper, because energy saved (and thereby available to other users) is the cheapest source of new energy. There was no emphasis in the Paper on suiting thermodynamic design to purpose. For example, gas-engined heat pumps have the potential to supply 150% of primary energy burnt, and wind pumps have driven viscous fluid (oil) through small bore pipes and have heated greenhouses.

85. In § 2, there was no discussion on nuclear wastes, dangers during their transport, waste disposal, radiation effects on health, dangers of generation, the US rejection, Three Mile Island, radioactivity leaks, fires in nuclear power plants, load factors, etc. The problem of waste disposal cannot be said to be solved by pointing

at all the efforts to solve it. Nuclear power is therefore not proven.

86. With reference to § 26, a return on investment is less important than resources saved. Much more effort should be applied to conserving fossil materials rather than using them as fuels.

87. With reference to § 27, new perceptions and responses do require analysis of appropriate management, organizational and institutional structures. Let there be no delay in their formation.

88. Regarding wind energy (§ 36), economic, environmental and health considerations favour the renewable transfer systems relative to nuclear and fossil fuel systems, and would encourage land-based aerogeneration. Acid rain, radioactivity and pollution are not caused by the renewables. These wind machines would often be placed in attractive countryside, and their visual impact would be lessened by architectural solutions achieving elegance in their settings.

89. With reference to § 45, the most attractive environmental, economic, job-creating, energy-gaining system is an energy conservation programme. Contemporary economic criticism includes the CSENE report,[9] Jones/Jeffery continuing correspondence, evidence at the Sizewell Public Inquiry, US experience, report of the Electricity Consumers Council, NCB evidence at the Sizewell Public Inquiry, Hunterston B experience, etc. The London Dumping Convention's ban on dumping of radioactive waste at sea will increase costs. The EEC had decided to stop dumping nuclear waste at sea; some of its Members of Parliament declared sea dumping to be an irresponsible criminal act, and yet the UK has been dumping 90% of all its wastes into the sea, and the UKAEA has planned to increase its dumping by 20% this year. Surely mixed renewables are attractive and nuclear generation is not?

90. Regarding recycling of a resource (§ 56), this should have precedence over gaining energy from its incineration. Paper recycling reduces the need to fell trees, and will help to end the unnecessary remorseless destruction of tropical and remaining temperate rain forests.

91. Further to the Author's conclusions (§ 65), with resource considerations given precedence and integrated into this assessment, the contribution from renewables will be significantly increased. Resources saved would remain as raw materials for future careful enterprise.

Mr D. H. Dale, Engineer

The Author indicates (§ 33) that wave power ranks low in the economic priority list, and wind power high. Land-based wind power is higher than offshore, although the advantages of the latter are important and are listed in § 36.

93. It would appear that an advantage could be obtained by bringing together wind and waves. The oscillating water column (OWC) in a structure founded on the sea bed (which I understand is now the most favoured arrangement) would seem to provide a cheap—almost ready made—foundation for an offshore aerogenerator. It should be possible to bring the wind- and wave-produced electricity ashore through a shared main, and a row of OWCs could support one or two aerogenerators on 'swellings' along the length of the main structure. Indeed, it might be possible with a vertical-axis aeroturbine to combine this on the same shaft with a wave-driven air turbine supplied from manifolds connecting the adjacent OWCs in the row. Such a combination could provide an opportunity for substantial savings and may earn a place near the top of the priority list. Could the Author say whether any such arrangement has received attention, and if so, with

what result?

94. It would be interesting to know more of the way in which comparisons are made between various sources of energy. In particular, how does one debit sources with considerable uncertainty (e.g. 'dry' geothermal holes mentioned in § 19 or similar failures of hot rock holes) and credit sources where technology is familiar, even old fashioned, where all one needs to do is to see that blades do not blow off nor the supporting structures overturn?

95. How does one allow for the extra use available from structures likely to have an active life of 70–100 years as against, say, 35 years for others? Again, thermal power stations built in the late 1940s are being demolished now and leaving sites fully serviced and suitable for industrial development; will nuclear stations be equally useful when they are shut down, or will they represent a very long-term liability? These matters appear to be of fundamental importance in making comparative economic assessments, and the Author's comments would be of great interest.

96. As we have a breathing space due to the present pause in the growth of power consumption, as we have a plentiful supply of coal and a supply of oil for a few more years, as we have engineering industries civil, mechanical and electrical all under-utilized, and labour being paid nearly half its working cost for doing nothing, it would appear to be very foolish not to pursue the more promising renewable sources of energy to the stage of full-scale prototypes in their most favourable locations as a matter of urgency. This applies particularly to those sources which can be tested in small units costing a few million pounds, or at most a few tens of millions. This seems particularly so when we are spending thousands of millions of pounds on nuclear fusion which may never produce a single kilowatt-hour, and about which one can hardly help having an uneasy feeling, although it is difficult to put a price on this unease.

97. These matters may be regarded by the Author as outside his brief, as they fall to be decided by politicians, but they are of such obvious importance that the profession as a whole should do all it can to encourage the development of renewable energy sources as one of the best ways of stimulating the economy. There could not be a better time to start than now.

Mr E. S. Carrick, James Williamson & Partners

Dr Dawson's timely paper should provoke forward thinking on the subject of renewable sources of energy by engineers generally.

99. I was surprised to note the absence of relevant comment on hydro-electric schemes as an energy resource. The parenthetical reference in § 18 makes an invalid comparison between assumed potential geothermal energy and actual present hydro schemes. The moratorium on hydro-electric schemes politically imposed in 1962 has distorted present-day production. The potential which might be available using both conventional and more wide-spread mini and micro hydro schemes has not yet been explored in any depth, although some preliminary work is in hand. The full value of this potential is unlikely to be fully evaluated for a long time to come. I would assume that this renewable resource is omitted from the Paper because techniques for its exploitation in part are already available. Further development work would be desirable.

100. A further statement which invites comment occurs in § 31. The CEGB appraisal is, I believe, particularly pertinent to tidal power which is one of the most regular and predictable sources of renewable energy, and thus the programme for

load absorption is readily identifiable. In the ultimate not only is there the random variability of supply from renewable sources but, as stated in § 32, the future input will exceed the 20% limit. One must therefore distinguish between the statement that renewable resource input *can* be accommodated without storage and the conclusion that therefore the input is *best* accommodated without storage. The two propositions are very different and in the long term it seems storage will be required. It should therefore be an integral part of planning.

101. In looking forward it is not possible to ignore factors which are in broad terms political, both in a UK and global context. I trust that the Infrastructure Planning Group will not avoid such issues. It is also necessary to define one's terminology in order to avoid misunderstandings. In the following I shall use 'planning' to mean the thinking through of long-term scenarios, leading ultimately to the elimination of non-renewable energy sources in sequence from the economy; and 'programming' to mean the shorter-term tactics required to achieve the above in a logical manner and to best advantage.

102. As Dr Dawson states, the one certainty in planning is that eventually oil, gas, uranium and coal supplies will be exhausted. The lack of a precise time scale does not inhibit the production of scenario-type planning and many have been propounded. What is lacking is a consensus view of what the planned route should be on which to build our national programmes. There must be a mean path between rigid preconceived planning and unthinking procrastination. This path should be earnestly sought and an engineering contribution would be to the nation's advantage.

103. In the field of programme initiation, one big inhibiting factor is the difference between the lead time required for the conception of a large energy-related project and the life of a Parliament. This underlines the necessity for consensus planning as outlined above, otherwise policies of stop-go or sheer delay which have been seen, for example, in both the nuclear and hydro electric sectors, will bedevil rational developments.

104. To treat energy supply merely as a 'traded good' seems to me a potentially dangerous simplification. The concept may be tenable in the UK situation today while the full range of resources is available. Other countries already realize that the price associated with trade in energy has a strong political component in addition to the obvious financial one. With this in mind I would suggest that self-sufficiency overall in energy production is not a matter to be abandoned lightly when it can be achieved.

105. Regarding the figures of energy usage in § 9, i.e. currently 330 Mtce/year with only 200 Mtce/year from renewables, given the very long time scale under consideration in these remarks it may well be that this apparent gap may be bridged and even the usage of energy increased by efforts to improve the efficiency of energy usage for which there is considerable scope. It may also be that having overcome problems of storage and distribution, the contribution of renewables may be greater than presently anticipated. Further, there remains as a possibility the development of fusion power. I would expect this to emerge in the USA, the USSR and the People's Republic of China. I would not expect the UK to be able to support this development alone. I would hope that this could and would be capable of development in the wider context of the EEC without the creation of a client state situation with respect to the three large powers noted above. It would be interesting and instructive if Dr Dawson could comment on this aspect of energy development.

106. In conclusion I would echo Dr Dawson's concluding remark that renewable resources are a subject on which civil engineers have much to contribute. Indeed, engineers have a duty to society to do so not only as individuals, but as a corporate body through the Institution of Civil Engineers.

Mr J. E. Phythian, Tokoroa, New Zealand

It is worth mentioning that biogas and compressed natural gas (CNG) are now seriously considered as alternative fuels for motor vehicles. CNG is available to over half the North Island population of New Zealand, but not in the South Island, although some South Island farmers have installed biogas generators. The economics of conversion to CNG are favourable for long-distance operators and operators of large vehicles, e.g. over 70 out of 81 taxis in Hamilton are converted to run on CNG. The expense of installation of biogas generators would deter smaller operators from conversion of machinery to run on biogas. In spite of stated Government policy favouring conversion to CNG, no tax concessions are provided—the cost of conversion incorporating a 50 litre bottle is approximately $A1500 (approximately £650).

108. As an operator of a larger car (Holden Kingswood HQ 3·3 litre) converted to run on CNG, I find that the fuel cost per unit distance travelled is half that of petrol—35 ¢/l (69¢ per gallon) as opposed to 71 ¢/l for petrol, with about 100 km range from a 50 litre bottle (water capacity), with the energy equivalent to 16 litres of petrol. The loss in performance is noticeable on CNG and there is some inconvenience on longer trips. However, these are more than offset by the cost savings.

109. The involvement of civil engineers in natural gas reticulation and retail sale, and in biogas generation, is not great, being restricted to pipeline construction and to the provision of minor structures. However, there are much better opportunities in the design and construction of methanol and synthetic fuel plants.

Dr Dawson

Mr Dale and *Dr Hambly* raise the issue of how our economic comparisons are made. I would refer them to ETSU Report No. 13,[10] which is now available in two volumes and which contains full details of the methods and results.

111. *Mr White* and *Mr Lawrence* refer to the importance of energy conservation. The Department of Energy recognizes that importance, and the Secretary of State has announced the setting up of a new Energy Efficiency Office which will spearhead a nationwide effort with the objective of making Britain the most energy-efficient country in the Western World. ETSU is involved through its management of the Department's Energy Conservation Demonstration Projects Scheme and a longer-term R & D programme.

112. Several comments and questions are concerned with tidal energy. Readers are referred to reference 7 for detailed technical points. In answer to *Mr Baker*, the Severn Barrage Committee does not now operate, but the Department of Energy still has an active interest in pursuing the subject and has announced its intention to support further studies related to the Severn Estuary. These will include an assessment of means by which the construction of a barrage could be financed. *Mr Derrington* raises the more general question of major civil engineering ventures. The possibilities which are currently being pursued within the renewable energy programmes, apart from a Severn barrage, are geothermal energy and offshore

wind power 'farms' (where the support structures for the aerogenerators become very important).

113. At the other end of the scale of magnitude is the small-scale hydro resource, referred to by *Mr Carrick*. This could provide a small but not insignificant addition to the UK energy supply, and assessments have been carried out to identify the most suitable sites. The economic aspects turn out to be very site-specific and will also depend on some of the institutional problems noted by *Mr Widgery*. Several novel machines are being developed with a view to extending the range of water sources which might be used.

114. *Mr Paterson* asks about work on small windmills. The major thrust of the Department of Energy's programme is on the large machines because that is the route by which a substantial contribution may be possible to the overall UK energy supply. Some of the more basic work does have a spin-off which can be useful in the context of small machines. There is considerable interest in the development and marketing of small windmills by private industry.

115. *Mr Scott* enquired about photo-voltaic power. ETSU's view is that, despite the impressive technical advances which have been made in this field, the production of electricity on a scale large enough to be nationally significant from photo-voltaic devices is not likely to become economically competitive in the UK. Therefore no research and development is included in the Department of Energy's programme. Some support is provided by the Department of Trade and Industry.

116. *Mr Roberts* referred to the need for alternatives to the disposal of sewage sludge at sea, and asked whether any investigations were proceeding on the possibility of drying the sludge for use as a fuel. I am not aware of any work of this nature; there are other, standard, methods of treating the sludge.

117. Finally, *Mr Hammond* and Mr Roberts wanted to know about long shots other than geothermal hot rock which might come good in the future. I would place the possibility of growing certain energy crops for conversion to biofuels in this category. The priority in the UK programme is the use of organic wastes as fuels, but in the long term it may be possible to increase the resource substantially through the growth of special crops without encroaching on the use of land for food or timber purposes. This work is still in the assessment and early research stage, so the amount of money devoted to it is comparatively small, but some interesting possibilities are emerging.

References

9. *Nuclear energy—the real costs. CSENE report.*
10. *Strategic review of the renewable energy sources: an economic assessment*, Her Majesty's Stationery Office, London.