Hydro-electric power in France

by

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Mr F. W. D. Davis (retired) called attention to the Author's remarks in § 35 on the near-completion of the Rance tidal power electricity generating scheme and the absence of enterprise in the United Kingdom in this direction. In the discussion on Paper No. 6669 by Price and Kendrick²⁷ (which contained an account of the investigation by the D.S.I.R. Hydraulic Research Station into the siltation problems of the Mersey Estuary now prevailing after 73 years of intensive dredging and training works), Mr Davis had suggested that positive means of improving the navigation depths in the Mersey and its sea channels would be to impound the whole of the Dee Estuary to the level of mean high water of neap tides and discharge the impounded water by way of tunnels through the Wirral Peninsular into the Mersey below the Eastham Locks. By utilizing the full capacity of the Dee Estuary, approximately 10 million cu. yd of tidal water could be transferred on each tide, thus increasing the tidal capacity and the scour in the Mersey.

43. If the Rance installation proved successful, it would appear to be possible to develop the Dee-Mersey scheme for the generation of electricity on a large scale as well as for flushing the Mersey. The recent report of the Chairman of the Central Electricity Generating Board gave a warning that they anticipated difficulties for many years to come in keeping pace with the ever-increasing peak demand, accentuated by teething troubles at the thermal stations and the disappointing output at the nuclear plants. A hydro-electric scheme with an unfailing water power supply might be of interest to the C.E.G.B. and in that event a precise investigation of the scheme might reveal the optimum impounded level of the Dee estuary to be higher than 23·0 Liverpool Bay Datum mentioned. With a lock in the dam, ships using the Dee Estuary would benefit from the impounded water which would render unnecessary the training works that have been proposed from time to time. The several purposes for the scheme would spread the cost and make it more attractive.

Mr C. A. Gillett (Manufacturer, New Zealand) observed that he became interested in tidal power as a hobby in 1954, at first with considerable mystification, and later with a deep amusement. So much so that he had presented the subject in science-mystery form in a 100-page book²⁸ which was published in July, 1958, combining instruction with entertainment. By the publication of the book, a copy of which was presented to the Institution Library, Mr Gillett was able to secure copyright over most of the world and simultaneously to stake an unassailable claim to being the first and only writer in the world to have published a logical argument showing that tidal power was nothing more than an impossible dream.

45. Such as it was, the theory of tidal power was shot through with half-a-dozen fallacies, any one of which would be enough to topple the whole structure. This could be seen from the following example: thermodynamics taught us that power

* *Proc. Instn. civ. Engrs*, vol. 26, September 1963, pp. 51-78.

could not be produced except by heat, and that all such forms of heat were derived, either directly or indirectly, from the heat of the sun. But tidal power expressly disclaimed any connexion with the sun's heat, proposing instead to rely entirely on certain interplanetary gravitational forces. Therefore, tidal power was to be produced without heat, which thermodynamics declared to be an impossibility.

46. Mr Gillett complimented the Author on his review of the French hydro-electric system, in regard to which there could be no question that the whole of its power derived directly from the heat of the sun, but he suggested that on further examination the Author might well find it necessary to reconsider his attitude towards tidal power in general, and towards the Rance and Severn schemes in particular.

47. Meantime, Mr Gillett was naturally gratified by the fact that it was only after his book had been published that E.D.F. took the firm decision to spend £30 or £40 million to prove him right.

The Author, in reply, observed that Mr Davis's remarks regarding a Dee-Mersey tidal scheme were extremely interesting. Before making any pronouncements on the validity of such an enterprise it would be necessary, however, to carry out considerable preliminary investigations. Approximate costs would have to be balanced against the potential value of the power available and any hydraulic or structural difficulties determined. If such a scheme could materially assist in the scour of the Mersey the power potential would not be the only consideration as any reduction in dredging costs would have to be included on the credit side of the scheme's ledger.

49. Two snags, however, were immediately evident in the scheme. The first concerned the probable necessity for the evacuation of the Dee during each tide cycle in order that the scouring of the Mersey estuary could be maintained. This would imply electricity generation tied to the tide cycle which was not normally considered to be economic.

50. The second difficulty was that of the moderate tidal range and the lack of any large difference in level between the two estuaries. This was not to say that such a scheme should be dismissed without any further thought, but it would be necessary to consider the effects of restrictions on the working of such a scheme.

51. To answer Mr Gillett's remarks was more difficult since it would appear from reading his book that he was not easily convinced by reasonable arguments.

52. However, to deal first with one of his remarks, that 'thermodynamics taught us that power could not be produced except by heat'. To the best of the Author's belief neither this statement nor any similar one had yet been substantiated. It was true that the major sources of power that were put to general use were due, either directly, or indirectly, to the sun's heat. The burning of coal and oil were prime examples. The other major source of energy that had to be considered, however, was gravitational attraction and this could not be attributed in any way to solar energy. When an object fell from rest its potential energy was converted into kinetic energy; whether or not it had attained its original position by means of solar energy, as, for example, the water in the mountain reservoir, was immaterial. The hydro-electric power so generated was due to this conversion of potential to kinetic energy which in turn depended upon gravitational attraction.

53. Continuing to the more specific question of the possibility of the utilization of tidal power, this was again a result of gravitational attraction. The moon and the sun both exerted attractive forces on the sea masses causing the cyclic phenomenon of the tides. It was not proposed that the actual tidal movement could be used to generate energy but when an estuary or river basin had been filled with the tidal influx, that the flow of water from this basin should be controlled on the outgoing tide. In practice this was achieved by placing a barrage or dam across the river. Water flowed through sluice gates in the dam to the river basin as the tide rose. At high tide the sluice gates were closed: the tide level on the sea side of the dam began to fall, but the basin level remained constant. A growing difference in water level would then

exist. The turbines would be placed at the foot of the dam and the head available for power generation would depend upon the difference in water level on the two sides of the dam. The turbines would 'roll' when a sufficient difference or head existed, which might be as little as 8 ft. On a 32-ft tide range this difference could be maintained with both levels falling simultaneously for three-quarters of the outgoing tide, i.e. approximately $4\frac{1}{2}$ hours. In practice the number of turbines would be so arranged that this difference in level would increase slowly, i.e. the water level downstream fell more rapidly than the basin level and the available head was thereby increased. The operation could be continued on the rising tide until the difference in levels was again the minimum allowable.

54. It could therefore be seen that this type of scheme was almost identical with any ordinary hydro-power scheme except that its operation could not be continuous unless it was allied with pumped storage. The operation depended solely upon gravitational attraction: first of all the heaping of the water as a tide, due to the gravitational pull of the sun and moon, and then the earth's gravitational force acting on the water impounded behind the dam. This was represented in diagrammatic form in Fig. 13 of a recent paper by the Author.²⁹

55. This description applied only to single-stage operation, but as was evident two-way operation was possible with a reversible turbine and the effect could be improved to give peak-load power on demand if reversible pump-turbine machines were installed, as on the Rance scheme.

REFERENCES

27. W. A. PRICE and M. P. KENDRICK. Field and model investigations into the reasons for siltation in the Mersey Estuary. *Proc. Instn civ. Engrs*, vol. 24, April 1963, pp. 473–518; Discussion, vol. 27, March 1964, pp. 613–647.
28. C. A. GILLET. 'Can the tides be harnessed?' The Author, Box 17, Raetihi, New Zealand, 1958.
29. J. A. SANDOVER. Hydro energy; a review of present-day hydro-electric practice. *Wat. and Wat. Engng*, vol. 66, September 1962, pp. 377–385.