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March 1979

Commercializing Solar Architecture

Summary of SERI Architectural Planning Seminar, July 1978

Gregory Franta

Solar Energy Research Institute
A Division of Midwest Research Institute

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COMMERCIALIZING SOLAR ARCHITECTURE

SUMMARY OF SERI ARCHITECTURAL PLANNING SEMINAR, JULY 1978

GREGORY FRANTA

MARCH 1979

Solar Energy Research Institute

1536 Cole Boulevard
Golden, Colorado 80401

A Division of Midwest Research Institute

Prepared for the
U.S. Department of Energy
Contract No. EG-77-C-01-4042

PREFACE

This technical report, prepared by the Market Development Branch, Technology Commercialization Division, Solar Energy Research Institute, is a summary of the SERI Architectural Planning Seminar, July 1978. This report documents the statements and comments of the participating architects and SERI staff members who attended the seminar. It will be used as a planning document for the SERI design and construction activities. This report was prepared under U.S. Department of Energy Contract No. EG-77-C-01-4042, Market Development Branch Task No. 6203.

Sincere appreciation is expressed to all seminar participants and report reviewers who provided the needed support for the preparation of this document.

Gregory Franta, AIA
Task Leader

Jon M. Veigel
Chief
Market Development Branch

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SECTION 1.0

INTRODUCTION

1.1 OVERVIEW

The design professions can assist in the acceleration of solar technology commercialization. The comprehensive problem-solving process of architectural design, coupled with appropriate solar technology input, can effectively impact the approximately one-third of our nation's nonrenewable energy used in buildings. To better understand the role of the design professional in solar energy, the Market Development Branch of SERI organized an informal architectural advisory committee and sponsored an architectural planning seminar. During the seminar various attitudinal, technical, and institutional issues were identified along with suggested actions related to information development, acquisition, and dissemination; education and training; and demonstrations and design competitions.

The attitudes of architects, their clients, government officials, and design/construction professionals were considered major barriers to solar technology commercialization through architecture. Other potential barriers include technical issues related to the environment, building design and construction, operation and maintenance, and performance evaluation of solar heating and cooling of buildings (SHACOB) and general lack of technical awareness by architects regarding non-SHACOB technologies (wind, biomass, process heat, photovoltaic cells). Finally, institutional issues related to law and government and the solar infrastructure were identified as important.

In response to many of these issues, it was generally hoped that SERI actions would allow the variety of solar data to be better understood and to present the information in a form that integrates solar technology as a part of the total energy-conscious design process. Suggestions were given as to the specific types of information that need to be developed, acquired, and disseminated. Education and training programs on the total energy-conscious design process for all design professions and their educators are needed immediately. Solar demonstrations were suggested; however, the credibility of the existing federal solar demonstrations must first be established. Design competitions can have a good effect on professional awareness but the financial burden on architects must be carefully considered. Other proposed actions emphasized SERI involvement in the Federal Buildings Program, Domestic Policy Review, and the development of marketing tools.

1.2 BACKGROUND

The Architectural Planning Seminar was held at SERI in Golden, Colorado, on July 10 and 11, 1978. Practicing architects and planners were invited from large and small firms, solar- and nonsolar-oriented firms, and public and private organizations. Nine SERI staff members also participated. See Appendix A for a complete listing of participants' names and addresses.

Others were invited to participate as advisory committee members and in the seminar. Most of those unable to attend sent comments related to issues and actions to the committee for inclusion in the proceedings. These people include:

Jeffrey Cook, Architect and Professor; Tempe, Arizona
James Lambeth, Architect and Professor; Fayetteville, Arkansas
Michael Maybaum, DOE; Washington, D.C.
Ronald Scott, DOE; Washington, D.C.
Donald Watson, Architect and Professor; Guilford, Connecticut
David Wright, Architect; the Sea Ranch, California

FIGURE 1-1. SERI ARCHITECTURAL PLANNING SEMINAR

Information on SERI's overall mission and a paper titled, "The Architectural Role of SERI," (See Appendix B) [1] were mailed to each participant and presented during the seminar introduction. Seminar participants also met with Paul Rappaport, Director of SERI, to discuss SERI's mission. SERI staff members outlined related SERI involvement and led selected sessions. For example, a preliminary draft of the "Commercial Readiness Assessment for Passive Solar Heating Systems," prepared by the Passive Solar Heating Commercialization Task Force was discussed. A matrix of barriers and actions from this assessment, related to the commercialization profile for passive solar heating, is attached as Appendix C.

This report is intended to document the seminar discussions on attitudinal, technical, and institutional issues (Sections 2.0, 3.0, 4.0 respectively) and the suggestions related to information development, acquisition, and dissemination; education and training; demonstrations and design competitions; and other actions (Section 5.0). This document is not intended to present actions that will be implemented only by SERI. The SERI staff will evaluate the comments and use them as guidelines in program planning. The proceedings will be disseminated to other organizations (i.e., Department of Energy, Regional Solar Energy Centers, American Institute of Architects) for assistance in their program planning.

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SECTION 2.0

ATTITUDINAL ISSUES

Awareness of Architects

There is a general lack of awareness by architects regarding social, economic, and technical aspects of solar applications for building design.

Proprietary Design Process Attitude

The architectural profession's tendency to keep the core material of the design process proprietary in the apparent fear that competitors will use the innovative work hinders innovative design information transfer to other professionals.

Additional Responsibility

The architect, already overburdened with responsibility as a building designer, hesitates to accept the additional responsibility of solar energy design.

Credibility of Information

Because of much conflicting data, architects doubt the reliability of solar information and are often unwilling to "dredge" through the overload of information to find what they need.

Client Skepticism

Many architectural clients question the technical and economic feasibility of solar applications and, therefore, do not allow for proper consideration. The client may suspect the architect of trying to make more money through a more expensive building. Clients are particularly "mystified" by the passive technologies since much of the general public equates solar heating with roof-mounted collectors.

General Ethics

Much of the general public has neither the desire nor the knowledge to save energy or preserve and best utilize our natural resources through the use of alternate energy sources. Economics are often the basis for decisions, and initial cost parameters often outweigh life-cycle cost considerations.

Image Acceptance

The aesthetics of a solar building often vary from those of a conventional building, and the solar building image has not been completely accepted by the general public. The public views solar as "sexy," probably expensive, and therefore, not "sensible."

Government Terminology

The terminology used in the federal bureaucracy may overemphasize issues. For example, by publicly emphasizing the identification of commercialization barriers to solar technology, perceived barriers could become real ones. Also, the Department of Energy and others emphasize the difference between active and passive solar technologies. This emphasis can set up active and passive technologies as opposing forces, making it harder for the designer and client to understand an integrated solar design approach.

Government Approach

The primary goal of the National Solar Energy Program (Public Law 93-409) has been:

> . . .to stimulate the development of an industrial, commercial, and professional capability for the production and distribution of practical, competitive, and environmentally acceptable solar heating, cooling and hot water systems.

With this government attitude, the goal is to stimulate a new industry through the sales of manufactured products, not to save energy or energy-related dollars. Again, the differentiation between active and passive systems provokes confusion as to the real goal.

Budget for Public Buildings

Budgets for public buildings are often based on past patterns for initial costs rather than life-cycle costs that include energy considerations.

Engineers' Attitude

The attitude of many mechanical engineers is that they should either design all thermal applications for buildings or accept no liability for them. hem.

Lack of Building Industry Awareness

Builders are often "mystified" by solar technologies. They perceive numerous problems with their first solar installation with regard to technical concerns, economics, and consumer acceptance. Furthermore, the present market

allows builders to sell as many "conventional" homes as they are able to build. Therefore, they have little reason to build and sell solar homes.

Credible Economic Information

Credible information is lacking on economic benefits for both the designers and consumers, especially related to passive technologies. Passive systems may involve higher first costs, but it is often not the significant problem that may be encountered with active systems.

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SECTION 3.0

TECHNICAL ISSUES

3.1 ENVIRONMENTAL CONSIDERATIONS

Climatic Data

Specific climatic data, or information necessary to modify general climatic data to a specific site or microclimate, are generally unavailable. Furthermore, the quantity, quality, type, and form of the climatic data currently available are not geared to the architect's needs.

Site-Specific Environmental Conditions

The effect of site-specific environmental conditions on energy-conscious design and energy usage in buildings is not well understood. Information is sometimes available, but not in a form conducive to the architectural design process. These environmental conditions include:

- ground water (levels and temperatures),
- soils (thermal conductance, storage, insulation),
- snowfall (groundcover duration, reflectance),
- topography (effects on wind patterns),
- insolation (daily and seasonal),
- vegetation, and others.

3.2 BUILDING DESIGN

Energy Conscious Design Knowledge

Architects generally have a lack of awareness or certainty about the various solar technologies and the process of appropriate integration of energy aspects in programming, planning, building design, and architectural detailing. As a result, solar applications are often considered as "add-on" and not as an integral design parameter. Architects have difficulty identifying the actual problems and have a lack of images for the final design solution. Problem identification is especially confusing in retrofit applications, where the architect may be forced to be a technologist rather than a building designer. In many cases, designers are primarily concerned with intangibles such as expression, color, texture, composition, scale, proportions, excitement, articulation, relationships, etc. Generally, the architect's desire to

learn about energy-conscious design is overshadowed by technical confusion and a lack of understanding of design impact related to solar technology.

Architectural Constraints

Architectural constraints will be major technical design issues for solar-oriented buildings. Solar-oriented buildings may significantly impact architectural form, shape, style, function, details, structure, aesthetics, and relationships.

Design Tools

Design tools for solar applications related to planning, building, designing, and architectural detailing are extremely limited. Existing data and procedures are fragmented and are often more applicable to postdesign analysis than to predesign data or early design process. A valid energy-conscious design process must allow energy concepts to evolve from the architectural program and the environmental potentials of the site. The design tools must encompass natural daylighting, active/passive heating and cooling, domestic hot water, and other solar technologies related to building design. A framework to incorporate these design tools in a process and language familiar to architects is needed.

Confusing and Inadequate Information

Architects are confused by the quality, quantity, and content of solar information. Credible performance and economic data for many types of solar applications for various climatic regions do not exist. Furthermore, the terminology and format used in reference to solar data are often foreign to architects.

Commercialization Activities

Federal commercialization activities have not emphasized architectural solutions. In order to broaden the architect's concept images, more exposure is needed to architectural solutions that utilize natural lighting and passive solar heating and cooling, as well as integrate active heating and cooling applications. Also, few marketable designs, products, and systems incorporate architectural solutions.

3.3 BUILDING CONSTRUCTION

Builder Knowledge

The construction industry is generally unaware of construction techniques and applications of the various solar technologies. Using solar technologies often increases the number of contractors and builders involved, and architects are placed in the role of educators.

High First Costs

Many solar applications included in building designs involve first costs higher than those for conventional building. This is more often an issue with active solar systems than with passive technology. Builders unfamiliar with solar systems may overestimate bids to cover anticipated problems. This "fear factor" results in higher construction costs.

Low Public Building Budgets

Construction budgets for public buildings are often based on past patterns and may not allow for solar applications on new projects.

3.4 OTHER TECHNICAL ISSUES

Operation and Maintenance

Many architects are concerned with the operation and maintenance of building systems and components, especially innovative designs. Overly complex systems should be avoided, and emphasis should be placed on simple and low-maintenance designs. Although the energy-related cost savings resulting from solar applications can be achieved, the perceived maintenance costs can still destroy the project. Involving architects in the operation and maintenance of solar systems can afford an educational opportunity regarding economic and performance data and design appropriateness.

Performance Evaluation

Performance data for specific solar applications related to various building types and climatic locations are lacking. The performance of existing solar applications as well as new innovative designs must be evaluated and documented. The lack of performance data was indicated to be one of the key issues hindering solar architecture commercialization.

Knowledge of Non-SHACOB Technologies

Architects know very little about wind usage, biomass energy, agricultural/industrial process heat applications, and photovoltaics.

SECTION 4.0

INSTITUTIONAL ISSUES

4.1 LAW AND GOVERNMENT

National Energy Plan

The appropriate use of solar energy in architecture has been hindered by the lack of a national energy plan and a federal commitment to solar utilization.

Government Program Emphasis

Many government programs overly encourage or demand the use of highly technical solutions. The strong emphasis of these programs on the difference between active and passive systems sometimes results in inappropriate solar design solutions. Both architects and the public are confused about the appropriate use of active, passive, or hybrid systems.

Solar Access

Solar access is generally not guaranteed through conventional easements, covenants, zoning, or subdivision regulations. In many circumstances, guaranteed solar access may be complicated and difficult to achieve, especially in retrofit applications. Administrative exceptions and nonconforming uses may defeat many land use planning proposals.

Building Codes

Building codes normally address health and safety issues and do not specifically define guidelines for solar installations. Therefore, they are often perceived to constitute a barrier to solar applications.

Building Officials

Building officials may be hesitant to approve solar installations through normal procedures, probably because solar represents a new, innovative approach to providing adequate heating and cooling. In addition, the materials and design safety of the structure may vary considerably from those to which the building official is accustomed.

4.2 SOLAR INFRASTRUCTURE

Qualified Designers and Educators

The lack of qualified environmental designers, planners, architects, engineers, and design educators is a barrier to the initial deployment of solar technologies. Many designers and design educators are not adequately aware of the design processes and options related to solar technologies. Furthermore, the designer must play the new role of educating the consumer about the advantages and disadvantages of using appropriate solar technologies.

Consumer Knowledge

Consumer ignorance of solar technologies is also a barrier to their initial deployment. Consumers are often unaware of the energy crisis, the solar options, the advantages and disadvantages of using solar applications, and procedures for maintaining the solar system(s).

Labor Force Skills

Accelerated commercialization of solar technologies will require more solar equipment installers and maintenance personnel. This is especially true for small-scale applications.

Declining Solar Industry

Many small solar industries have gone out of business because they received few government funds and had to absorb the costs of the inevitable learning mistakes made while working for private clients.

Unions

Problems may occur between unions and architects if an architect's specifications regarding the installation of the solar system differ from the division of labor agreed to by the union.

Marketing

The marketing industry to sell and lobby for solar applications is inadequate. In some cases an information overload confuses designers, consumers, installers, and other sectors of the solar infrastructure. Furthermore, the marketing goal of the Federal Government has been to stimulate an industry in order to sell manufactured products, not to save energy. There is no federal marketing effort that concentrates on meeting an existing need with the knowledge that control of solar energy provides the means.

Finance

Expedient financing for solar applications is needed to facilitate the architect's use of solar concepts and technologies.

Utilities

A penalty may be placed on the power costs of public and regulated utilities for solar buildings if power is primarily needed during peak hours. Solar buildings should be designed so that backup power is used during off-peak hours.

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SECTION 5.0

ACTIONS

Possible actions to be taken by many organizations were proposed and discussed in the workshop related to the stated attitudinal, technical, and institutional issues. These actions have been categorized under the headings of information development, acquisition, and dissemination; education and training; demonstrations and design competitions; and other actions.

5.1 INFORMATION DEVELOPMENT, ACQUISITION, AND DISSEMINATION

- Publish outstanding solar architectural work in the architectural press, other professional publications, and in the general public media.

- Model the sharing of the design process after the medical and scientific professions. (Comment: Design products may not be typical of the medical and scientific professions; building designs are not patentable.)

- Disseminate information through the AIA Energy Notebook and other AIA publications.

- Give credibility to the variety of information. The information should demystify solar technologies, should be in a language familiar to architects, and should produce a standardized terminology.

- Present information in a form that integrates the solar technologies as part of the total energy-conscious design process that includes conservation and passive and active solar applications such as heating, cooling, hot water, daylighting, and other solar applications. (Comment: If an architect views part of the design task as saving nonrenewable energy and energy-related costs in a building design, the distinction between conservation, passive technology, and active systems becomes blurred and disappears.)

- Provide reliable information to the architect for dissemination to the consumer.

- Collect, document, and disseminate standard performance data on the various solar applications.

- Use a variety of media (i.e., TV, radio, newspaper, etc.) to educate the public on various solar aspects.

- Develop and disseminate general description pamphlets for heating and cooling, wind, biomass, photovoltaic, process heat, and other solar technologies specifically for architects. Provide cataloges of equipment currently available on the market. Provide periodic

updates of the information. Don't oversell solar applications that are not ready for market diffusion.

- Develop and compile "concept images" for architects (i.e., model plans or design products).
- Develop and disseminate guidelines for modification of general climatic data to microclimates.
- Present climatic data in a more useful form for architects and in a single text or manual.
- Develop a microclimate checklist system so that the proper site-specific data can be gathered for any given site.
- Develop and compile additional climatic data to meet the needs of solar architecture (i.e., ground temperatures, night sky radiation, ground water levels, ground conductivity, insolation, etc.). Provide an ongoing data base. (DOE and SERI are already developing and compiling much information.)
- Develop programming and site analysis techniques related to solar applications and use AIA documents as a format and dissemination vehicle.
- Develop energy audit forms.
- Identify and disseminate various solar retrofit design techniques and appropriateness. (Comment: Don't limit to just solar applications, but include as part of the energy-conscious design analysis.)
- Develop and disseminate design tools that include a framework of the energy-conscious design process including solar technologies.
- Develop computer, hand calculator, and hand method programs for solar designing, especially for passive technologies.
- Develop a better framework for all government solar technology transfer programs.
- Provide "stamp of approval" for the quality of solar literature, educational programs, products, etc.
- Provide construction details for solar applications through regular publications, a solar graphic standard, AIA Energy Notebook, or other vehicles. Provide a handbook on assemblage of components.
- Provide mobile demonstrations that include conservation and passive and active solar applications. (Comment: Not like the Honeywell Lab that only demonstrates active systems.)

- Disseminate estimated component and system cost data through conventional cost estimating documents for architects and builders.

- Assist in the development and encourage the use of maintenance and operators' manuals for consumers. Develop manual guidelines and system specifications. (Comment: The operation and maintenance of solar applications provide opportunities for engineers and architects to assist in a properly maintained and operated building and to learn how to improve their next projects. However, the owner also must bear responsibility.)

- Develop and compile performance data for existing solar buildings. Package the performance data in usable form for the architectural design process.

- Develop materials and information programs to increase financial communities' understanding and acceptance of solar as a safe venture and investment.

- Provide a central point of rapid information dissemination of a research nature as opposed to the HUD clearinghouse (Franklin Institute) which is oriented toward the nonprofessional. A newsletter of work-in-progress with a "tear sheet" to request information would be useful. (Comment: SERI should be the center for solar information dissemination because SERI should be the focus of all solar research.)

- Develop and disseminate backup material for architects in order to educate and sell consumers on energy sensitive design.

- Develop design manuals to guide architects, engineers, and contractors in designing and constructing buildings incorporating solar thermal and other energy conservation elements into an integrated total design system.

5.2 EDUCATION AND TRAINING

- Educate architects, engineers, environmental designers, and planners as to a comprehensive energy-conscious design process that includes conservation and passive and active solar applications. (Comment: Use "fallout shelter" technology transfer programs as a model. Educational courses should provide some degree of certification for the rightfully very-nervous consumer.)

- Educate architects to emphasize life-cycle costs as opposed to initial costs of solar installations.

- Provide education programs to identify specific materials and system integration.

- Educate trainers for national training programs at a regional level. (Comment: DOE may already place too much emphasis on installer training programs. Educate at the community college level.)

- Assess the characteristics of the manpower mix that services the solar-related sector of the construction market and develop programs to meet the market's projected needs for the various solar technologies. (Comment: In some parts of the country, the market is slack, and firms that specialize in solar are going out of business. It appears that firms should not specialize in solar but rather complement a HVAC skill mix with solar skills to stay in business.)

- Develop a major retrofit educational program with emphasis on cities.

- Provide educational programs and materials for building officials through professional associations. (Comment: Based on the experiences of the architects at the meeting, building officials have generally not denied solar applications).

- Provide an updating educational service for architects. Include information on jurisdictional agreements.

- Sponsor education and training seminars in various regions of the country, providing instruction in local approaches to solar design for architects, engineers, and other building professionals. (Comment: SERI's role could be twofold in this area--as a catalyst/coordinator and as a convener. Eliminate the overlaps and qualify the plethora of seminars and workshops that bewilder the design professions.)

- Sponsor a memorial, prize, or special series lecture on an annual basis.

- Work with design schools to assure that energy consciousness is a key element in their curriculum.

5.3 DEMONSTRATION AND DESIGN COMPETITIONS

- Sponsor solar design competitions and solar demonstrations. (Comment: The financial burden of design competitions on architects can be great. Sponsor special programs for students.)

- Give credibility to the existing federal solar demonstrations.

- Sponsor national, regional, and state design/build competitions and grants.

- Provide commercial product development grants and small business loans.

- Commit to a widespread use of solar energy in federal, state, and local public facilites.

- Sponsor regular solar design award programs.

5.4 OTHER ACTIONS

- Provide a service to architects that helps them give credibility to the various solar options to their public and private clients.

- Encourage public officials to provide adequate budgets for energy-conserving and solar-oriented building design and construction. (Comment: Work with Federal Building Program.)

- Assist in the development of national energy program plans. (Comment: SERI was praised by the seminar participants for its participation in the Domestic Policy Review. The goal should be to save nonrenewable energy or energy-related dollars, not to sell manufactured solar products.)

- Provide legal assistance in the form of guidelines for attorneys that specialize in architectural contracts. Liabilities need to be clarified as to what, when, who, etc.

- Provide legal and planning assistance to modify existing techniques (i.e., zoning, subdivision regulations, and PUDs) in order to guarantee community access to sunlight. Do not rely on common law doctrines to ensure access to sunlight for specific sites. Plan for access by easements, restrictive covenants, and outright grants.

- Assist designers and consumers to ensure that solar homes are designed so that backup power is needed only during off-peak hours. It is expected that state utility commissions and the National Energy Act will adopt peak-load, marginal-cost pricing structures.

- Analyze and assess standards, codes, and access related to wind applications.

- Develop marketing tools and strategies in conjunction with material producers (i.e., masonry, glass, etc.) for their products as they are used in solar applications. (Comment: Stay responsive to the state-of-the-technology's diffusion. Appeal to the higher income population.)

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SECTION 6.0

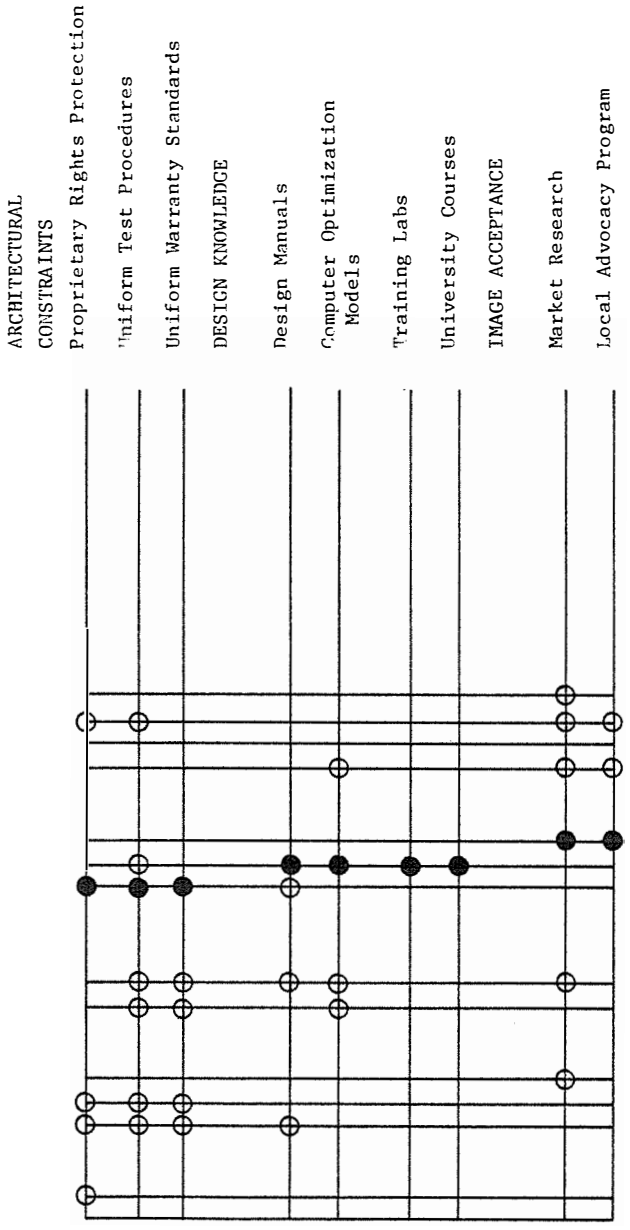
SUMMARY

The SERI Architectural Planning Seminar produced a variety of comments on attitudinal, technical, and institutional issues and appropriate commercialization actions. The attitudes among architects, their clients, government officials, and others in the design/construction professions were considered major barriers to the commercialization of solar technologies through architecture. The major technical issues were related to environmental considerations, building design and construction, operation and maintenance, and performance evaluation of solar heating and cooling of buildings (SHACOB). A general lack of technical awareness by architects with regard to wind usage, biomass energy, process heat applications, photovoltaic cells, and other non-SHACOB technologies was indicated as a potential major barrier as these solar technologies are further introduced to the marketplace. Finally, institutional issues related to law and government and the solar infrastructure were also considered important.

In response to these issues, most of the seminar discussion was on information development, acquisition, and dissemination. Generally, it was hoped that the related SERI programs would give credibility to solar data and present the information in a form that integrates solar technology as part of the total energy-conscious design process. Suggestions were given about specific types of information that should be developed or acquired, and dissemination means.

Education and training, demonstration and design competitions, and other actions were also discussed. Reputable education and training programs on the total energy-conscious design process for all design professions and their educators are needed immediately. Solar demonstrations on private and public buildings were discussed as a means of commercializing solar architecture. However, credibility must be established for both existing federal solar demonstrations and future demonstrations. Programs must be carefully and properly implemented in order to be successful. Solar design competitions can have a tremendous awareness impact, but the financial burden on architects must be carefully considered. Solar design awards programs are less expensive and can have a very successful impact. Other actions were discussed with an emphasis on SERI involvement with the Federal Building Program, Domestic Policy Review, and the development of marketing tools.

Don Watson submitted to the committee a paper on "Barriers to a Solar Building Technology: Possible Innovation Strategies" [2]. Mr. Watson's proposed innovation mechanisms are summarized in Figure 6-1.



I. PRODUCTION/MARKETING
   a. Volume Production
   b. Demonstration
   c. Tooling/Packaging
   d. Financing

II. DESIGN PRACTICE
   a. Image Acceptance
   b. Design Knowledge
   c. Architectural Constraints

III. ENERGY COST ANALYSIS
   a. Life Cycle Cost
   b. Net Energy Estimate

IV. PROTOTYPE TESTING
   a. User Testing
   b. Full Scale Test
   c. Model Experiment

V. TECHNICAL RESEARCH
   a. Experiment Development
   b. Conceptual Development

Figure 6-1. PROPOSED INNOVATIVE MECHANISMS

This document presents the issues and actions as discussed at the seminar and does not attempt to define SERI architectural program plans. The document will be used as background material and as guidelines for appropriate SERI program planning. The seminar did not attempt to rank the importance of the issues and actions. It is anticipated that a consensus ranking of current issues and actions will be part of future seminars and correspondence with the architectural advisory committee. Program planning advice will also be solicited from other construction and design professionals (i.e., builders, land use planners, environmental designers, engineers, building inspectors, etc.). This document will be used with other similar documents related to commercialization planning to develop SERI design and construction activities.

A new era of architecture that will emphasize responsible energy-conscious design is possible by the turn of the century. The opportunities are tremendous to provide this new architectural approach with appropriate energy technologies. SERI's plans are intended to reflect the diverse and changing attitudes and design approaches in its market development activities. Through comprehensive and flexible program planning, SERI can provide major assistance in the commercialization goal of accelerated utilization of appropriate solar energy technologies through the design professions. Support from the entire solar infrastructure, primarily the private sector, is needed to assure commercialization of all appropriate solar energy technologies. The SERI Architectural Planning Seminar was part of the program planning process in order to better understand the issues and actions related to the commercialization of solar-oriented architecture.

REFERENCES

1. Franta, Gregory, AIA, "The Architecural Role of SERI," AS/ISES Annual Meeting Proceedings, "Solar Diversification," (AS/ISES: Kileen, Texas) 1978.

2. Watson, Donald, "Barriers to a Solar Building Technology: Possible Innovation Strategies," Industrial Forum, Vol. 7, No. 2-3, 1978.

APPENDIX A

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APPENDIX B

THE ARCHITECTURAL ROLE OF SERI

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ABSTRACT

The Solar Energy Research Institute (SERI) intends to assist in the acceleration of solar technology commercialization through the design profession. The solar architectural market development role is to continuously identify the problems and implement appropriate programs to mitigate these problems. At present, these problems and barriers are in the area of effective technology transfer and attitudinal, legal, governmental, and institutional barriers. As a result of the problem identification activities, SERI can properly plan and implement effective technology transfer programs, education and training seminars, and other market development activities that will productively accelerate the commercialization of solar technologies through the design profession.

1. INTRODUCTION: THE PROBLEMS

There are a number of problems hampering the rapid diffusion of solar energy technologies through the design profession of the solar infrastructure. These problems are primarily related to the effectiveness of technology transfer activities and attitudinal, legal, governmental, and institutional barriers. These commercialization problems apply to many solar technologies, but the principal architectural concern at this time is the solar heating and cooling of buildings (SHACOB). SERI's architectural role is to identify these problems, a continuous process, in order to prepare and implement program plans that can mitigate the various problems. The intent is to induce an accelerated utilization of appropriate solar energy technologies through the design profession.

One of the major problems in solar designing is the lack of awareness of the appropriate design process and of current design tools by many architects, engineers, planners, and environmental designers. The appropriate process and tools for designing solar-oriented buildings, both active and passive, are being developed by various designers throughout the United States. However, these are being developed by relatively few designers and the technology transfer is limited. More appropriate information needs to be compiled, edited, reproduced, and disseminated to other designers.

It is a slow process to effectively change the standard practice of architecture and the acceptability of new aesthetics. In 1973, William Ewald of the Midwest Research Institute estimated that, "On the average, technological change (in construction) requires 17 years from first commercial use to general acceptance as standard, state-of-art option or practice [1]." Some technology transfer programs, governmental and private, have been highly successful; but the total impact has been minimal on the total building profession. The profession is huge, and a number of good programs are needed in order to effectively accelerate the commercialization process of solar technologies. In the United States, there are approximately 60,000 licensed architects and 150,000 home builders. In addition, there are hundreds of thousands of engineers, planners, nonresidential builders, and building regulators that must have proper data and education in order to make intelligent decisions regarding solar energy applications.

The role of the architect in the long term can play an important factor in reducing our national energy demands. Approximately one-third of our nation's nonrenewable energy use is for buildings, with approximately 22% used for space and water heating [2]. However, architects are limited in their direct impact on residential construction. According to unpublished 1976 data of the National Association of Home Builders (NAHB), only about 10% of their nearly 100,000 members have architects or designers on staff and 45% retain architects on a fee basis for certain projects; but architects can also have a significant indirect impact due to the fact that many of the remaining builders who do not retain architects often purchase plans designed by architects of model homes through magazines and other sources. This would indicate that the majority of home designs in the United States are architect-derived, directly or indirectly. Nonetheless, the primary practice of architecture by the large firms in the United States is for nonresidential uses. For example, Skidmore, Owings and Merrill, an architectural firm in Chicago with nearly 800 professionals on staff, provides approximately 95% nonresidential services (commercial, educational, medical, etc.)

and only 5% residential [3]. This is somewhat typical of many large architectural firms in the United States.

According to Robert Balivet, AIA, architects must face five basic problems in the energy dilemma:

1. Public image.
2. Education of selves and consultants.
3. Education of clients regarding the cost-benefits of architectural services.
4. Self-images as designers of new buildings.
5. Contracting building and research services [4].

The attitudinal barrier of "public image" of the architect is a major stumbling block. Architects are often not directly considered in the home designing process of many average American home buyers. Architects are thought to have costly and "far-out" solutions. Construction costs are already high and rising steadily with the average U.S. home in 1977 costing $45,000 according to NAHB. This attitudinal barrier prevails even of the leading energy-conscious architects. In a recent survey, Robert Balivet, AIA, asked energy-conscious architects their response to public requests regarding more energy information on subjects that the firm was known to have expertise. The general reply was, ". . . requests were referred to HUD's Solar Information Center - which was considered a disaster [5]!"

The attitudinal barrier of architects themselves may also be a major constraint. Philip Johnson, FAIA, is a world-renown architect (of nonsolar oriented buildings) and winner of the 1978 AIA Gold Medal Award. Mr. Johnson was recently asked when he would start including solar applications in his design process. His response was, ". . . only after all of the other architects do [6]." Another leading architect, John Dinkeloo, was quoted during the judging of the 1977 Progressive Architecture Awards Program as saying, "I'll be glad when 10 years have passed, and everybody has gotten off this solar kick. They'll find out what a bunch of bologna it is, and get back to work [7]." The attitudinal barriers of leading architects may be a much more serious problem than many people care to admit.

Additudinal barriers by the architect may exist due to the lack of awareness of the seriousness of the energy dilemma and of the solar design process and tools, as well as exposure to existing examples of poorly performing and/or costly solar-oriented buildings. The attitudes of many designers, builders, consumers, and others in the construction-related industries compound the problems that hamper or halt the technology commercialization of active, passive, and hybrid solar systems. If the designer is aware of the appropriate design process, he or she may encounter resistance for use of a passive or hybrid system from builders who do not understand the systems and who are not convinced of the systems' potential, and from consumers who are unwilling to alter life-styles necessary for some systems or are not convinced of the economic and energy payback. In these cases, the designer must be capable of educating the builders, designers, and others.

Legal, governmental, and institutional barriers are also common problems that the solar designer will encounter. In some cases, building codes and zoning regulations will not allow proper design flexibility in order to adequately utilize solar applications. For example, a county zoning regulation in Colorado does not allow for underground structures, even if the safety requirements of the building code were met. This restricts the use of passive solar dwellings where the north, east, and west exposures are totally or primarily underground. Other zoning regulations and subdivision standards may restrict the use of active systems and may be purely based on aesthetics. Financial institutions may have lending standards that also restrict or limit the use of nonconventional heating and cooling systems.

These problems must be further defined and understood in order for proper national program planning that results in the responsible energy-conscious design of buildings by the majority of architects. As Balivet summarizes it, "The greatest danger is that architects may abandon their responsibilities to the general public to others far less qualified [8]!"

2. SOLAR ENERGY RESEARCH INSTITUTE (SERI)

The Solar Energy Research Institute (SERI) was mandated by Congress as a part of the Solar Energy Research, Development, and Demonstration Act of 1974. SERI's primary mission is to function as the U.S. Department of Energy's lead institution for solar energy research, development, and demonstration. SERI formally opened on July 5, 1977, in Golden, Colorado, and is managed by the Midwest Research Institute. In June 1978, SERI employed about 300 staff personnel. SERI should stabilize in the early 1980s with 600 to 800 staff members.

SERI has developed an organizational structure consisting of four main operating divisions and one support division: Research; Information, Education, and International Programs; Analysis and Assessment; Technology Commercialization; and Administrative and Technical Services. The diffusion of solar technologies through architecture falls in the Technology Commercialization Division (TCD). TCD maintains extensive communication links with all sectors of the solar community and assesses the market readiness of each solar technology. This division collects and distributes information on

materials, markets, standards, regulatory requirements, business risks, market barriers and constraints, and consumer attitudes.

Technology commercialization is the dynamic process of developing a healthy, growing, and self-sustaining private solar industry based upon a particular field of technology. It deals with both supply of, and demand for, solar products and services and is the deliberately stimulated movement of the technology from research and development, through economics verification and demonstration into production, and finally into the consumer marketplace. The objective of SERI's Market Development Branch in the Technology Commercialization Division is to define, through a continuing dialogue with industry and the user communities, those barriers and economic doubts which inhibit the growth of the solar market and to participate in the resolution of those issues. Further, the association of the Market Development specialists with the various elements of the solar and consumer communities provides viable channels for the solar advocacy function of SERI.

3. MARKET DEVELOPMENT OF SOLAR ARCHITECTURE

The SERI Market Development Branch serves as an interface between the research, analysis, education, and evaluation activities of SERI and the solar infrastructure. The staff specialists, in constant communication with those who influence policy and those who make decisions relative to solar utilization, provide feedback from the various solar user communities for the planning of the scientific, engineering, and analytical programs of SERI and DOE. The Market Development Branch specialists are responsible for maintaining working relationships with the following user communities of the solar infrastructure: Law and Government; Finance; Design and Architecture; Equipment Manufacturers; Small Business; Labor; Development and Construction; Distribution, Maintenance, and Service; Public Institutions; Utilities; and Consumers.

The basic function of the Architectural Specialist is to establish and maintain a dialogue with the architectural profession. The purposes are to understand the current attitudes and problems, to identify the key leaders and policymakers, to encourage a positive attitude toward the solar technologies, and to bring the resources of SERI to the resolution of barriers in the implementation of those technologies.

The market development architectural activities will be primarily concerned with the architects and architectural firms that are responsible for the majority of new and retrofit designs of residential, commercial, institutional, industrial, and agricultural buildings. At present, the solar heating and cooling of buildings (SHACOB) is the principal architectural concern. SHACOB is well-introduced into the marketplace and now needs to be appropriately diffused into the architectural profession. SHACOB includes active, passive, and hybrid systems. The advancement of other solar technologies, i.e., wind, biomass, photovoltaics, and process heat, are being carefully observed as to the implications with the architectural profession.

Other specific elements of the architectural activities will have a special emphasis. For example, the problems and planning of large urban areas will have an important role. There are 25 cities in the United States that have a metro-area population of over one million people, which is deserving of special attention. Retrofit applications will be emphasized because of the fact that new construction will only have long-term impact, and retrofit applications are often more difficult and could provide significant short-term impact if properly implemented. Mobil or modular homes deserve special note due to the fact that, in 1970, 16% to 34% of all new single-family construction was for mobile and modular homes. Passive technology will also be focused upon due to the unique architectural design character of the systems. Passive systems are unique enough to have a separate branch in the Technology Commercialization Divison, Passive Technology Branch.

A framework for the design process, reference material, design tools, and other technical data must be prepared and/or collected in a data base and disseminated through technology transfer programs, education and training seminars, and other market development activities. This is a continuous process as new developments occur in all solar technologies that relate to architecture. The structure of this commercialization process should be developed nationally, adapted to the various regions, and implemented on regional levels through the regional solar centers and locally with the cooperation of state and local solar and/or architectural organizations (i.e., the American Institute of Architects, AIA).

3.1 Information Collection. A quality information collection system and an accurate assessment of the user needs are essential in order to provide successful technology transfer programs, education and training seminars, and other market development activities. The information collection process should include the identification of potential users, direct contact with users (i.e., meetings, workshops, telephone discussions, etc.), and user needs surveys. Much work has been done on the analysis of information collection for solar technologies that is under evaluation in order not to duplicate existing usable programs. For example, a data management program has been suggested by David Christensen in his paper, "Analysis of Data User's Needs for Performance Evaluation of Solar Heating and

Cooling Systems," supported by the Department of Energy [9]. This analysis and others will be considered in the information collection process.

Further in this regard, SERI is designing and developing a Solar Energy Information Data Bank (SEIDB). The SEIDB will incorporate a broad range of information and data to serve the research community, legislative bodies, commercial and industrial groups, and, eventually, the general public. As it concerns the design profession, it is under consideration to include data bases for builders, installers, manufacturers, and architects/engineers relating to products, system performance and cost, financial, insurance, and regulatory information.

As part of the information collection for the planning of the diffusion process, unofficial national advisory committees will be established with the architectural and construction related professions. For example, a working relationship has been initiated with the American Institute of Architects in regard to cooperative programs for diffusing appropriate solar technologies. Over 40 design, construction, and building regulator associations as well as government agencies have been contacted in this regard. The purpose of these contacts and advisory committees is to assure that SERI receives timely information on which it can act promptly. This information will also provide a source of feedback to other SERI branches (i.e., Technology Evaluation Branch, Information Systems Branch, Education and Training Branch, International Programs Branch, and other branches in the Analysis and Assessment Division, and the Research Division), Department of Energy, and the regional solar centers. Such feedback is vital to the entire SERI effort and illustrates one of the key ingredients of the interrelationships between the research, analysis and assessment, education, and commercialization activities of SERI.

3.2 Technology Transfer. The technology transfer activities of the solar architectural market development primarily relate to the information dissemination for designers and for assistance of the education and training programs. The activities will complement the DOE Solar Technology Transfer Program and the technology transfer programs of the regional solar centers. A framework for the design process, reference material, design tools, and other technical data is the primary information that will be developed and disseminated. The information will be disseminated through SERI communication channels, governmental technology transfer programs, and professional organizations.

The technology transfer process will utilize the information generated from the solar research development and demonstration activities of SERI. For example, a recent report from SERI's Research Division identifies a method for sizing solar energy space and water heating systems. This method, the GFL method, is a simplified sizing technique modeled after the successful F CHART method. It is now being developed as one of a series of architectural design tools by the Market Development Branch. As other developments occur in the various SERI branches, appropriate design tools or other information will be compiled for dissemination.

Coordination of solar design processes and tools from the private sector is also necessary. For example, Steven Ternoey of HOK, Inc., a large architectural firm in St. Louis, Missouri, is in the process of developing "energy conscious design tools." To date, the work has three major parts. The first part introduces the process and tools and builds a vocabulary of alternatives. Among the topics analyzed are solar heating, building shading, internal and external building loads and forms, and daylighting. The second part consists of the tools and methodologies used in applying the principles to any particular project. The third part is the pre-design data for specific projects, analyzing base loads and potential energy systems in order to make intelligent design decisions during the schematic design phase. Another example is the Energy Analysis Workbook for Architects being developed by Michael Sizemore of Sizemore/CRS in Atlanta, Georgia. These projects and others deserve special consideration in the program planning of SERI's architectural activities.

A close association and coordinated programs with DOE, the regional solar centers, and the professional organizations will result in a stronger technology commercialization impact. For example, DOE recently contracted Doug Balcomb and Bruce Anderson to develop design guidelines for passive systems. SERI, AIA, and passive solar experts are reviewing the guidelines. The results should be coordinated dissemination activities from DOE with SERI, AIA, the HUD Solar Information Center, and others. Another example is the AIA Energy Notebook with its periodic updates. SERI anticipates providing input to these updates. A multitude of impact levels and coordinated, cooperative programs are needed in order to produce a successful acceleration of the technology commercialization process.

3.3 Education and Training. Education and training programs for architects are being coordinated with SERI's Market Development Branch, Passive Technology Branch, Communications Branch, and the Education and Training Branch. The programs are intended to provide a framework for the design process accompanied by design tools. The national programs will lead to regional state and local programs.

The objectives of these education and training seminars are:

- To educate the architects as to the appropriate design process and tools for designing solar-oriented buildings.
- To illustrate the available options (especially related to performance and economics) as part of the energy-conscious design process so that the architect can make intelligent decisions regarding solar applications.
- To increase the market development of solar architecture technologies by removing misconceptions and providing factual design information.
- To train educators for seminar implementation at regional, state, and local levels.
- To provide avenues for education and information that are easily accessible to the architect.

One of the first SERI-sponsored and coordinated solar architecture seminars is a two-day seminar in cooperation with HUD Region VIII during late summer 1978. The seminar is for the housing authorities throughout the HUD Region VIII and their architects. This seminar is oriented toward the architectural solar applications for low-income housing. This is a prototype seminar that, if successful, will be implemented in the other HUD regions. Other seminars will be planned and coordinated with other governmental agencies, the regional solar centers, and professional organizations (i.e., AIA).

Another education and training activity of SERI's Market Development Branch is the cosponsorship of major solar programs. As an illustration, SERI is providing significant cosponsorship and support for the 1978 annual meeting of the American Section/International Solar Energy Society in Denver. This event should host between 2,500 and 3,000 participants. Another was the cosponsorship of the Aspen Energy Forum 1978, "Humanistic Choices," in Aspen, Colorado.

3.4 Design Competitions and Demonstrations. Another good tool for solar technology commercialization is the use of design competitions and demonstrations. This can stimulate the market diffusion by bringing architectural attention to solar technologies, encouraging architects to become educated as to the various solar applications, and by providing opportunites for information dissemination of the resulting designs.

As part of this type of SERI's commercialization effort, the SERI Passive Technology Branch is coordinating the technical reviews of the HUD "Passive Solar Design Competition and Demonstration, #H-8600." This is a $2 million program that should stimulate many architects to design passive solar applications in their residential designs.

3.5 Other A variety of other related programs will be developed in conjunction with the Market Development Specialists in the areas of: Law and Government; Finance; Equipment Manufacturers; Small Business; Labor; Development and Construction; Distribution, Maintenance, and Service; Public Institutions; Utilities; and Consumers. The development of the market development programs by nature is an ongoing and changing process. It must be ongoing and changing in order to meet the objective of defining, through a continuing dialogue with industry and the user communities, those barriers and economic doubts which inhibit the growth of the solar market and to participate in the resolution of those issues.

3.6 Constraints. Many constraints may continue or change along with SERI's program planning in regard to the technology commercialization of all solar applications. For example, many of the same technical constraints, although changing, that P. Richard Rittelman, AIA, gave testimony to a House subcommittee in 1973 still apply. Mr. Rittelman's technical constraints to the emergence of applied solar technology are summarized as: meteorological data, lack of hardware, lack of design procedures, data translation, limited research and development, architectural interface, and operation and maintenance [10]. These constraints have changed since 1973, but the general topics are still applicable for consideration of all solar technologies that relate to architecture.

Rittelmann further points out technological constraints to commercialization of solar systems summarized as: market aggregation, proof-of-concept, industrial engineering, prototype testing, vertical structuring, mutual dependencies, code approvals, and education [11]. Again these outlined constraints may still be topics of concern in the continuous commercialization process of solar technologies.

4. SUMMARY

It is apparent that there are a number of various problems hampering the rapid diffusion of solar energy technologies through the design profession of the solar infrastructure. These problems of effective technology transfer and attitudinal, legal, governmental, and institutional barriers are quite diverse in nature. Jeffrey Cook, AIA, who has been involved with various surveys of solar users, states: "A sociological or census profile of solar consumers also reveals that solar applications attract divergent sets of the population and for different reasons. It appears that the universal acceptability of solar energy is based on selected values that are not always common [12]."

The diverse and changing problems must result in continuous and flexible planning for national programs. SERI's plans are intended to reflect this attitude in the technology transfer programs, education and training seminars, and other market development activities. Through sound and comprehensive program planning, SERI can provide major assistance in the commercialization goal of accelerated utilization of appropriate solar energy technologies through the design profession.

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APPENDIX C

Matrix of Actions and Barriers
Passive Solar Heating Systems

		Technical			Economic		Initial Deployment					Environmental	Resource Availability	Institutional					
	Barrier Importance																		
Actions	Barriers / Actions	Lack of Marketable Designs, Products	Limited Design Tools	Performance Data Needs	High First Cost	Unfavorable Cash Flow	Lack of Consumer Awareness	Lack of Building Industry Awareness & Understanding	Lack of Credible Info. on Economic Benefits	Uncertain Resale Value	Image of Passive Solar to the Consumer	No Significant Barriers Identified	Lack of Qualified Designers	Zoning Land Use Controls	Subsidation of Conventional Fuels	Traditional Bldg. Industry Practice	Building Codes & Code Enforcement	Lender, Insurer Attitudes & Policies	Lack of Organized Passive Solar Constituency
Technical	Design Tool Development	2 / –	5 / 5	3 / 3				3 / 3											
	Performance Data Acquisition		2 / 3	5 / 5					4 / 4									– / 2	
Competition/Grant	National, Regional & State Design/Build Competitions	3 / 3	1 / –	2 / 2	2 / –		2 / 2	2 / 3	3 / 2	1 / –	2 / –					1 / –			2 / –
	Commercial Product Dev. Grants & Small Business Loans	4 / 4		2 / 2	2 / 2														3 / 2
	Design/Build Grants	4 / 4		– / 3	2 / 2	2 / –		2 / 2	2 / 2		3 / –								2 /
	Solar Energy in Federal Facilities	1 / 2	1 / 3	1 / 3			2 / 2	1 / 2	1 / –		1 / –		1 / –			1 / 2			
	Solar Energy in State & Local Buildings	1 / 2	1 / 1	1 / 2			2 / 3	1 / 3	1 / –		1 / –		1 / 2			1 / 2			
Educational	Designer/Builder Education							4 / 4	3 / 1				4 / 4			3 / 3			2 / 2
	Consumer Education				2 / 3		4 / 3		3 / 3	4 / 3	3 /							3 /	
	Financial Education							2 / 2	0 / 0	2 / 1	1 / –							3 / 3	
	Municipal Official Education							2 /						4 / 4			3 / 3		
	Realtor Education						3 / 3	2 / 2	0 / 0	3 / 3	1 / –							3 / 1	
	Utility Programs					2 / 1	3 / 3				3 / –							2 / 2	
Regulatory	Solar Access						2 / 2	3 / 3		3 / 1				4 / 4		2 / 2	3 / 3	2 / 2	
	Bldg. Code & Code Enforcement Program						2 / 1	– / 2				3 / –		3 / 3		3 / 3	4 / 4	2 / 2	
	Designer Recertification	– / 2						3 / 3					4 / 4			3 / –			
Financial	Federal & State Fuel Subsidy Reductions							2 / 3	1 / 3		2 / –				5 / 5				
	Income Tax Credits				3 / 3	2 / 2	4 / 3	4 / 4								2 / 2		3 / 3	
	Income Tax Deductions				2 / –	1 / –												2 / –	
	Investment Tax Credits				– / 3	– / 2												– / 3	
	Accelerated Depreciation					– / 3												– / 3	
	Low Interest Loans					3 / 3													
	Loan Guarantees																	4 / 4	
	Rollover Mortgage/ Variable Interest Loans				2 / –	4 / –													
	Tax Incentives				3 / 3	2 / 2												3 / 3	
	Government Insurance Program									2 / 1								3 / 3	

BARRIER IMPORTANCE NUMBERS

1. No significant obstacle to commercialization.

2. This barrier represents a modest but measurable obstacle to technology commercialization. While it will not delay the timing of initial commercial introduction of the technology, without effective Federal action, the rate of market penetration will be reduced.

3. This barrier constitutes a moderate although important obstacle to technology commercialization. Without effective Federal action, it will delay the introduction of the technology by up to 5 years and may also reduce somewhat its rate of market penetration.

4. This barrier constitutes a significant obstacle to technology commercialization. Without effective Federal action, it will delay the introduction of the technology by more than 5 years and/or will reduce substantially its rate or market penetration.

5. This barrier represents a virtual "show-stopper." Without effective Federal action it will essentially prevent technology commercialization beyond a small number of relatively isolated situations.

EFFECTIVENESS OF EACH FEDERAL ACTION

5. Will eliminate barrier

4. Substantial effect

3. Moderate effect

2. Some effect

1. No effect

SERI

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