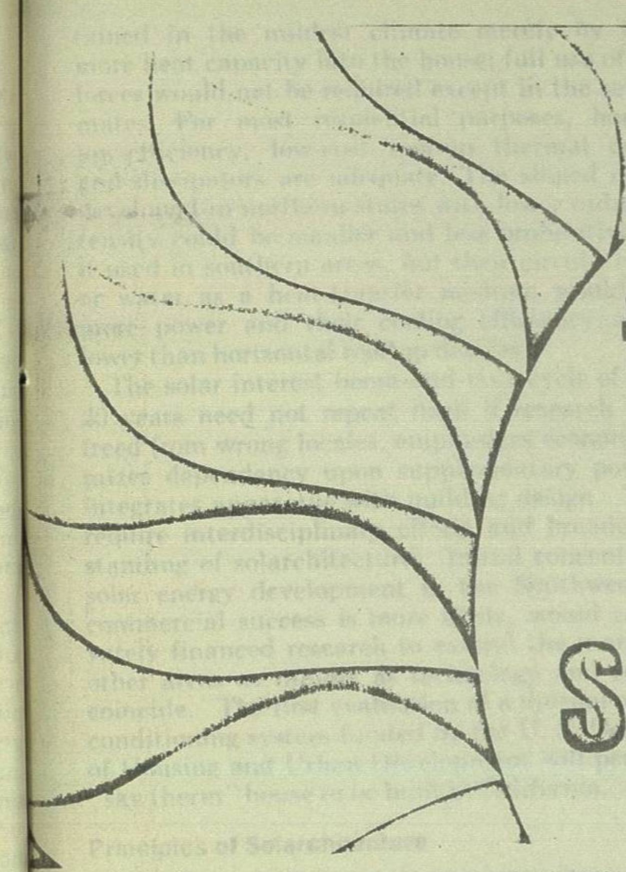

energy, technology and solarchitecture

Solar architecture can ease the energy shortage over the next two decades. It can reduce by 70 per cent the residential power needs in most of the Southwest through buildings whose materials, structural elements, landscaping, and operation are designed to take maximum advantage of night-sky cooling and direct use of solar energy for space and water heating. Such a structure, "Sky Therm," is now being evaluated by the government.

H. R. HAY

Sky Therm Processes and Engineering, Los Angeles, Calif.

The first commercial impact for solar energy will be for space heating in the Southwest, where most of the heavily populated areas have abundant sunshine and mild climate. In Southern California, perhaps 90 percent of residential use of power for thermal comfort can be eliminated; the other 10 percent is needed during protracted rainy or overcast days. In 1968, winter heating consumed 63 percent of domestic power demand and water heating required 15 percent—another area for solar energy direct use. About 62 percent of summer household electricity use was for air conditioning and again about 15 percent was for water heating. Thus natural energy forces have the potential for reducing home power use by 70 percent.

The air-conditioning load coincides hourly and seasonally with the peak power demand on the distribution system. Thus, there is strong justification for going to the trite ultimate of specialization: "... to know all there is to know about nothing." This particular nothing is outer space. Man made better use of it thousands of years ago than we do after physically penetrating it. To save power, we must return to the direct use of the night sky as a heat sink. There are advantages in coordinating this effort with the direct use of solar energy.

Mutually Advantageous

Facing a power shortage and brownouts, the Los Angeles Water and Power Department has stopped promotion of "Gold Medallion" all-electric homes. To prevent the crippling of industry and consequent unemployment, end use priorities for power may soon deny occupants of "electric homes" the thermal comfort which produces about 15.5 percent of the system demand. Southern California may be forced to use high sulfur oil that will increase smog problems; the city is on record as regretting its part in the air pollution formed by thermal power plants hundreds of miles away in the deserts. It is, therefore, advantageous for both utilities and industry to promote diurnal energy heating and cooling.

In addition to assuring comfort in periods of power brownout, natural air conditioning may also relieve the new house owner of unnecessary expenses. In Los Angeles, heating and cooling a 2000- to 2400-sq -ft house, plus water heating, costs $18.50 in a $24.00 monthly electric bill. Disregarding any rate change, 70 percent reduction by use of diurnal energy flux would result in a $17-saving. Applied to reduce a $25,000, 30-year mortgage on a house, this saving would permit paying off the mortgage seven years earlier with over $10,000 less interest calculated at only 7.0 percent, (a $12,700 saving at 8.5 percent interest rate).

Wherever heating and cooling are used in the Southwest, natural energy flux utilization can reduce ... comfort can be maintained in the mildest climate merely by building more heat capacity into the house; full use of diurnal forces would not be required except in the severe climates. For most residential purposes, horizontal, low-efficiency, low-cost rooftop thermal collectors and dissipators are adequate. The sloped collectors developed in northern states with lower radiation intensity could be smaller and less prohibitive in cost if used in southern areas, but their circulation of air or water as a heat-transfer medium would require more power and their cooling efficiency would be lower than horizontal rooftop devices.

The solar interest boom-and-bust cycle of the past 20 years need not repeat itself if research becomes freed from wrong locales, emphasizes economy, minimizes dependency upon supplementary power, and integrates apparatus with building design. This will require interdisciplinary efforts and broader understanding of solarchitecture. Initial concentration of solar energy development in the Southwest, where commercial success is more likely, would cause privately financed research to extend the markets into other areas as rapidly as technology and economics coincide. The first evaluation of a diurnal energy air conditioning system funded by the U. S. Department of Housing and Urban Development will pertain to a "sky therm" house to be built in California.

Principles of Solarchitecture

Within local limitation, solarchitecture is better practiced as an art in developing countries than it is in the advanced regions of the world. By reviewing the basic principles, modernizing the technology, and analyzing the impact which solarchitecture can make on the power and pollution crises, we may recognize not only great potentials but we may also find reasons for reconsidering substantial portions of our way of life.

Solarchitecture, in the recent past, has not been so closely related to space heating with solar energy as it has to reduction of heat load through site selection, orientation, overhangs and brise soleils, fenestration treatments, and landscaping. This emphasis was directed toward lowering the operating cost of powered air conditioning. With seasonal peak demand for power now resulting from air conditioners, a national effort is being made to increase the amount of insulation in the walls and attics of new houses. Since this is intended to reduce solar radiation effects, solarchitecture is as directly involved as if the insulation were used to retain heat derived from solar collectors.

The future use of photovoltaic cells (mounted on the walls and roofs of buildings) to supply the electricity for those purposes for which the more efficient direct-use solar energy appliances are not adaptable will become an important aspect of solarchitecture. It is a very broad, interdisciplinary subject and it is fundamental to the development of economic use of natural energy forces.

Geographic Climatology

Geographic climatology is a developing science basic to the use of diurnal energy flux. Climate data provided by weather stations do not approach the qualitative or quantitative needs of solarchitecture. Climates vary recognizably within a few miles; shade patterns of hills and buildings create large differences in micro-climate within hundreds of feet. Detailed data on temperature, dew point, precipitation and cloud cover, and solar radiation are prerequisites for selection of house design and materials and for consideration of heating and cooling. We can no longer afford the convenience of ignoring the climate and installing overpowering thermal rectifying appliances where these are not essential. In terms not requiring technical acuity, plot maps of zoned property should reveal climate-related energy requirements for obtaining thermal comfort.

In practical terms, solarchitecture is entirely compatible with the objectives of conservation groups both in energy and in land usage. Neither solar heating nor night-sky cooling is enhanced by recessing a house under large old trees on a hillside. Collection of solar energy is not so feasible on north hill slopes where the vegetation grows more slowly. Direct night-sky cooling is independent of solar exposure, but efforts toward conversion of solar energy to produce cooling have the same orientation limitations as those of solar heaters. It would be well for solar advocates to fully respect the environmental concerns of our time; direct use of solar energy does; indirect use for the production of transmissible power does not. Abandoned fields without trees become choice sites for new construction in accordance with solarchitectural principles. Such fields allow freedom of orientation and for tree planting which avoids undesirable shading effects.

Structural Features

The high heat capacity of earth, stone, and brick is now little used to modulate diurnal energy effects in industrial countries. Costs of manufacture, transport, and erection of these materials for walls having required thickness for adequate heat storage are excessive—as is also the cost for concrete. Earth materials acquire new status through solarchitecture. Sand-filled cavity walls can add heat capacity and obviate the need for hauling sand away from some construction sites. More significantly, the ground can be better used as a heat sink.

Plastic moisture barriers permit use of slab-on-ground construction and also of walls that are built partially below ground level—especially where the annual mean ground temperature is within the comfort zone. Use of perimeter insulation has demonstrated that a slab-on-ground floor may be the most thermally stable element of a room; wall-to-wall carpeting is then insulation wrongly placed.

Heat storage is being studied by other investigators not only to better utilize solar energy but also to shift a portion of peak power demand to hours of lower load. Conventional electric heating and cooling devices operated during off-peak hours have their excess thermal effects stored in high-heat-capacity materials which are a source of thermal comfort during peak hours when the devices are not expected to be operable. Chemical salts and rocks have been used as heat storage materials, but the high heat capacity of low-cost water is made increasingly appeal-