the role of the Catholic Church in technical astronomy. On the one hand, the Church's involvement in, and patronage of, science did not stop with Galileo's condemnation. On the other hand, in its very places of worship devout astronomers made measurements that strengthened the Copernican "hypothesis" and finally made all other astronomical theories simply irrelevant.

BOOKS: ENERGY TECHNOLOGY

A Bright View, Too Focused

David Faiman

Hans Ziegler, a former German bombing expert, was responsible for the Americans using solar cells aboard their first space satellite. Lloyd Lomer was a U.S. Coast Guard captain who never made it to the rank of admiral because of his crusade for photovoltaics. Bernard Verspieren is a priest who made Mali one of the world's foremost users of photovoltaic water pumps. The sagas of these and other unsung heroes, and anecdotes embracing characters with Runyanesque names like "Available Jones," are chronicled in John Perlin's latest book. Twenty years ago, in *A Golden Thread*, Perlin and co-author Ken Butti provided a delightfully informative history of human efforts to harness the sun's energy (*1*). When Perlin considered writing an updated version, he concluded that although most aspects of solar technologies seemed in decline, photovoltaics (the direct conversion of sunlight into electricity) was a success story begging to be told. Thus solar cells are the focus of his attention in *From Space to Earth*.

From Space to Earth
The Story of Solar Electricity
by John Perlin
Aatec, Ann Arbor, MI, 1999. 240 pp. $32. ISBN 0-937948-14-4.

Perlin starts by relating several stories of 19th- and early 20th-century attempts to convert sunlight into electric power, directly or via a thermal intermediate stage. His account is not comprehensive. (When I began to feel somewhat put down by my ignorance of such solar-power pioneers as Willoughby Smith, William Grylls Adams, Richard Evans Day, Charles Fritts, and George M. Minchin, I desperately sought "Becquerel" in Perlin's index. I was greatly relieved to find reference to a footnote that informed me the Frenchman had indeed discovered the photoelectric effect some 40 years before the research efforts discussed in the main text.) And as fascinating and well-written as these and many of the subsequent anecdotes are, the book soon becomes tedious because Perlin laboriously documents attempt after attempt to "market" photovoltaics.

Sunlit flare. Powered by photovoltaics, low-orbiting Iridium communication satellites link solar-powered phone booths around the world.

According to its subtitle, the book tells the story of solar electricity, not just photovoltaics. If that is so, it tells a highly partisan one. On the few occasions that the important solar-thermal part of the story is not totally ignored, it is ridiculed by the author. For example, in reference to the solar-thermal water pumps that had been tried out in Africa in the pre-photovoltaic era, Perlin writes: "Each thermal pump required a resident engineer...to make adjustments and repairs. ...Verspieren would have nothing to do with them. And that was smart as none of them ever worked for very long." But only a few pages later, when referring to mechanical problems associated with the first photovoltaic pumps, Perlin observes: "Problems such as these would have spelled doom for Verspieren's solar project had he not built up a stockpile of spare parts, an ultramodern repair facility, and a highly trained staff of African and European technicians."

I am no less enthusiastic about the potential of photovoltaics than the author, but it is important not to let enthusiasm cloud one's judgment of where the true problems lie. Solar-thermal pumps, of the kind originally tried out in Africa, may have had low efficiency (caused by thermodynamics, not poor performance). Nonetheless, similar low–boiling temperature Rankine turbines later powered a 5-megawatt solar demonstration plant at the Dead Sea. This plant, which is not mentioned by Perlin, is the only example to date of solar power generation with built-in night storage.

Perlin, in my opinion, overdoes the use of quotations. Thus most of the copious notes and comments that follow each chapter are of the type "interview with *x*." In a number of cases, the information he presents, often obtained from sales material or personnel, is misleading or even incorrect. For example, when discussing the use of rooftops as mini–solar power stations in the chapter "Solarizing the Electrified," Perlin quotes an executive of a Japanese solar cell producer as saying: "Nobody is even talking about big photovoltaic plants, central power stations anymore." It happens, however, that I am a member of a newly established International Energy Agency photovoltaics working group (Task VIII) set up to study the feasibility of very large photovoltaic power plants. And the coordinators of this working group are mostly Japanese.

The message is clear that photovoltaics are an effective solution for regions in which the implementation of grid electricity would be too expensive, and Perlin need not have emphasized it as frequently as he chose to. In addition, his discussion of the economics of photovoltaics in a utility setting is misleading and possibly confused. Perlin quotes the manager of the Sacramento Municipal Utility District as saying: "This year we installed systems at $5.30 a watt." The author interprets this as "generating electricity at between 16¢ and 18¢ per kilowatt-hour." But "1 watt" of photovoltaic cells can produce at most (that is, in a sunny desert region) about 1.5 kilowatt-hour per year. Thus a $5.30 per watt system would need a trouble-free life of at least 20 years (assuming a zero-interest loan) in order to meet the claimed 16¢ to 18¢ per killowatt-hour value. Furthermore, Perlin tells us in the following chapter that the present price of cells is $5 per peak watt. It is difficult to imagine how the other system components (inverter, wiring, stands, connections, installation) could cost a mere $0.30 "a watt."

Because I enjoyed *A Golden Thread*, I began *From Space to Earth* with great enthusiasm. My enjoyment, however, was soon undermined by Perlin's sales-talk style and his partisan attitude. This book could have been a timely discussion of all the approaches to solar electricity–producing technologies. A hundred years from now a world without solar power will hopefully be as difficult to imagine as a world without electricity is for our generation. But it would be rash to bet that photovoltaics will be the single technology that gets us there.

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