ALTERNATE SOURCES OF ENERGY:

A Bibliography of Solar, Geothermal, Wind, and Tidal Energy, and Environmental Architecture

by

Barbara & David Harrah

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with a Foreword by
Brent M. Porter

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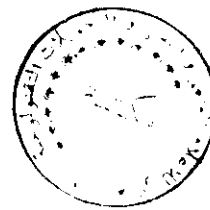
To Our Parents

Joan and Henry Koch

and

Dale and Rosanna Harrah



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FOREWORD

As this bibliographical reference book to alternative sources of energy becomes available, it is important to look ahead for issues which will arise as these energy sources are utilized for power.

Studies performed for the National Science Foundation, private industry and others; research in several fields for over a half century; practical applications by home owners; as well as recent testimony before Congressional committees have established that alternative sources of energy conversion can make a significant contribution to the power supplies of the nation. One of the applications which appears to be ready for widespread adoption at this time is the heating and cooling of buildings using solar energy, as well as the provision of hot water for these structures.

The international implications are of a great magnitude, especially as one examines the building practices and indigenous methods for harnessing natural energy sources of people in many countries. As we examine roof overhangs, wind scoops, natural ventilation, cooking techniques, recreational and social zones, etc., from the viewpoint of many users of the environment, we see that "there is little new under the sun" in their day to day lifestyles. Builders and architects throughout the world know the importance of a good overhang to block summer sunshine and facilitate winter sunshine. The United Nations, in its many publications in the field, and such authors as Bernard Rudolfsky (Architecture Without Architects) and Pearl Buck have shown the international base for energy conservation and utilization. We should anticipate some of the worldwide situations which may result.

The sun is a limitless source of energy, along with geothermal, tidal and the less constant wind energy. These are unlike other sources which are depletable. The four alternative energy sources are interrelated. The sun with Earth's moon establish the system within which the oceans respond.

The sun affects the winds. Its wavelengths within the light spectrum are constants for man's calculations, manipulations --and dreams. Its spent radiation, transformed to other forms of matter and heat, is prevalent throughout our earth. As we rediscover the chief inexhaustible source of energy in a post-industrial world, will we run rampant with it? In utilizing all forms of natural energy we are presented with trade-offs and long range dichotomies.

Consider the parameters of use

National planning, country by country, will require new approaches. Conventional land-use planning may be inadequate because it is based on exhaustible energy sources and limited services within a given area. Needed are commonality of interest and a less egocentric reflection of an individual citizen and his impact on the destiny of a city or town. With alternative energy systems, there is a potential historic reversal: Man may regain his own castle, and do so at a time when societies are organized as high density communities and when few men can afford their own castle. There is the possibility, for instance, of masses of incredibly poor residents of Le Corbusier's cities and megastructures in India one day possessing a simple solar stove, water heater, etc.; then, too, there is modern urban man's use of his city. The latter increasingly regards his surroundings as a fortified environment, a "defensible spaced" city (see Oscar Newman's findings) and as a place he would prefer to express manageable or perceptible personal identity, jurisdiction and direct control over some piece of space or activity.

As a case in point, consider the urban infrastructure of Boulder, Colorado. The city has established a "Blue Line." No municipal utilities can extend beyond this ring. Nature might be assumed to be temporarily protected. With the advent of alternative energy systems, and workable subsystems, DEVELOPMENT may spring up anywhere, certainly beyond Boulder's own Blue Line. Energy conversion, when integral to a specific site and in accordance with the determination of the individual user, will surely alter the theory of a number of planning professions, the direction taken by governments --and the individual or collective incentive regarded by the populace.

Consider new forms of collection

Engineers and scientists conclude that solar energy systems alone will collect so much energy, that disposing of this overwhelming supply will become a major challenge. This disposal is not to be confused with the inherent losses in conversion and transmission of power. There are standard losses expected. The initial conversion as well as transmission systems have restraints; there are limited capacities for handling limitless energy. With the need for excessive handling of excessive energy, we may find an indirect variant of POLLUTION FROM OVERABUNDANCE.

This energy overload is not likely with Peter Glazer's concept; however, the manpower and material required to implement his scheme may place impossible demands upon the earth's resources. He foresees a satellite collection concept beyond the earth's atmosphere at synchronous altitude (22,000 miles above ground surface) in which an array of photoelectric cells which convert solar energy outside the atmosphere to electrical energy. This energy is then beamed to earth by microwave, the beam uninterrupted by the atmosphere. The national and international implications of this ultimate form of collection are obvious. Collective expertise and resources of many nations may make the space platform approach possible with less danger to the biosphere.

Consider energy "intensiveness"

Glazer's concept not withstanding, energy and capital can be overly concentrated upon one locale or endeavor, a single facility or a special project, resulting in high economic and social cost. This overconcentration can result from the often separate, emphatic actions of those who are most sincere in their beliefs; bureaucrats, industrialists, small businessmen, conservationalists, educators, et al. As ECOLOGY became a household word, and as a period of environmental awareness peaked in the early seventies, many people called for the repair of the environment at such a high economic and social cost that much of the improvement effort would establish even more "energy intensive" processes in our society.

Conversion of energy can be dispersed and yet localized. Not only individual households, whether within low, medium or high density areas, but urban complexes too can be supplied with power with less need for transmission of that

power at (1) a personal unit scale, and (2) a metropolitan or regional scale. A four-story townhouse will need a greater collection area than present flat plate collectors can provide, but a series of windmills could be at the summit of the World Trade Center in New York.

Hopefully we have the options, without further harm to the present environment and with little depletion of these usable energy resources. However, there is the potential difficulty of repetition, when the concentration of energy collection and its conversion are equally possible. As much energy intensiveness as now experienced can result when a society makes the new technology available to people directly on an individual basis. The environment--and cities in particular--may either radically change in form or stabilize its present form by improvements from within, expending less total energy. The trends in renovating old buildings which have sound structures --and that are so expensive and energy intensive to build anew--point to the latter. Experiments in desert climates, on the other hand, suggest bold new structures for mankind.

Finally, consider the pioneers in alternative energy systems and their entourage

In the United States, the wide disparity between homeowner oriented systems and city-wide services is paralleled by the remoteness and location of work in the field of alternative energy systems. There is ample communication, although a rather underground, less integrative spirit exists.

At present, pioneers in the field, the academicians and professionals in related fields, and industry are largely pursuing systems for single family, detached dwellings and suburban or rural facilities. The social response is negligible at this point, both from the supplier of prototypal systems and the early users of these systems. Performance criteria on not only a technological but also a social basis are gradually being examined. As the need for development of alternative energy systems becomes apparent to everyone--fuel shortages and new federal legislation predicating our lifestyles--research and implementation will likely increase in scale and comprehensiveness. The U.S. endeavor thus inherently offers substantiation of regional aspects of various prototypal systems, geographic test data, application of science along with indigenous skills, and updating of work by European and Asian forerunners in the field. The U.S. prototypes also reinforce

international test facilities in that not only small, single-purpose buildings exist but also a broad range of architecture is imminent; schools, office buildings, mobile and modular housing units, and residential complexes, for example.

There are three categories of leaders in the field of alternative energy systems. These respective camps address their work primarily to solar energy utilization.

First, the ranking leaders in the academic community are George Löf, Director of the Solar Energy Laboratory at Colorado State University, Ft. Collins, Colorado; Dr. Erich Farber, Director of the Solar Energy Laboratory, University of Florida in Gainesville; and Professor John Yellott, College of Architecture, Arizona State University. For wind and tidal energy utilization, Professor William Heronemus at the University of Massachusetts in Amherst is a leading authority and designer.

Second, the suppliers of components on a production scale include Pittsburgh Plate Glass, Pittsburgh, Pennsylvania, and Revere Copper and Brass, Rome, New York. These companies are manufacturing flat plate solar collectors. There are several small companies producing other equipment and components for the utilization of alternative sources of energy.

Third, the developers of systems are represented by corporations: General Electric, Westinghouse, Honeywell, and Thompson Ramo & Wooldridge. For wind energy, Grumman Aircraft is the principal developer. For geothermal energy, the most significant work is being conducted by the Mexican Government, whose largest single project is located in northern Mexico where a geologic abnormality produces dry, relatively noncorrosive steam. For tidal energy, no significant contracts have been awarded in the United States, whereas the French are proceeding with an experimental tidal plant.

It is evident that as these individuals and organizations are joined by those who have recently shown great interest, the realization of alternative energy utilization--and the impact upon our lives--has arrived.

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INTRODUCTION

The Arab oil embargo caught the major industrialized nations with their diversification down. And as any good ecologist knows, a lack of diversification makes an ecosystem extremely vulnerable: should a blow befall a one-species community and the blow prove harmful to that species, the community may be destroyed because there is no replacement for the lost or damaged element.

With diversification, the ecological community is cushioned with the variegated physical strengths, immunities, mental prowesses, and natural and acquired survival mechanisms of its inhabitants. A blow that is potentially lethal to one may do little or no harm to the others. The community struck falters but rapidly bounces back.

Economics reflects the laws of ecology within the fiscal world. The effect of the embargo is an example. American energy needs are based almost exclusively on oil, and when a significant amount of that oil was removed we became as desperate as an animal that feeds on a one-species diet and wakes one morning to find his meal-ticket species flown the coop. To cover our vulnerability laid bare by the oil crisis, we must emulate in our energy policy the dictates of the physical world. There it is the animal which subsists on various food (energy) sources that survives. When one dish absents itself, another dish remains. By diversifying our economic energy supplies we will not be caught without fall-back sources.

We must avoid, therefore, the trap of viewing any potential energy source as the "answer" to our energy needs--no matter how promising its present potential. Oil in the 19th century promised a cheap, plentiful, safe source of energy. Its negative polluting aspects were not considered, its exhaustibility shrugged off as a problem for future generations. Then in the 1950's nuclear energy began priming for its eventual ascent once King Oil abdicated. But today the nu-

clear panacea is posing more questions than it is answering, and so solar energy proponents link their newly rediscovered product with the ultimate answer. Only time, experimentation, and careful evaluation of the results of applied research will prove or disclaim our hopes for solar energy. But for now we should put aside the illusions of single answers for the safety of diversification. Solar power, like wind power, tidal, and geothermal energy, belongs within a well-integrated community of energy sources, adapted for their particular regions, compatible with their immediate environments.

The energy sources discussed in these pages are not new. At the time of the Revolutionary War, Boston powered a mill by trapping the high tide and allowing it to flow out through the mill wheel. The Philadelphia Centennial Exposition on 1876 featured an "amazing new" solar-run steam engine--twenty-three centuries after Archimedes destroyed an entire fleet with sun power. The wind throughout man's and beasts' history has provided a reliable energy source. For men it has powered ships and wind mills; for birds it is an aid in flight. The Romans long before the birth of Christ used geothermal energy to heat their bath water.

Of the four sources of solar, geothermal, wind and tidal energy, solar power holds the greatest promise as a widely usable energy source. More research is being conducted in this area, and more has been written on it. We have, therefore, devoted the greatest part of this bibliography to solar energy and have compiled the significant literature of the last five years as well as the "classics" as a springboard for further intensified solar power applications. Producing reasonably priced solar equipment is the next challenge in solar energy research, and once the federal government outgrows its current infatuation with the bureaucratically entrenched conventional power sources and allocates proper funds for development of cheaper solar energy hardware this challenge will be met. The sun can be a significant, on-line power source by the end of this century--at the latest. For it is no longer a question of whether solar energy is practicable: already throughout the country--not just on the sunny western desert--solar power is providing heat, hot water, and electricity to residential and commercial buildings. The problem remains in making the costs of solar equipment for residential use competitive through mass production so that solar energy becomes an attractive alternative to fossil fuel sources. The equipment to power an American home costs today between $5000 and $8000. With the present high

cost of oil, gas, and coal the investment pays for itself within five years. But the initial cash outlay is still beyond the reach of most homeowners.

The bibliography which follows contains more than 1700 entries, mostly on solar energy. But with an eye on diversity, we have included a number of sources dealing with wind, geothermal, and tidal power. The listings are divided into six subject areas:

(1) Various Unconventional Sources of Energy [entries 1-154]. This section includes general articles that cover more than one of the four sources. An example is entry 60, Allen L. Hammond's "Energy Options: Challenge for the Future." It gives a broad overview of the possible sources of power recommended for national future use.

(2) Solar Energy [entries in 1000 and 2000's]. This section includes articles dealing principally with solar energy power. A Solar Energy Subject Index to the various topics within the general subject--collectors, distillation, conversion, etc.--is found at the back of the book. Books listed in this Index under Solar Energy General are either overviews of the broad topic of solar energy or deal with two or more of the narrower topics. References cited under specific topics do not necessarily deal exclusively with that one topic. It is merely the focus of the reference. This index, therefore, should be used as a loose guide.

(3) Geothermal Energy [entries in 3000's] contains articles and books that deal exclusively with geothermal power.

(4) Wind Energy [entries in 4000's]. This section is a short bibliography providing an introductory reference to sources on the generation of electricity through the use of windmills.

(5) Tidal Energy [entries in 5000's] contains 37 entries and is designed to serve as a brief introduction to the use of tidal power.

(6) Environmental Architecture (Climate and Energy) [entries in 6000's]. Application of new sources of energy and conservation of present and potential energy sources has, and will increasingly, influence the design of buildings and of cities. This section contains 22 books and articles which

concentrate on the architectural aspects of climate and general energy usage and gives 48 cross-reference to sources listed under Section 2 (Solar Energy).

The Appendix contains a directory of the periodicals, firms, foundations, organizations, and individuals who are presently working on the application of alternative energy sources. The listing is by no means complete, but it contains the major sources of information.

At the very back of the book is a Key to Abbreviations we have used.

Note: Government reports are followed by their NTIS accession number and are available from the National Technical Information Service, Springfield, VA 22151. These reports are sold at a standard price of $3.00 for reports of 200 or less pages, $6.00 for 201 to 600 pages, and $9.00 for reports exceeding 600 pages. Microfiche copies are available for most documents at a standard price of 95¢ each. Always refer to the accession number provided when ordering material from NTIS.