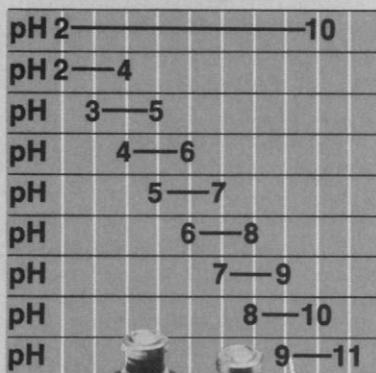


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LETTERS

Cogeneration in West Germany

Amory B. Lovins, in his letter to *Science* (24 June, p. 1384), states that "... President Carter's speechwriters may have taken the incorrect cogeneration figure for West Germany from the same source I did," referring to his article in the October 1976 issue of *Foreign Affairs*. Lovins then identifies the "incorrect" source as our report (1). On page 6 of our report we said:

In West Germany, a much larger proportion of the electrical energy is generated by self-producers (principally industrial establishments), rather than utilities, as indicated in the following tabulation.

	United States	West Germany
Utilities	94.3%	71.5%
Self-producers	5.7	28.5

Of the West German industrial (excluding railroads) net production, 59 percent goes for their own use. The generation (and sale) of this much surplus electricity suggests a wider practice of the energy-conserving techniques of combining the generation of electricity and process heat in West German industry.

We did not identify how much of the 28.5 percent of electricity generated by self-producers represented cogeneration, and did not mean to imply that all of it did. Since then, R. H. Williams has determined that 12 percent of electricity generation in West Germany represents cogeneration, which corroborates our suggestion that the practice is more widespread in West Germany than in the United States.

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"Lovins' Fever"?

As usual, Allen L. Hammond and William D. Metz have done a fine job in summarizing the vagaries of the federal program in solar energy R & D (Research News, 15 July, p. 241). Unfortunately, and not surprisingly, this critique shows evidence that they, like so many others, have caught "Lovins' fever"—for which there is no known antidote.

Without any great hope that further analysis can really change minds, I think it may be worth reminding the readers of *Science* of several unresolved difficulties before they begin to bang on ERDA's

(the Energy Research and Development Administration's) door.

1) To assert that solar energy is fundamentally different from other energy sources because it is "democratic" is, indeed, a beautiful thought. But examinations of decentralized solar systems which would provide temperature conditioning and electricity to communities indicate they will be more "democratic" for the well-to-do located in the suburbs than for the lower-income groups in urban centers.

2) Assessments of on-site solar systems to the contrary, no one has articulated in any detail—let alone determined—the energy system-wide effects of meeting a substantial fraction of total final energy demands at a regional level through the use of such distributed energy technologies. These effects may include added costs to consumers still relying on utilities, a decrease in overall community energy efficiencies as a result of the displacement of commercial and industrial activities to remote locations, and increased state and local government responsibilities in case of disruption of the local systems.

3) For the next 40 to 50 years, and probably much longer, a major fraction of the nation's energy system of production and distribution will rely on centralized energy facilities. Dialogs which focus on solar energy's role in a hybridized complex of centralized and distributed subsystems are, therefore, much more productive than those which cast the situation in an either-or context.

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Archeoastronomy at Pueblo Bonito

Jonathan E. Reyman's article "Astronomy, architecture, and adaptation at Pueblo Bonito" (10 Sept. 1976, p. 957) raises an interesting question about the intended functions of buildings that were purposely astronomically aligned. In 1975, Fisher, O'Flynn, and I reported (1) on the same window alignments in Pueblo Bonito to which Reyman refers. His measurements confirm our findings that the two windows open to the winter solstice sunrise. However, we feel that his hypothesis of "adaptive strategy" for the windows is far from settled. That the alignment is real there is no doubt. However, if it is intentional, it is certainly not clear that the alignment ever served to set a calendar. To begin with, because of the angular width of the windows, it is impossible to determine the date of the

solstice very accurately simply from seeing the sun at the center of the windowsill. For example, the window in room 228B is about 6.5° wide as seen from the opposite corner of the room. Without a marker of some sort on the sill, it would be very difficult to judge just when the rising sun appears at the center of the window. Furthermore, there is the problem of where in the room one is to stand to see the sun at the solstice. It is merely a guess that the appropriate place to stand is where the sun at winter solstice sunrise appears at the middle of the sill.

The sun does appear to stand still for several days around the solstice in its yearly journey north to south and back, and this phenomenon could be easily seen from these windows. What is more to the point, though, is that the sun appears to "stand still" near the solstices when seen from any fixed point at any local horizon. In this respect, the sun-watching stations we have discovered in Chaco Canyon (1, 2) are more effective for actually setting a calendar because they allow one to predict accurately the advent of the solstices a number of days before they actually occur. The windows in rooms 225B and 228B are deficient in this respect as well as being poor markers of the winter solstice. We prefer to explain the orientation of these windows by noting that this sort of alignment is similar to the summer solstice alignment of the northeast window in Casa Rinconada (1), a great kiva across the canyon from Pueblo Bonito. The windows were likely constructed in Pueblo Bonito to be open to the winter solstice sunrise, which had ceremonial significance.

Because the windows from rooms 225B and 228B connect to rooms at the same level to the southeast, it is probable that there were exterior walls which would block the views from these two rooms and thus make the windows doorways. Reyman discusses this possibility but finds little evidence that there was such a wall. However, he states that the windows are on the third story when, according to his own figure 2 and Judd's plate 15 (3), they are on the second story. Furthermore, Reyman's figure 2 gives ample evidence of the probability of a second-story exterior wall.

However, the possible presence of an outside wall obstructing the view from the window fails to defeat the assumption of purposeful astronomical orientation for the windows. As we have noted previously (1, 2), the Zuñi placed ports in their exterior walls to admit the light of the sun on ceremonially and agriculturally important days (4). A similar practice could have been followed in

Pueblo Bonito, a port in an exterior wall admitting the light of the sun through the corner window at the winter solstice. Such a port could certainly establish a calendar accurately, as the combination of it and the doorway could define the direction of winter solstice sunrise precisely. As judged from Cushing's account, however, the Zuñi ports served only as reminders of the important days, since the sun priest still made his observations from his sun-watching station. As Young (5) has demonstrated, the acceptance of the sun into one's room at ceremonially important times of the year has clear religious importance that is supported by ample mythological references as well. Thus I believe that the solar alignment of the corner windows at Pueblo Bonito were of richer significance than Reyman allows for in his article. It may be an example of an early technology serving ritual needs. It seems to me that this could only have happened after the demands for an accurate calendar had been met.

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5. M. J. Young, unpublished manuscript.

In that it relies on the present-day lack of sill markers at Pueblo Bonito, Williamson's argument that it was difficult to determine accurately when the sun rose in the center of the windows is weak. As I noted in my article, any markers which may have existed prehistorically in conjunction with the windows have since disappeared. Given the engineering skills of the ancient Chacoans, the placement of markers on the sills or elsewhere would have been an easy task. While the lack of such markers today does not mean they never existed, neither can their former presence be demonstrated. Thus further discussion about them seems pointless.

Even without markers, it is not as difficult as Williamson assumes to determine when the sun rises in the center of each window, especially if one uses the windows in conjunction with topographic features on the horizon. I noted in my article that the use of architectural features in conjunction with horizon calendars is well documented ethnographically for the Pueblos. When looking from



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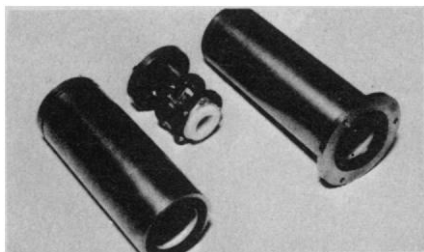
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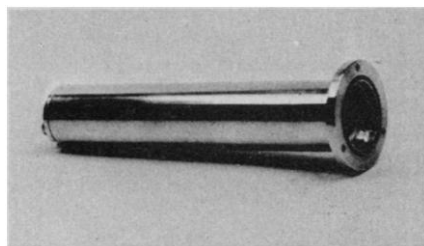


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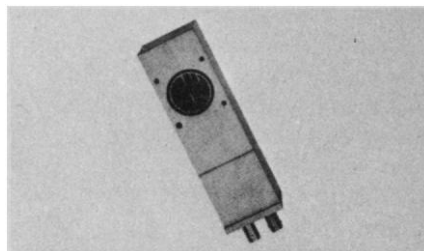
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the Pueblo Bonito windows, the use of a horizon calendar would also allow one to predict accurately the advent of the winter solstice sunrise; the windows need not be considered deficient in this regard. The reader should note that the "sun-watching stations" to which Williamson refers are considered by Williamson *et al.* (1) to be possible observation sites. Thus, additional evidence is needed before these sites can be used as a standard by which to evaluate the Pueblo Bonito windows.

Williamson's statement that, "It is merely a guess. . . ." puts the cart before the horse. The correct procedure, which was followed, is to test specific hypotheses generated from the ethnographic data for the Pueblos—in this case, that the windows were aligned along their central axes to the winter solstice sunrise. Therefore, we first determined the central axis for each window and then sighted along each axis to the horizon. On the winter solstice, the sun rose at the sighting point on the horizon for each window. For the window in 225B, the central axis can be determined from the intersection of the stones which comprise the bottom edge of the window; this is not possible, however, for the window in 228B, which is constructed differently. The central axis must be determined by physical measurement, a technique which can also be used on the window in 225B.

Williamson notes that these solar alignments may have had religious significance. This is probably true, but his argument ignores the fact, discussed by Rappaport (2) and well-documented for the Pueblos (3-4), that religious ceremonialism contributes significantly to human adaptation. As I noted, in the case of the Pueblos, the major ceremonials center on the planning and implementation of the farming system. Thus, that the alignment of the windows to the winter solstice sunrise may have had religious significance does not preclude the more fundamental, adaptive function of these architectural features, since the religion itself serves the same adaptive strategy, at least in part. Similarly, that accurate predictions of astronomical events increases priestly power and prestige (4, p. 206) does not preclude the more basic function of such predictions to gain a greater understanding of seasonal changes in order to increase the likelihood of a successful harvest. Pueblo religion, at its base, serves to increase the adaptive efficiency of subsistence strategies; therefore, while the alignments may have had "richer significance" as suggested by Williamson, we must first examine them within a framework of ecological adaptation. My

article attempted to do this and no more.

Finally, Williamson is correct in pointing out that the windows are in rooms 225B and 228B, not 225C and 228C, as I stated. My error resulted from an attempt to resolve an apparent inconsistency in Judd's (5) room designations. In so doing, I mislabeled the rooms. As Williamson notes, however, the alignments are real; they are correct, but my original room designations are not.

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Taxonomists Wanted

As a chemist with a research interest in archaeology, I have for some time been concerned with increasing contacts between physical scientists and archaeologists. One modest result has been the "Archaeometric Clearinghouse" published recently in the *Journal of Field Archaeology*. It will, it is hoped, lead archaeologists to those physical scientists who are best equipped to extract useful information from archaeological finds and result in useful interdisciplinary collaborations.

The project is actively supported by the Committee on Science in Archaeology of the Archaeological Institute of America. The response has been good, and I have been asked to enlarge the range of the "Clearinghouse." A badly needed roster is one of taxonomic experts who can identify organic remains: wood, seeds, pollen, bones, and so forth. Unfortunately, such specialists, many of whom have never worked on archaeological materials, are difficult to locate.

I therefore ask that interested taxonomic specialists in relevant fields send me their names, addresses, and fields of specialization for inclusion in a future listing.

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