ENERGY

Breeders and the numbers game

Even if America's breeder reactor program can overcome the emotional issues of safety and environmental protection and the technological uncertainties of how to proceed (see pp. 51 and 59), the question still remains as to whether the effort is worthwhile economically. The Government says that for an $8 billion investment, society will reap a $14.7 billion benefit. But a new study by physicist Brian G. Chow (*The Liquid Metal Fast Breeder Reactor, An Economic Analysis*, published by the American Enterprise Institute for Public Policy Research) concludes that a net loss will occur, instead. He estimates the loss at anywhere from $200 million to $4.3 billion, depending on various assumptions. However, he quotes another study by Harvard University economist T.R. Stauffer, R.S. Palmer of General Electric and H.L. Wyckoff of Commonwealth Edison (*An Assessment of the Economic Incentive for the Breeder Reactor*, Harvard University) to the effect that benefits from the breeder might be as great as $76 billion.

The two studies offer revealing insight into the games economists play, for the wildly differing conclusions depend on relatively small and sometimes subtle changes in assumptions about what the future will bring. [All prices in present dollars].

The key difference between Chow's figures and those of the Government involves the cost of building breeders, compared with that of conventional reactors. Government experts expect the cost difference (per kilowatt of generating power) to drop to zero by the year 2000, and Chow assumes it will stay at about $50 per kilowatt. "This cost differential turns the benefits of the LMFBR into losses for all cases under consideration," he concludes. (There is an additional implicit assumption, however, that the need for breeder reactors will eventually be negated by the coming of fusion power.)

The challenge to the breeder looks even more formidable if Chow is correct that the Government has underestimated uranium supplies. "There is little doubt that uranium resources will eventually exceed the present indication," he says. Thus, official estimates show the price of uranium rising to $65 a pound shortly after the turn of the century, and even then total resources available would be only 4.2 million tons. Chow doesn't expect that price to be reached until much later and says it would make as much as 7.5 million tons available. This figure is key to the Harvard report, which assumes only 2.4 million tons would be available at this price. Changing this figure alone, Chow says, would bring the Harvard study's estimates of benefits into line with those of Government scientists.

The best policy alternative, says Chow, is to lower the emphasis on breeder reactors in favor of high-temperature, gas-cooled reactors (HTGR) for the intermediate term and fusion reactors in the long term. He says that HTGR's can be built for about the same plant cost as conventional water-cooled reactors, but they have higher efficiency and half the net uranium consumption. Given an adequate uranium supply, these might then bridge the gap to the age of fusion.

How much uranium?

An explanation of some of the uncertainty over uranium supply comes from energy economist Milton F. Searl of the Electric Power Research Institute: "Estimates have frequently been made of United States uranium resources available at various prices. . . . Footnotes to these estimates generally reveal that they apply to only a fraction of the western United States. But there is a largely unevaluated potential for uranium resources in Alaska and in the eastern United States." (EPRI Research Progress Report ES-2.)

ANTHROPOLOGY

Recalibrating radiocarbon dating

There's a monkey wrench in the archaeology tool kit. Since its first successful use in the 1940's, radiocarbon dating has become one of the most important tools of archaeology. With it, organic materials can be fairly accurately dated back to 70,000 years. The process, however, is not as accurate as was once thought. Living objects absorb radioactive carbon 14 from the atmosphere. When they die, the C-14 decays at a known rate, and the time of death can be calculated. Unfortunately, the amount of atmospheric radiocarbon has fluctuated in the past, and it is necessary to correct or calibrate radiocarbon dates.

Dendrochronology, the study of trees and their yearly rings, helps in this calibration. The amount of C-14 in a tree ring of known age can be measured, and atmospheric C-14 during the year the ring was formed can be accurately measured. With such measurements, a number of calibration curves have been plotted that can be used to correct radiocarbon dates. But, says R.M. Clark of Monash University in Australia, "most of these curves are unsatisfactory from the statistical viewpoint."

In order to correct deficiencies in C-14 dating, Clark has produced another calibration curve. He has taken into account the possibility of variation due to differential rates of absorption of C-14 in different species of trees growing in different localities as well as the varying results of measurements of the same tree samples from different laboratories and even from the same laboratory. The object, he says, "is to produce a single calibration curve (based on pooled data from many laboratories) to be used to calibrate any radiocarbon date from *any* laboratory based on *any* organic material from *any* geographical region." Clark's recalibrated curve, along with data on how it was derived and how it will be used, is in the December ANTIQUITY.

Reestimating Mayan population density

Population density is one of the most important and controversial issues surrounding the Lowland Mayan Classic civilization that occupied the Yucatan peninsula from about A.D. 200 to A.D. 1000. Knowledge of overpopulation or an extreme disparity between population and agricultural productivity, for instance, might help explain the demise of the Mayan civilization.

The controversy arises from the two approaches that have been used to calculate population density: the number of house sites and estimates of the agricultural carrying capacity of the land. The house site approach suggests a peak population of as many as 700 people per square kilometer. The agricultural approach, based on contemporary swidden (slash-and-burn) methods, suggests no more than 85 people per square kilometer. The wide difference between these figures challenges the validity and accuracy of both methods, but new evidence may solve the riddle.

Recent discoveries of relic terraces and raised fields throughout the central lowlands indicate that the Classic civilization was supported by forms of cultivation much more intensive than the swidden. With this evidence, B.L. Turner II of the University of Oklahoma in Norman has reestimated both the housing and agricultural capacity of the area and found them to be in accordance. His findings are in the January GEOGRAPHICAL REVIEW. Housing estimates, he says, range from a minimum of 150 to a maximum of more than 500 people per square kilometer (around the larger civic-temple centers). Intensive agriculture, he says, could have supported from 321 to 643 people per square kilometer. In other words, he says, it is theoretically possible, given known agricultural techniques, for the area to have supported the maximum populations associated with the house site estimates.