final summary of the main points of agreement and disagreement between them.

THERE are two principal points of disagreement: (1) the extent to which wind power (with 150-h storage) can provide a reliable heating supply; and (2) the variation of net power output with aerogenerator rating.

(1) Ryle[1] considered the question of domestic heating demand. He concluded that wind power with the addition of 150-h storage on the consumers' premises could meet this demand at all times and thus replace an equal amount of conventional or nuclear generating plant.

In an analysis covering a six-month period, Leicester *et al.* (ref. 2 and above) found periods of a week or more during which the 150-h storage, initially full, would have been completely discharged and therefore unable to meet any of the heating demand. They pointed out that at such times there would have been little reduction in the heating demand imposed on the electricity grid and, consequently, little saving in the amount of thermal plant needed to meet peak demands.

Anderson *et al.* later proposed[3] a modified system with a store in which the heat output is a linear function of the energy remaining in the store. In this system as the heat output from the store fell short of that required the demand on the grid would progressively increase. They found that over a 17-year period this demand would never exceed about half the average heating load, with a corresponding reduction in the required installed thermal power station capacity. Thus, although a wind energy system in which there was no surplus capacity would be unable to supply the entire heating load, it could, nevertheless, make a significant power as well as energy contribution.

Leicester *et al.* agree that this second proposal is of interest, but further work will be required before the full implications of such a system can be assessed.

(2) The disagreement on the second point is less easy to explain. Based on the analysis of wind data, the Cambridge group suggest that changing the rated speed of the aerogenerator from 2.3 to 1.5 times the mean site wind speed decreases the annual energy output by between 15 and 25% (in agreement with the data given in the ETSU paper) whereas the CEGB group, from a similar analysis, derive a figure closer to 40%. The two groups agree that the precise figure will be a function of the generator characteristics and the wind speed distribution function and this matter warrants further study.

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1. Ryle, M. *Nature* **267**, 111–117 (1977).
2. Leicester, R. J., Newman, V. G. & Wright, J. K. *Nature* **272**, 518–521 (1978).
3. Anderson, M. B., Newton, K., Ryle, M. & Scott, P. F. *Nature* **275**, 432–434 (1978).

On an environmental model for the type Kimmeridge Clay

TYSON *ET AL.*[1] have proposed that Kimmeridgian coccolithic limestones were the result rather than the cause[2] of extreme anaerobic conditions analogous to those in the Black Sea today. Anoxic water columns develop where a salinity or temperature gradient causes density stratification which restricts circulation. However, anoxic mid-water columns develop in some areas due to high productivity in the euphotic zone[3]. If circulation was restricted, perhaps by topography, this process could go to extreme, therefore the suggestion of Gallois[2] cannot be discounted. The microlaminated marls associated with oil shales may form at maximum development of anoxic conditions. However, observations of major developments of the coccolithic limestones contradict this proposition for their origin. Also, carbonate will tend to dissolve below the O_2–H_2S interface[4].

The Rope Lake Head Stone Band interbedded with the oil shales is bioturbated with *Rhizocorallium* and encrusted with oysters. The White Band contains distinct burrows at certain horizons and ripple cross-lamination. The evidence is conclusive, the major developments of coccolithic limestone occurred in aerated bottom water. Transpositional structures within the limestones indicate the substrate was unstable and this would account for the lack of benthos in places.

I believe the oil shales mark the maximum stand of the O_2–H_2S interface. Vertical movement of this interface could cause the lithological change clay–bituminous shale–oil shale, but dilution by terrigenous material can account for it equally well. In the Kimmeridge Clay both factors interact. The coccolith limestones accumulated when circulation increased. The previously anoxic water would supply concentrated nutrients, in particular HCO_3^-, and favour the propagation of coccoliths. This model accounts for incomplete cycles, such as, bituminous shale–coccoliths–bituminous shale and is more consistent with observational evidence.

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1. Tyson, R. V., Wilson, R. C. L. & Downie, C. *Nature* **277**, 377–380 (1979).
2. Gallois, R. W. *Nature* **259**, 473–475 (1976).
3. Didyk, B. M., Simoneit, B. R. T., Brassell, S. C. & Eglinton, G. *Nature* **272**, 216–222 (1978).
4. Degens, E. T. & Stoffers, P. *Nature* **263**, 22–27 (1976).

TYSON REPLIES—Irwin has proposed an interesting modification of the stratified water column interpretation for the cyclic sedimentation observed in the type Kimmeridge Clay. While we apparently agree that the sequence clay–bituminous shale–oil shale represents a transition from aerobic to anaerobic bottom conditions (coupled with the progressive development of an O_2–H_2S interface in the lower part of the water column) our respective interpretations for the depositional conditions of the coccolith limestones are directly opposed.

On the basis of field observations Irwin claims that the coccolith limestones were deposited in aerobic bottom conditions when the dispersal of anoxic, nutrient-rich bottom water had promoted increased propagation of coccoliths. As I have only just completed a detailed examination of the sequence I must contradict Irwin's evidence: (1) The Rope Lake Head limestone, although bioturbated, is not oyster encrusted (and is not a true coccolith limestone). (2) Only a single poorly developed horizon of bioturbation occurs in the White Stone Band coccolith limestone, reflecting what was clearly a transient improvement in bottom oxygenation (for example, associated with limited advection due to a density current). (3) The White Stone Band coccolith limestone does not contain any evidence of bottom currents, but penecontemporaneous deformation structures do sometimes resemble ripples. (4) The coccolith limestones are devoid of benthos.

The remainder of Irwin's argument contains several inconsistencies. While solution of inorganic carbonates (such as, 'seekreides'[1]) is an important process below the O_2–H_2S interface, it is not relevant to this discussion for coccoliths are at present day accumulating on the floor of the Black Sea[2] (despite *p*H values of 7.6 ref. 3). If the deposition of coccolith limestones were initiated by the dispersal of anoxic bottom water (coincidental with the development of aerobic bottom conditions) then: (1) There is no reason why 'varve-like' microlaminations should form. (2) Any microlaminations would have been destroyed by bioturbation (there is no *a priori* reason to suppose the substrate was unsuitable for benthos—especially when one considers the bioturbation in the White Stone Band). (3) This would contradict the geochemical[4] and palynofacies evidence (ref. 5 and personal observations). (4) It would imply that the coccolith limestones should always be underlain by oil shales (that is, sediments representing anoxic bottom conditions) which they are not. (5) According to Gallois[6] the decay of the resultant phytoplankton bloom would recreate anoxic bottom condition anyway. (6) A greater degree of lateral variation would be expected. Bottom water dispersal events are recorded in the stratigraphic record, but not by laminated coccolith limestones[7].

Any belief in a stratification/O_2–H_2S interface model is incompatible with Gallois' original hypothesis[6] which was an alternative to the restricted basin models.