

Archive

SOLAR HEATING AND COOLING OF HOUSING:

FIVE INSTITUTIONAL ANALYSIS CASE STUDIES

Thomas E. Nutt-Powell, Michael Furlong,
Patricia McDaniel, Barbara Parket and Andrew Reamer

June 1979

revised December 1979

MIT Energy Laboratory Report No. MIT-EL-79-030

ABSTRACT

This paper is one of a series resulting from institutional analysis of photovoltaic (PV) acceptance. The case studies reported here involve use of solar thermal technologies in various residential settings. All of the projects are part of the DOE-HUD Solar Heating and Cooling Demonstration Program. This program provides grants to developers to prompt them to use this innovation. Each of the five cases illustrates one or more institutional forces which influence the acceptance of solar energy in the residential sector. Friends Community is an instance of developer involvement for reasons other than profit, and the way in which other factors (such as designers and consumers) react to such housing development. Reservoir Hills Solar Houses illustrates the process of entry by new development firms, the role of public agencies in encouraging various forms of housing and the problems of using product innovations without adequately developed industry support infrastructures. Project Solar for Indiana illustrates the importance of supporting institutional networks, in this case the homebuilders association, the state government and key individuals, who play mediating and legitimating roles in solar acceptance. Solar in California discusses public efforts at a city level -- Santa Clara, a county level -- San Diego, and the state level in what is generally regarded as the state most active in turning to forms of solar energy. Finally, PNM/AMREP illustrates the process of large development corporation decision making, and the manner in which an investor-owned utility is shifting its orientation of energy provision.

ACKNOWLEDGEMENTS

This report is possible only because of the many valuable contributions of the people involved in demonstrating solar energy as part of HUD's residential demonstration program. Many but not all of them are named in the cases. Everyone with whom we talked about the program and his/her involvement was most generous in giving us time and insight. We are especially appreciative of the many helpful comments from project participants on earlier drafts of this material.

David Moore, who directs HUD's residential demonstration program, has been unstinting in his help and support from the very beginnings of this study. He has helped us understand the program, identify useful cases for study, and provided ongoing review and comment on our efforts. This report is much the better for his assistance.

Etta Roth of Real Estate Research Corporation was most gracious in sharing their information on projects they are studying, and in providing a market perspective on the solar home.

Janet Needham-McCaffrey did the illustrations found throughout the text, while Michael Furlong prepared the full-page graphics introducing the report and each of the cases.

Though this report is fully a group effort, the work of individual authors on particular cases should be noted. Primary responsibility for case preparation was as follows: Friends Community, Patricia McDaniel; Reservoir Hill Solar Houses, Thomas Nutt-Powell; Project Solar for Indiana, Barbara Parker; Solar in California, Michael Furlong (county and state), Andrew Reamer (city); Public Service of New Mexico/AMREP, Andrew Reamer.

TABLE OF CONTENTS

Abstract	i
Acknowledgements	ii
Table of Contents	iii
Introduction	1
Theory and Methods of Institutional Analysis	1
Background of This Study	2
Project Summaries	4
Institutional Analysis Case Studies	7
Friends Community	7
Reservoir Hill Solar Houses	19
Project Solar For Indiana	35
Solar In California; CITY/COUNTY/STATE	51
PNM/AMREP	84
References	115

This paper is one of a series resulting from institutional analysis of photovoltaic (PV) acceptance. These studies are undertaken with sponsorship of the US Department of Energy (DOE) as part of its Photovoltaic Program. In addition to institutional questions, DOE is interested in economic, marketing, and technological issues, and is sponsoring a series of studies and field tests on these topics. Institutional analysis studies have typically been undertaken in relation to particular PV field tests, though in some cases studies have focused on comparable technologies and institutional forces influencing their acceptance.

The introduction of PV into the housing institutional arena is being investigated in the context of the DOE-HUD Solar Heating and Cooling (SHAC) Demonstration Program. This program involves direct federal grants to prompt project developers to incorporate solar thermal approaches to heating and/or cooling into various building forms. In this context, institutional analysis is directed to understanding those forces which influence the rate and nature of innovation acceptance.

THEORY AND METHODS OF INSTITUTIONAL ANALYSIS

Institutional analysis focuses on the interactions of institutions in a given sector. When such an analysis is undertaken in order to ascertain means of facilitating innovation acceptance, particular attention is directed to 'routines' in the sector, so that the possible meaning and impact of an innovation is under-

stood in context. An institutional analysis proceeds in a series of steps, beginning with sector identification and preliminary exploration. These two steps yield an hypothesized institutional arena, which is a formal representation of the institutional entities in a sector, and the routines of their interaction. A "perturbation prompter" is identified, enabling the analyst to follow the process by which an institutional arena handles a 'non-routine' using a research method specifically designed for the arena and nature of perturbation. The actions of the arena in handling the 'non-routine' are monitored and analyzed. (For a further discussion of the theory and method of institutional analysis see Nutt-Powell et al, 1978.)

BACKGROUND OF THIS STUDY

DOE is anxious to introduce PV into the residential sector. Though the technology is yet not fully developed in terms of efficiency or cost competitiveness, these barriers should be overcome within a very few years. Thus studies to understand the institutional dimensions of PV acceptance are appropriate at this time. This is especially the case in the housing sector, which is generally regarded as complex and diffuse, in short difficult to speedily penetrate with either product or process innovations.

Fortunately, an analogous innovation -- solar thermal -- is more advanced in terms of technological and economic

standards, and is now the object of a federal innovation dissemination program, the National Program for Solar Heating and Cooling of Buildings. This program has elements dealing with research and technology development, engineering development, demonstration of solar heating and cooling systems in commercial and residential buildings, and market development. (DOE, 1978.) The residential demonstration component of this program provided an excellent context for purposes of this study.

An initial set of papers served as the format for the preliminary sector exploration. These papers dealt with housing production (Swetky and Nutt-Powell, 1979), governmental involvement in housing (McDaniel and Nutt-Powell, 1979), research and socialization (Furlong and Nutt-Powell, 1979), energy provision in housing (Reamer, Heim and Nutt-Powell, 1979) and standards in housing (Parker and Nutt-Powell, 1979).

The structure of HUD's residential demonstration program was reviewed, and a specific research design developed. (Nutt-Powell, 1979). The HUD program uses a single-focus intervention strategy -- financial grants to developers. Grants have been awarded to types of developers. The research design eliminated from consideration those serving captive markets, such as universities. Using a process of indicative sampling eleven projects were selected for on-site case study. The primary criterion guiding sample selection was the probability that the case would provide useful illustration of one or more types of institutional forces which were hypothesized to influence innovation acceptance. Five case studies, involving six of the sample projects, are presented here.

FRIENDS COMMUNITY

Friends Community is a 160-unit semi-detached single-family housing development in North Easton, Massachusetts, developed under the aegis of the New England Society of Friends. Housing has normative importance, with meanings beyond the bricks and mortar of the structure. Friends Community illustrates this in at least three ways: (1) The developer is involved for reasons other than profit. (2) There are supporting actors who, though profit-oriented, also want to carry out their roles in expressively normative ways. (3) There are users of housing who do not choose housing on the basis of financial and structure qualities.

RESERVOIR HILL SOLAR HOUSES

Reservoir Hills Solar Houses is a 15-unit single-family attached development in the Reservoir Hill urban renewal area of Baltimore, Maryland. It is the first development venture of Centennial Building and Development Corporation, the success of which has rapidly expanded the firm's business. The case illustrates three dynamics of the housing arena: (1) The process of entry by new development firms; (2) The role of public agencies in encouraging various forms of housing; (3) The problems of using product innovations without adequately developed industry support infrastructures.

PROJECT SOLAR FOR INDIANA

Project Solar for Indiana involved seven builders, each constructing a single family house, identical in terms of design, square footage, insulation factors and solar units, in seven different regions of the state. Though technically each of the builders applied separately, their efforts were coordinated through the Homebuilders' Association of Indiana (HBAI) and submitted in a package. This case illustrates the importance of supporting institutional networks, including HBAI, the Indiana state government and a number of individuals, who together served mediating, legitimating and other supporting roles.

SOLAR IN CALIFORNIA: CITY/COUNTY/STATE

California is generally regarded as the state most active in turning to forms of solar energy. Active efforts at various levels of government have provided an environment which supports switching to alternative energy sources. This case study illustrates how public efforts at three levels of government -- municipal, county and state -- influence the acceptance of solar energy in the residential sector. Santa Clara, a city in the San Francisco Bay area which has a municipally-owned electric utility, is the study setting for the local level. The city has a number of solar applications in public buildings, has a solar utility encouraging solar heating of swimming pools, and involved a major northern California developer in testing solar home heating as part of the HUD residential

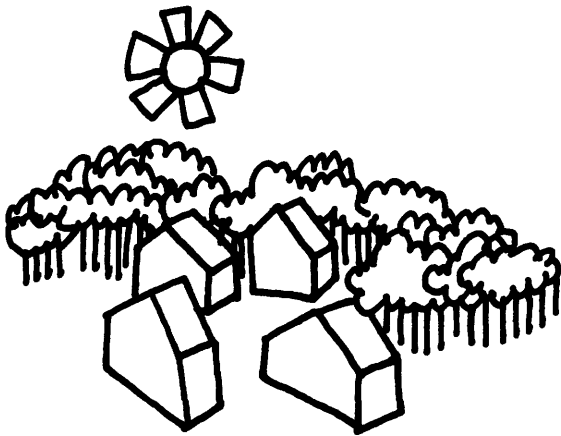
demonstration program. San Diego is the setting for the county study. One development is reviewed, with attention to the approach of the design firm involved. The county's support for solar through an ordinance requiring solar hot water heating in new home construction is discussed. Finally various state support for solar, including the solar tax credit, are summarized.

PNM/AMREP

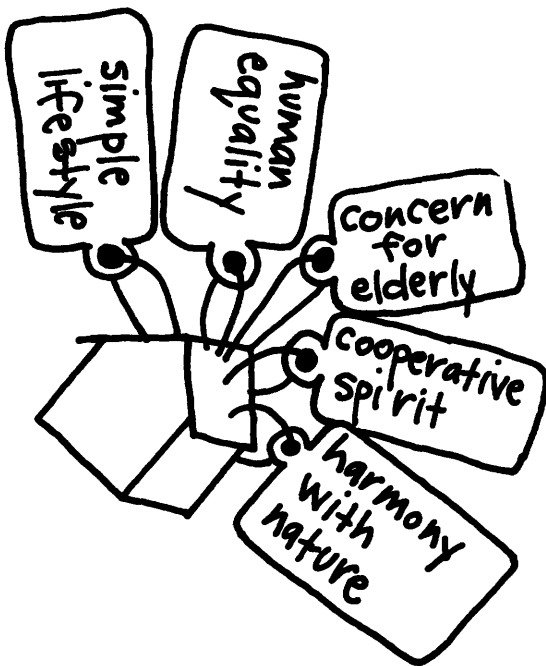
PNM/AMREP is a case involving the collaboration of a major utility (Public Service of New Mexico -- PNM) and a major developer (AMREP) in the development of 25 solar homes. 23 of these homes are located at AMREP's Rio Rancho development near Albuquerque, NM, with the other 2 at its El Dorado development near Santa Fe, NM. Over a period of several years AMREP became interested in solar as a means of market expansion, while PNM's interest was prompted by load-management and cost issues in provision of energy to its large, and expanding customer pool. PNM/AMREP joined on the development of a prototype residence, then on the submittal of the successful application for HUD funding under Cycle 3. The case illustrates four institutional dynamics: (1) How innovatively-disposed organizations find a common vehicle to serve their separate objectives; (2) the role of linking-pins; (3) the importance of a threshold density of information exchange in innovation acceptance; and (4) the role of the translator.

FRIENDS COMMUNITY





Friends Community is a 160 unit semi-detached single family housing development in North Easton, MA. Construction is scheduled in three phases. Though the HUD grant of \$132,879 applies only to the 69 units of Phase I, the entire development is planned to be solar. The development grew out of the concern of the New England Society of Friends about the tendency to "warehouse" the elderly. Thus, among the community's objectives are: 50% elderly occupancy; cooperative operation in harmony with nature; conservation; and minimal use of natural resources; and development in line with the Quaker testimony to simplicity.



Housing has normative importance, with meanings beyond the bricks and mortar of the structure. Friends Community illustrates this in at least three ways: 1) The developer is involved for reasons other than profit. 2) There are supporting actors who, though profit-oriented, also want to carry out their role in expressively normative ways. 3) There are users of housing who don't choose housing on the basis of financial and structural qualities.

NORMATIVELY MOTIVATED DEVELOPMENT

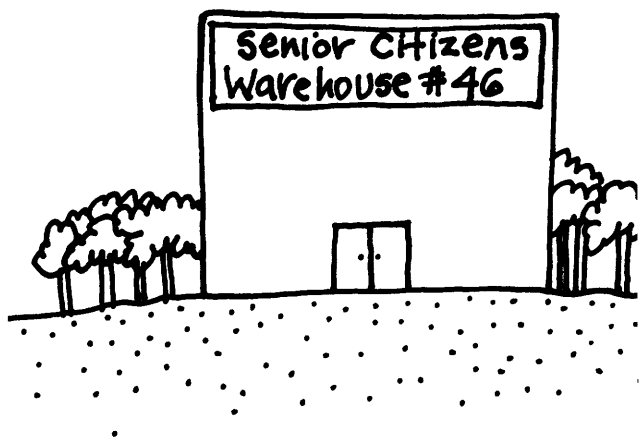
Profit-oriented development dominates the nation's thinking about the provision of housing. Even a cursory review of federal programs records a heavy reliance on financial incentives (direct grants, subsidies and/or favorable tax treatment)



as a means of encouraging activity in various forms of housing. Though the financial dimension is unmistakably important, it is not necessarily the initial motivating force for all developers of housing. Some developers, usually characterized as 'non-profits' and often church sponsored, become involved in housing as an expression of their beliefs. Such housing activity we call *normatively motivated development*. The Friends Community, sponsored by the Friends Community Development Corporation, a non-profit corporation created by members of the New England Religious Society of Friends, is an example of this form of housing development.

As a religious group, the Friends (also known as Quakers) do not have a single statement of doctrine. Rather there is what is referred to as the Quaker testimony -- what Friends have stood for publicly as a form of Christian witness. This testimony derives from a central belief in human brotherhood and essential equality. As summarized in various literature, this belief "has found expression in simplicity of lifestyle, integrity in personal relations, and at times controversial stands on public issues. Under a sense of concern -- inner prompting, divine obedience, urgency -- Friends are drawn to humanitarian callings and to programs of education and evangelism, to projects of service and constructive action."

At the 1971 New England Yearly Meeting there was expressed such a 'sense of concern' about the treatment of the elderly in this country. The Friends were disturbed by what they regarded as a growing tendency toward 'warehousing' the elderly. The Yearly Meeting decided to research more completely the needs and desires of the retired and elderly community. A survey was circulated among New England Friends, under the guidance of an ad hoc committee. This survey led to a 1972 workshop, at which the concept of an all-ages community evolved. The decision to develop a community was motivated not by a desire to become involved in the housing market, but by a desire to create a supportive environment for Friends and other "like-minded" souls.

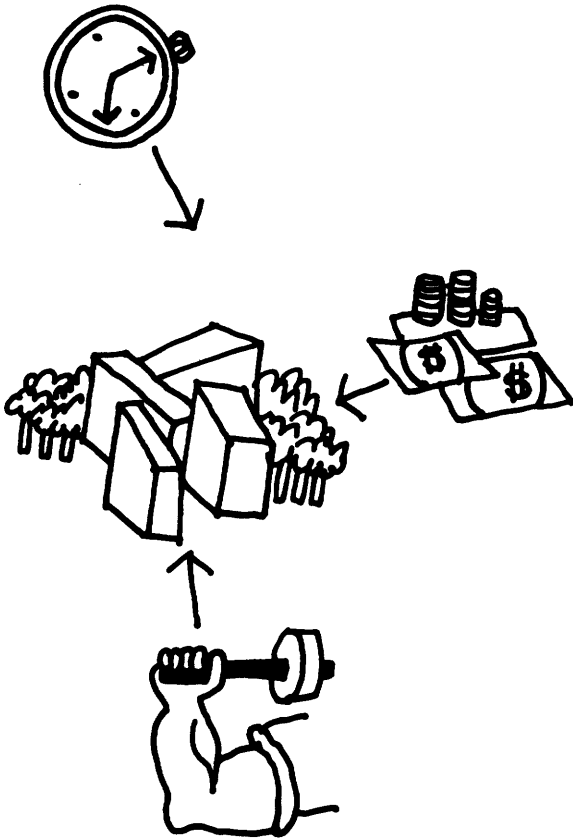


Thus the Friends became involved in housing development as a means of realizing certain ideals. They had a particular orientation regarding the "right way to develop a community"; the non-profit development corporation gave them a structure within which they could pursue these ideals.



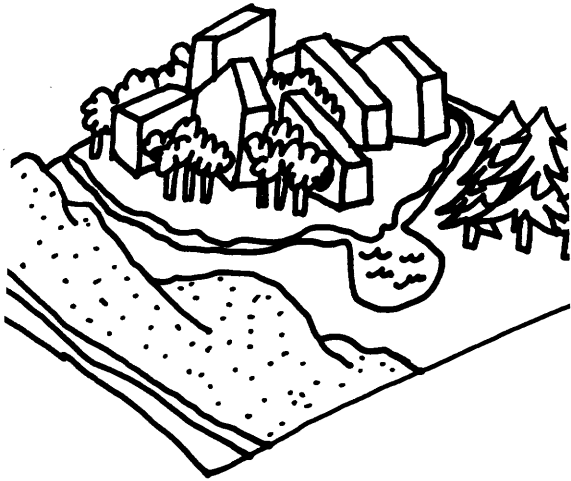
The articulation of the ideals began at the 1972 workshop. Stated in programmatic terms, they include: 1) An all-age community based on Quaker ideals of openness and simplicity. 2) An open, warm, friendly, trustful atmosphere, which recognizes the rights of all individuals. 3) Cooperative concept of governance, with decisions by consensus. 4) Mutual

support in day-to-day living. 5) Concern for peace and a non-violent environment. 6) Conservation of natural resources. 7) Creative community activities, arts and crafts to meet the common needs of all in dynamic ways. 8) An interchange of skills and knowledge among young and old. 9) Nearby availability of skilled medical and nursing care. 10) A social and physical setting designed by and for all community members. The Friends worked to carefully incorporate these objectives into the design so that they would become realities.

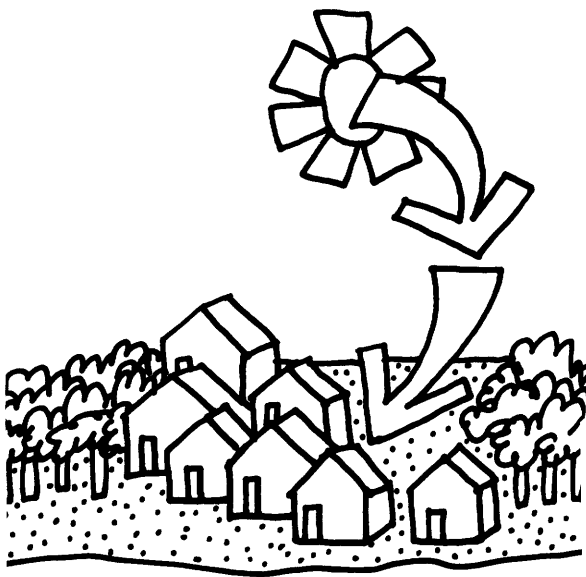


The Friends have a history of successful cooperative groups. Friends Community Development Corporation itself owes its existence to the network of Friends, local and national, who contributed time, money and/or information to the effort. For example, nearly \$1/2 million in gifts and no or low interest loans were raised from Friends to cover the planning and development costs. As John Winslow, who provided development consultation, says, "The continuing viability of the development is a testimony to the ability of the Friends as an organization."

A brief review of the structure of the development shows how decisions were based on ideals important to the Friends. The ideals of openness, cooperation, mutual support and community interaction led to structuring ownership as a cooperative, the form of common ownership which is not frequently used in Massachusetts.



Clustering the townhouses on 12 acres of the 85 acre wooded site meets the objectives of conservation of natural resources and the ideal of harmony with nature. The remaining open space includes a pond, hiking and biking paths, fields, and forests. The development also benefits from planned forest management and community gardens, which supply respectively, "home-grown" wood and food.

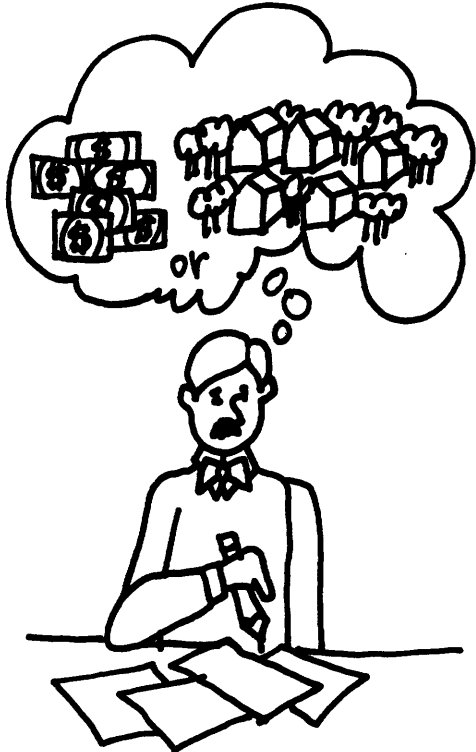


In the same spirit of self-sufficiency and harmony with nature, solar energy emerged as an obvious possibility. Because of their normative motivation, the Friends approached solar not as an innovation, but as a meaningful and necessary component of their ideal community. For them, solar is an understandable resource which offers energy independence. The question to the Friends was not whether to go with solar; by their standards it is the obvious choice, as it is clean, safe and abundant. Fuel oil seems likely to be both less available and more costly in the future; coal is a pollutant, and requires constant attention; nuclear energy is considered too hazardous, and wood is difficult for the elderly to manage. Thus, solar heating emerged as not only a potentially good investment, but also the energy form most in keeping with their ideals.

SUPPORT NETWORK

Some actors in the housing arena are profit-oriented, but professionally motivated by a separate normative framework. They are interested in making a profit, but professional norms cause them to act in a way that reflects minimally this

profit orientation. Such normatively motivated support for Friends Community was exhibited by the designer.

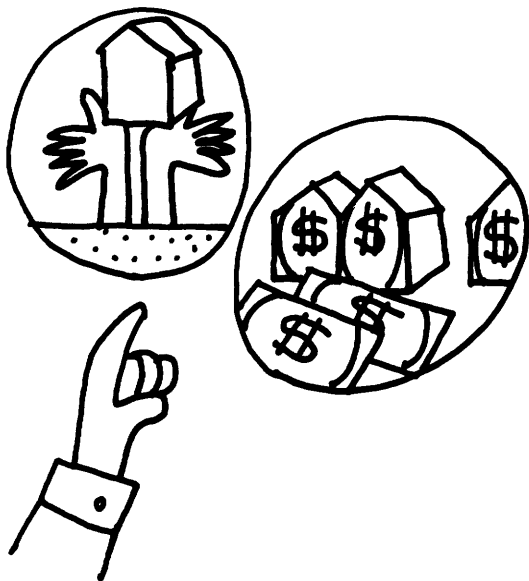


The Architects Collaborative (TAC), the design firm involved in the project, was founded in 1945, with the belief that many design challenges were better met by a team effort. Today, TAC is a prestigious and successful firm. Each of its projects is worked on by a team -- a principal in charge (who oversees many projects), an assistant in charge (who has main day-to-day responsibility) and various design members, depending on the changing needs of the project. Design activities proceed "collaboratively," (hence the firm's name), with a premium on contribution according to knowledge and insight rather than status.

TAC's founding principals have much in common with the Quaker ideals. Thus, TAC was especially attracted to the project. TAC's orientation made its staff especially willing to make commitments based on these beliefs. TAC's commitment to the Friends and the project underwent many tests, in part because the project had many design problems. At the project's inception, solar energy was

not yet a popular or easily available technology. Much of the project's preliminary research into alternative energy systems occurred before the oil embargo, and before the broader availability of information on solar energy. The use of solar energy also put design constraints on the orientation of the buildings. All face just east of south, making the design of outdoor community spaces difficult. Further, the physical qualities of the site necessitated an unusual amount of attention. In each instance the design solution required substantial expenditure of time and effort, most of it non-reimbursable given the fixed fee arrangements typical between architects and developers. TAC stayed with the project in part because it gave them the opportunity to express their own founding principles.

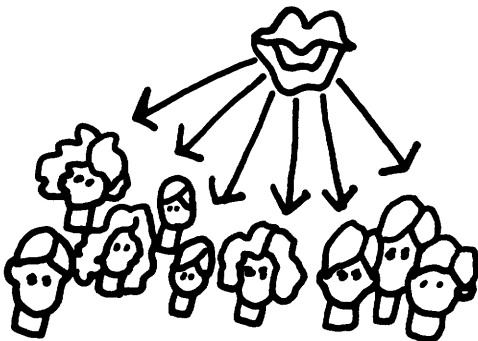
COOPERATIVE RESIDENTS



The housing arena includes the purchaser, who generally (and especially in current markets) makes decisions on the basis of financial issues -- purchase price, mortgage interest rate, taxes, and so on. The tendency today is to buy a single-family residence, maximizing one's personal financial involvement and potential for gain. By comparison, some people rationalize their housing choices based on non-monetary criteria. The people buying homes in Friends Community are in this category, as they are interested in living in a community where they can share interests, activities, and concerns with "like-minded souls." They

make this housing choice not because they are worried about resale value, but because of their belief that this is a way that people should live. As testimony to this, 12 homes were sold before the model units were completed.

That the Friends Community attracts as residents people with different housing values is revealed in the marketing approach being used for the community. The marketing firm is not trying to "sell" the community, but rather is concentrating on spreading information about it. The implication is that there is a type of person who will be so interested by the concept that it will not be necessary to "sell" it to him by "fancying it up." Rather than directly advertising the community, as in conventional marketing approaches, the marketing firm utilizes networking and information dissemination as part of a general public relations strategy.



The networking is done through groups supportive of the philosophy and principles of the community. The Society of Friends is, of course, the core group, but direct mailings are being made to many other groups. General public relations activities include free slide shows, lectures, and radio interviews as a public service to spread information about this innovative community structure. The attitude is that if everybody is told about the community, the subset of people interested in being residents will automatically



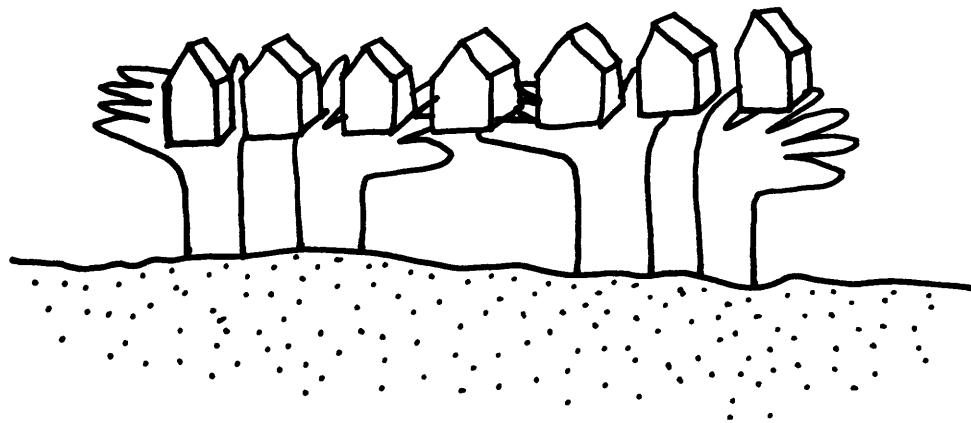
be contacted. As a representative of the marketing firm of Jackson, Jackson, and Wagner explained, "We are marketing it differently not only because of the solar, but also because of the whole genesis of the scheme." Interestingly, the marketing brochure provides little of the information normally found in such publications. Rather, it concentrates on the qualities of the community, including discussions of how Friends Community came to be, and on the selection of solar energy for the development.

SUMMARY

Friends Community is clearly a different form of housing development. Its developers are a non-profit corporation, with a very strong normative motivation for their involvement in housing. The project has prompted equally strong normative interest on the part of supporting networks, including those (such as the architect) whose motivation for involvement otherwise would be primarily profit. The community is attracting a group of residents whose interests are also consistent with the original spirit of the developers, a group which focuses on the communal rather than the financial aspects of housing.

What is perhaps most noteworthy about this case is the manner in which the particular norms that the Friends desired to make manifest in their community simplified the acceptance of building inno-

vations (most especially solar). Their initial acceptance, and their sense of the importance of their ideals and of this manner of achieving them, led others (designer and residents) to be equally willing to see the innovation in terms of the ideals first, and only afterwards in terms of the resulting operational or financial complications.



Chronology
Friends Community

1971 New England Yearly Meeting
Concern for elderly.

1972 Summer Workshop - Ad Hoc Committee
Idea of a community emerges, developed in terms of ideals.

1973 Beginnings of real design. TAC contacted by Friends,
joins project.

1974

April Friends Community Development Corporation formed.

Spring Petition for P.U.D. zoning.

1975 Investigation into solar in full swing.

March Tentative decision to use eutectic salt storage system
developed by Maria Telkes.

May Salt storage all designed.

June Financial hold-ups, doubts about solar system.

July Salt storage system dropped.

1976

February Willow Company formed to advise FC.

1977

March HUD Solar Grant application.

May Solar Grant announced, \$132,879.

1978 Contracts finalized.

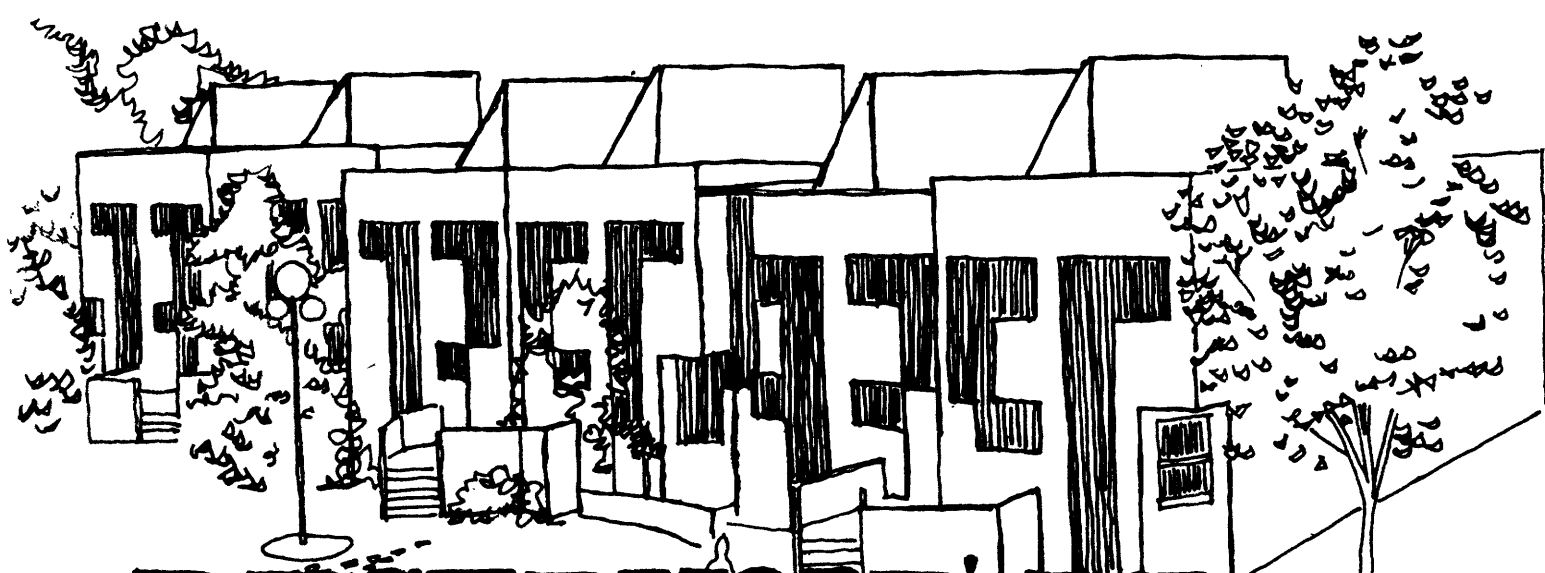
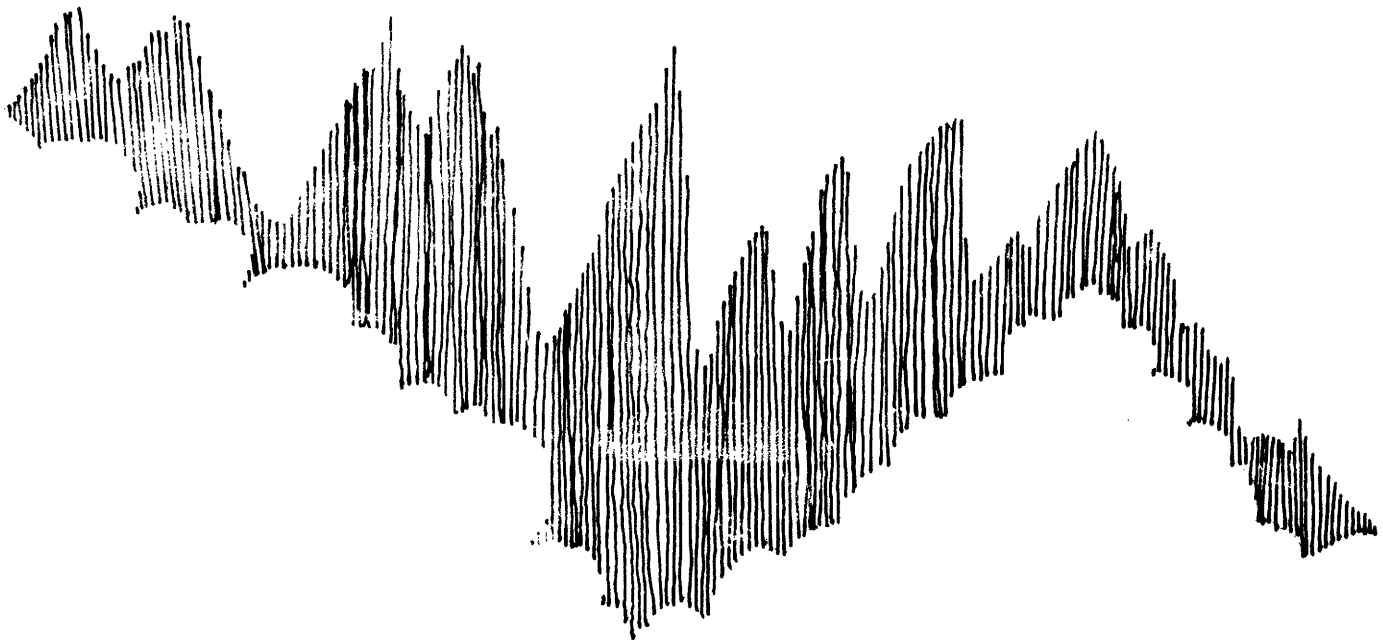
September FCDC begins accepting applications.

November 12 Ground broken, construction of first 5 units begins.

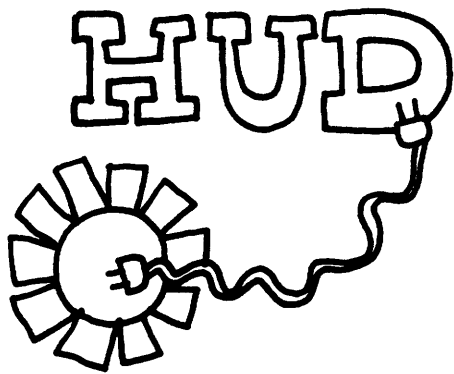
1979

March Shell construction of first five units completed.

May Two units completed, one with full solar system.

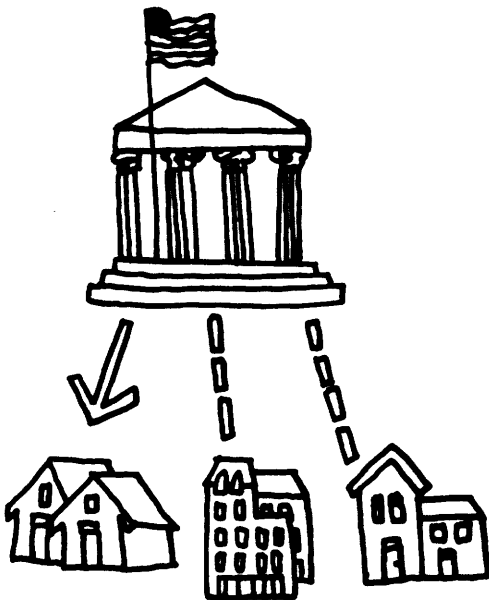


**RESERVOIR HILL
SOLAR
HOUSES**

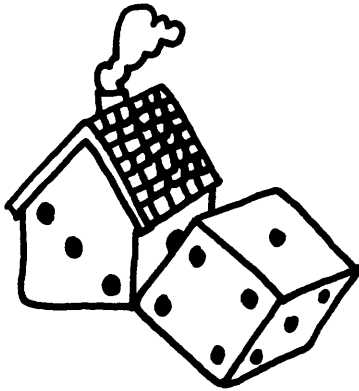


Reservoir Hill Solar Houses is a 15-unit single-family attached development in the Reservoir Hill urban renewal area of Baltimore. The project received a grant of approximately \$95,000 in HUD's Cycle 3. The first phase of 8 units has been completed and is being marketed. One unit is occupied. The intent of the developer, Centennial Building and Development Corporation, and of the city's Department of Housing and Community Development, was to provide market-rate sales housing at this site for a middle income inner city market. The grant application noted their intent to "design to cost." Reservoir Hill Solar Houses is the first development project undertaken by the developer, who, as a result of the success of this venture, is now involved in housing development valuing over \$20 million both within and outside of Baltimore City. This case illustrates three dynamics of the housing arena:

1. The process of entry by new development firms;
2. The role of public agencies in encouraging various forms of housing;
3. The problems of using product innovations without adequately developed industry support infrastructure.



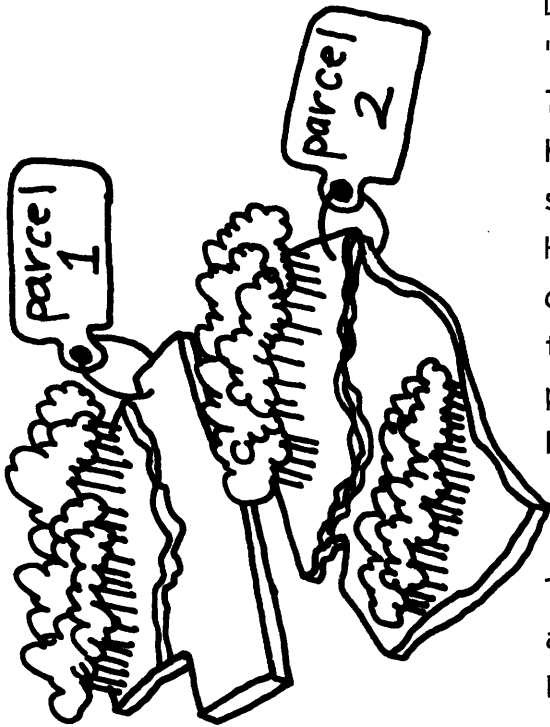
GETTING STARTED IN HOUSING DEVELOPMENT



In housing the stories about getting into the business all seem to have a common theme -- rugged individualism, the trials and tribulations of the entrepreneurial spirit, and serendipity. Success seems to be a function of patience, perseverance, the willingness to take a risk, and not a little luck, typically all focused in one individual. Housing seems to be one of the few areas left in our economic system which depends on the individual entrepreneur and which richly rewards those who are good at it. The story of Melde Rutledge, Jr. and his firm, the Centennial Development and Building Corporation (CDBC), fits this theme.

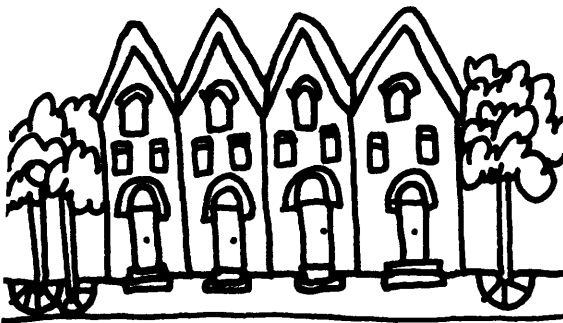
Rutledge is a dynamic young black man, a former insurance salesman who left that business because, as he says, "I was dissatisfied with having no tangible product." Rutledge's first venture into housing was to run, in collaboration with another person, a construction association for minority contractors in Annapolis. His interest in producing the product showed up in his approach to his job. "There was a disagreement between myself and the other guy. I said the way you teach construction is to get jobs and do it; he wanted to train first." The disagreement on approach was sufficient to lead Rutledge to follow his own advice. He left the construction association. In March 1976, Rutledge formed CDBC and began the search for a building site.

Al Thumel, staff member in the Land Disposition Department of Baltimore's Department of Housing and Community Development, remembers his first contact with Rutledge. "Melde had written several places in the city looking for land. It was early in 1977 when I first had contact with him. He was looking to enter the housing field. He seemed knowledgeable, but had no previous experience. He came into the office, and convinced me that he could develop housing. I convinced the City to make available these two small parcels in Reservoir Hill, so he could prove himself and his marketability. He has proven himself."



The parcels, located between the 2300 blocks of Madison and McCullough Streets on the western boundary of the Reservoir Hill renewal area, had been designated by HCD for market rate sales housing. The Reservoir Hill area, put into renewal execution in 1968, is immediately north of Bolton Hill, a very successful "Georgetown-esque" renewal project begun in the early 1960's. Though of comparable age, building type, and physical characteristics, Reservoir Hill has not yet generated the kind of middle- and upper-income interest as Bolton Hill.

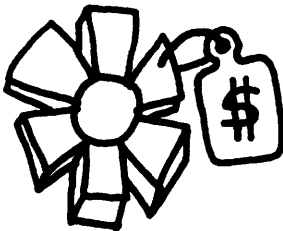
Rutledge viewed this as somewhat of a problem, given HCD's designation of his development parcels for market-rate sales housing. "The area is not quite ready to take off, like Bolton Hill. It is still low-moderate income. In real estate you have to do something fancy, to create some perception of bankability."



Faced with the problem of creating "bankability," Rutledge had his first piece of good luck. "By chance I met this

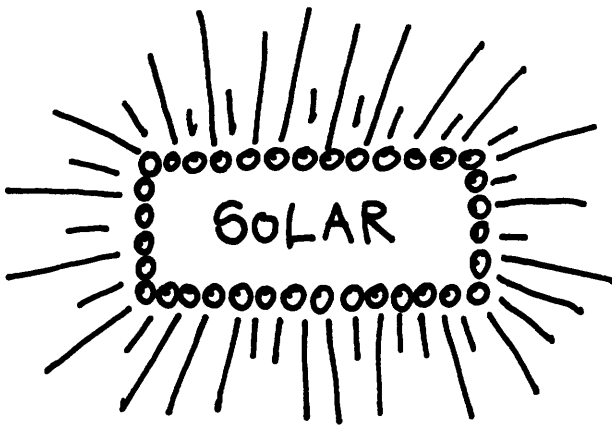
architect, Clarence Jackson, who did the design for the development. HCD wouldn't approve my first architect. Jackson was on their list of approved architects. HCD's Equal Employment Officer suggested I contact him. So I talked with him. Jackson said we could get a solar grant from HUD. He had done some projects in Columbia. Jackson had been the designer on a Cycle 2 project. So Jackson did the processing. It gave us the 'fancy' thing we needed for bankability. I didn't care one way or the other about solar, but thought the grant would help. It certainly helped the financial situation."

The serendipitous elements of this developer-architect connection are confirmed by Thumel at HCD. "We did disapprove the first architect. We recommend several architects, anyone of whom would be acceptable. (HCD's Design Review Panel and its staff generate a list of acceptable architects.) We had done prior work with Clarence Jackson, though we had no prior knowledge of his work with solar. That was a pleasant little surprise."



Working under pressure, Jackson and Rutledge were able to submit a grant application complete with preliminary designs to HUD by its March 1977 deadline for Cycle 3. CDBC was one of the selected projects, but it was not without its anxious moments. Recalls Rutledge, "HUD called and said that they had awarded \$54,000 for 7-8 units. I said we needed all 15 units to make the project work. They were still in their meeting. The guy said I had a lot of nerve, but he went back and they gave us the full request." (The award was for approximately \$95,000 for 15 units.)

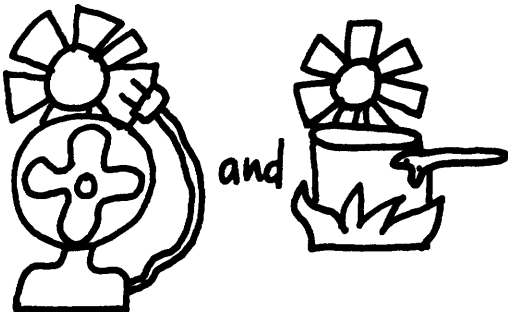
The solar grant then provided the 'bankability' factor for CDBC's first project. James C. Hunter, Jr., Senior Vice President of Baltimore Federal Savings and Loan Association, which financed the development of Reservoir Hill Solar Houses, confirms this view. "Baltimore Federal is oriented toward community reinvestment, toward neighborhood rehabilitation. It is our principle that this goal can be achieved with the participation of government, business and community, if they work together. Reservoir Hill is a neighborhood that fits the description. We decided to consider financing this project for this reason. But solar heating was the item that helped us make the decision to finance the project in its proposed form. We thought that having solar heat would be an inducement to buy. Given the price in that neighborhood, lower to mid 40's, in what was called a \$30,000 market, we needed a special attraction, a 'gimmick.' We didn't give any thought to measuring the cost savings, but to the appeal of the solar idea."



With financing obtained, CDBC was on its way toward success. With financing approved and the HUD award in hand, CDBC and HCD began formal negotiation on a land disposition agreement in July, 1977. The City's Board of Estimate (a fiscal review panel consisting of the Mayor, City Council President, and Comptroller) approved the agreement in September. Plans received all necessary HCD approvals (including that of the Design Advisory Panel and the Reservoir Hill Community Association) by early December. Before the year was out, construction on the Reservoir Hill Solar Houses had begun.

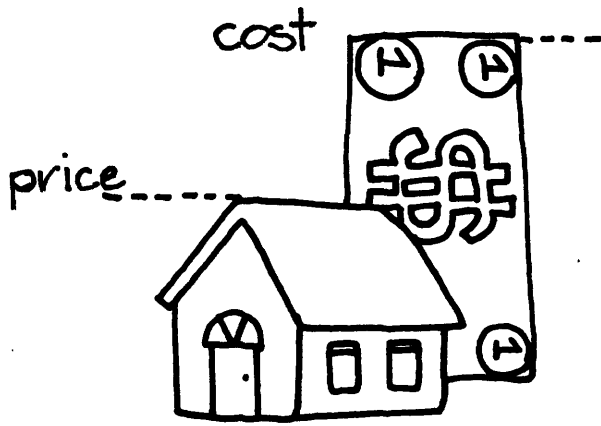
For Rutledge, doing the Reservoir Hill Solar Houses "made" CDBC. "The project was really important for our business. I regard it as a sort of loss leader. We lost money on it, but it lead to over \$20 million in housing for us right now. The City is happy with our work, and has asked us to do a major project in the Old Town renewal project in East Baltimore. We are getting \$3.3 million in UDAG money to do 288 units. We are doing the old Sherwood Hotel with Section 8. We have property in Salisbury (on Maryland's Eastern Shore) that we are developing 62 units on."

PUBLIC ACTION TO DIRECT HOUSING DEVELOPMENT

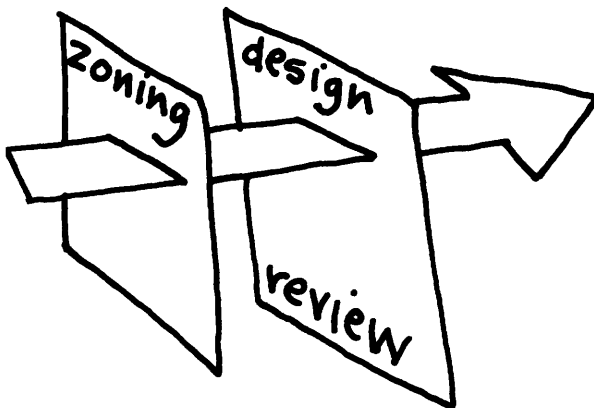


The HUD-DOE Solar Heating and Cooling demonstration program, providing direct grants to developers to encourage their use of solar thermal innovations, is one mechanism for governmental intervention into the housing market to encourage innovation acceptance. There are additional means of governmental intervention to encourage housing development in support of public objectives. Many of these mechanisms are within the purview of local government. Thus, we looked to see which, if any, forms of prompting were in evidence in the development of Reservoir Hill Solar Houses. Because the land was publicly owned, and its reuse specified as part of the City's urban renewal program, we did not have to search far.

It seems clear that in designing the Reservoir Hill renewal area the planners at HCD hoped to extend the successes of Bolton Hill, including its relatively high

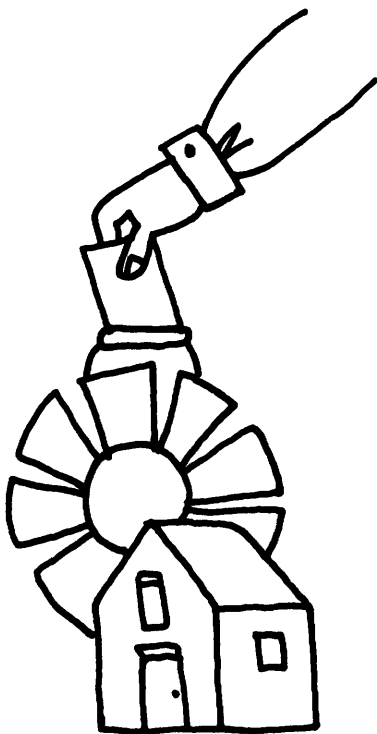


proportion of homeownership. Thus the first evidence of public intervention is the parcel designation for reuse as market-rate sales housing. Though the planners found this desirable, the realities of housing construction meant that costs under normal conditions would exceed by a large margin the typical selling price of existing housing in the rest of the neighborhood. This is a frequently encountered situation in renewal activities, as there must be a finding of blight in order to make use of the various renewal powers and funds. Thus for market-rate new housing (which does not use direct subsidies) to be successful, additional efforts were required. In this case, a critical factor would be the setting of a sales price for the land. If it were too high, it would make the project infeasible. As Al Thumel, of HCD's Land Disposition Department tells it, "We sold the land on our normal write-down provisions. This is based on our program for the site. We wanted to do market-rate housing. The appraiser knew our intentions and the market conditions of this neighborhood. We needed to keep the market price down. I think we got a fair price appraisal."



A second form of public intervention typically encountered is directed toward assuring a level of quality and attractiveness of the housing. Land disposition agreements provide for such factors as density, land coverage, set backs and related aspects, typically in greater detail than zoning provisions. A step beyond these zoning-like specifications is design review. Baltimore has an active design review process, involving scrutiny of the proposed project by community, staff, and a Design Advisory Panel. This last includes people from throughout

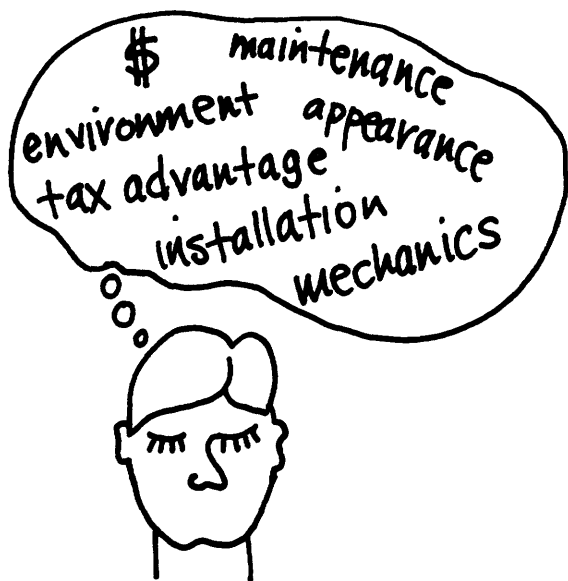
the East Coast. The design for the Reservoir Hill Solar Houses was accepted by the Reservoir Hill Community Association, the HCD staff, and the Design Advisory Panel. Reporting on the review by the DAP, Thumel said, "They were enthused at the effort on solar. For it to work, it needs an opportunity."



A third form of public intervention relates directly to the energy dimensions of the project. (The first two relate to the housing attributes.) Though Reservoir Hill Solar Houses were to be the first privately developed solar residences in Baltimore, the energy dimensions seem to have received no official encouragement. (This is not to say that the City is not involved in various energy efforts. They have received grants under the DOE portion of this program for solar heating, hot water and/or air conditioning on a community center, a fire house and five rehabilitated row houses; and have had an Energy Coordinator on full-time loan from NASA for a number of years.) The only evidence of formal energy action is a 1976 Maryland statute which provides that tax assessments will not be increased by virtue of installation of solar technology. Most observers feel that this is not an especially valuable bill, as assessments tend not to depend on the type of heating/cooling system, but on location, sales price and so on. However, Melde Rutledge did report that CDBC is in the process of "getting clearance on discounting the solar for tax assessment purposes."

USING INNOVATION IN HOUSING DEVELOPMENT

Given the importance of solar in making the success of CDBC, one is naturally led to ask, "Would you do it again? Would you make the solar innovation part of your development routine?" For Melde Rutledge, the answer is no. "We thought about being solar developers, but decided not to. Solar is not moving in this country. There are too many manufacturers. There is no control on the product. There is just too much information to decide what to do, especially for a buyer."



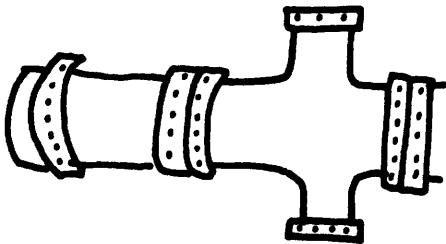
Since the HUD-DOE Solar Heating and Cooling demonstration program was intended to entice developers to use solar by subsidizing the costs of doing so, we pursued CDBC's decision against further use of solar. On Rutledge's introduction, we talked with Guy Cazzaza, a planner on CDBC's staff who worked intensively on the Reservoir Hill Solar Townhouses project. As Cazzaza reflected on the project, it was clear why there would have to be a pattern of innovation acceptance on the part of a number of actors involved in the project, not just on the part of the developer. Equally interesting, a negative conclusion on further use of solar per se did not necessarily need to be preceded by active rejection of solar on the part of participants. Things as simple as confusion of roles, or uncertainty about work activities, or unfamiliarity of plans or requests, when added up, create a pattern of complexity which only the most ardent advocate will continue to take on, especially in the face of possible income loss and/or business elimination



altogether. As Cazzaza put it, "Builders are a conservative group. They won't get into solar -- too many headaches. It involves subs they have never dealt with before. Everything is different. They can't walk in and know whether or not the sub is doing the job properly. A builder decides not to tamper with what he knows best."

The problems appeared to CDBC in many areas, something which Cazzaza summed up by calling the infrastructure of the industry "weak." Inventory turned out to be a big issue. Says Cazzaza, "The subs on the job were small. They have small staff and cash flow problems. This is especially true about the solar industry. There is no purchasing power for inventory; no cash to maintain a stock, plus there is no interchangeability of parts. Our solar sub has a small inventory, but only on the system they use." This inventory difficulty showed up in the process of installing the solar system for Reservoir Hill Solar Houses. "CDBC choose to buy all the materials, and put the subs on a labor and materials contract. Our solar sub wanted the one system with which they were familiar. We had specified another in the grant application. We wanted to buy the materials for cost savings. We bought from several locations, a decision which turned out to be inefficient. For example, we got 14 high-head pumps. There were no brackets, flanges. So I had to trace 21 sets of flanges. There weren't any locally, so we had to backorder from Atlanta, which took four to six weeks. There just isn't a basic materials system for the industry. There are multiple suppliers; it is a primitive industry."

The flange problem was not the only evidence of how an underdeveloped industry supply network hindered the speedy completion of the project. Cazzaza shook his head about their electric control system. "In Colorado they lost the wiring diagram. It took weeks to get that fixed up!" Cazzaza also feels that the same problems will show up during the first year or two of use. "Take services, for example," he says. "It isn't like calling the plumber for the toilet. Here they will call the builder back for repairs. People need to be better educated about how solar works."

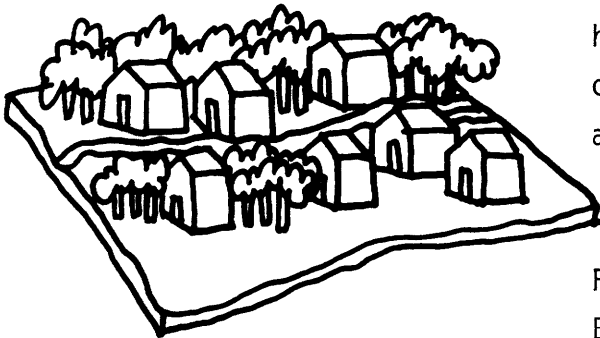


Rutledge emphasized some of these same themes, which might be called "difficulties of labelling" -- because something is differently labelled it must be different, and therefore confusing, difficult, even mysterious beyond comprehension. Said Rutledge, "Actually we would have done better with our plumbing sub doing the work. The HUD grant required naming a 'solar sub.' But it seemed that solar is different, therefore you get a solar sub. Most everything is just plumbing, and everything interfaces. We would do it with our plumbing sub now."

The fascinations and fears of something new were voiced by nearly everyone having something to do with the project. HCD's Al Thumel said, "There are so many merchants out there with different kinds of systems. They've never been proved. The market is confusing. What the federal government tells us is quite confusing. They say solar is proven, but where? They also tell us to be careful, that there are shysters selling it. I'm afraid of them too!" Jim Hunter, the project's

financial backer, sounded a positive note for the possibilities of space-age technology. "I look for a solar breakthrough some day, it's just not here now. Some day they'll find a super absorbent 'space-age' material, that you can self-install. Its efficiency will be up, and a shorter pay back." Hunter did say that Baltimore Federal is "positive" toward other solar projects, though in their appraisal practices they were not yet giving full credit for its use.

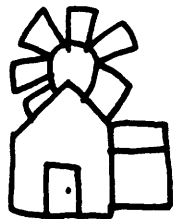
SUMMARY



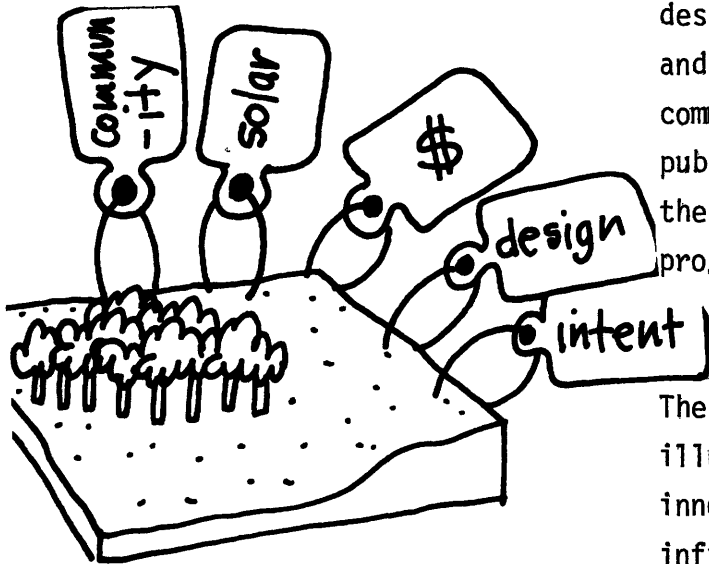
Reservoir Hill Solar Houses are an excellent example of how a new development firm successfully enters the housing field, of how forms of housing are guided by certain public action, and of how industry infrastructure affects housing construction and occupancy.

For Melde Rutledge and his Centennial Development and Building Corporation, the Solar Heating and Cooling demonstration program provided the opportunity to develop housing in a way which "made a name" for the firm. The difference between success and failure of a new development venture is often visibility. Winning the first HUD solar grant for Baltimore gave CDBC that distinguishing visibility. Though Rutledge clearly supports the use of solar technologies in housing, he views it first and foremost as "the fancy thing we needed for bankability." The subsequent success of the firm allowed Rutledge to write off the complications associated with using the new technology, regarding the project as "a sort of loss

leader." The other primary actors in this project, notably the city agency holding the land and the bank providing the financing, similarly viewed the use of solar as the element which gave this effort its distinct image, and therefore contributed to their willingness to support it. For James Hunter at Baltimore Federal, solar heating was "the item that helped us make the decision to finance," while for Al Thumel at the Department of Housing and Community Development (HCD), who was interested in seeing market-rate sales housing developed on the parcel, the move to solar was "a pleasant little surprise," one which made the project go.



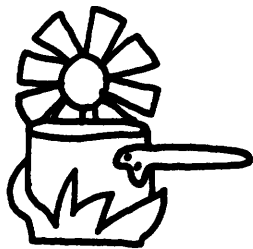
The development of Reservoir Hill Solar Houses illustrates how action by public agencies encourages certain forms of housing. HUD's grant for solar heating was obviously the only reason for the use of solar at this site. Even more interesting is the activity of public agencies at the municipal level. The Reservoir Hill renewal plan, initiated in 1968, had designated this site for market rate sales housing. Only because the land was in public ownership was it possible to hold it off the market nine years, waiting for a developer willing to undertake a housing venture that fulfilled that intended purpose. In this case, support for advance planning, parcel assembly, and annual carrying costs were all covered out of federal renewal funds. Moreover, when the right developer did come along, HCD was able to transfer the property at a price which made the project feasible; it did not have to recover costs incurred for holding the property, or make a profit. Beyond that, Al Thumel pointed out, HCD was able to convey its intentions for the use of the site to the appraiser, so that the price set to transfer the



property was consistent with project feasibility objectives. Similarly, it was able to influence housing design, both formally through its Design Advisory Panel and informally through its facilitation of developer and community interchange. In comparison with these active public interventions on cost and aesthetic considerations, the city played no role in the energy dimensions of this project.

The development of Reservoir Hill Solar Houses clearly illustrates the problems associated with using materials innovations without adequately developed industry support infrastructure. Most stories of the difficulties of using an innovation focus on intrinsic attributes of the innovation. While stories of this sort can be told here (for example, the flange problem with the pumps) even more interesting are the secondary elements -- role confusion, uncertainty over work activities, limited local supply of materials, unfamiliarity with plans -- which add up to a pattern of complexity and frustration. CDBC's Guy Cazzaza gave a clue about the impact of these secondary dimensions in talking about the relationship of general and sub-contractors: "It (solar) involves subs they (general contractors) have never dealt with before. Everything is different. They can't walk in and know whether or not the sub is doing the job properly."

This same sort of difficulty extends to housing occupants, who are uncertain regarding to whom to turn if something goes wrong with the solar unit. Cazzaza feels occupants will call the builder. "It isn't like calling the plumber for the toilet," he says. The



infrastructure stories crop up with nearly every participant, each seeing difficulties unique to his perspective. While the problems are not unsurmountable, and clearly do not contribute sufficient uncertainty regarding continuing with the project, it is this dimension which leads people to conclude, as did Al Thumel, "I'm afraid of them, too!"

Chronology
Reservoir Hill Solar Houses

1976

- March Centennial Development and Building Corporation formed by Melde Rutledge, Jr.
- Late fall Rutledge addresses inquiries to City of Baltimore about building site.

1977

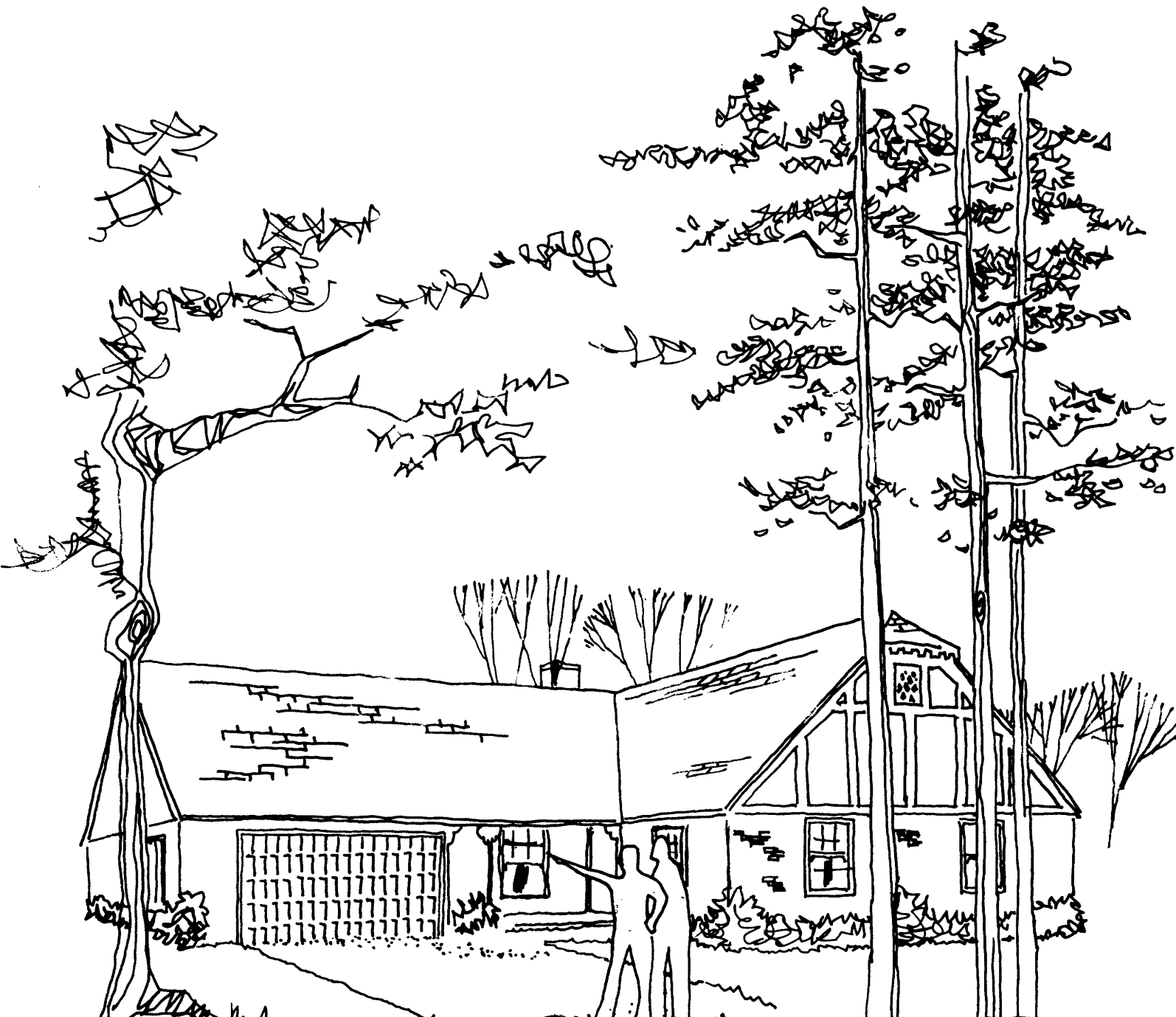
- January Rutledge meets with Thumel (HCD Land Disposition Dept.); obtains support. Two adjacent sites in Reservoir Hill identified for development. Initial architect refused by HCD. Rutledge referred to Jackson by HCD EEO officer. Jackson suggests seeking solar grant.
- February/March Preliminary designs developed; grant proposal drafted and submitted to HUD.
- May HUD announces grant to CDBC for 15 units.
- July CDBC and HCD begin formal negotiations on land disposition.
- September Baltimore Board of Estimate approves land disposition agreement.
- November Plans before Design Advisory Panel; groundbreaking.
- December Plans approved; construction begun.

1978

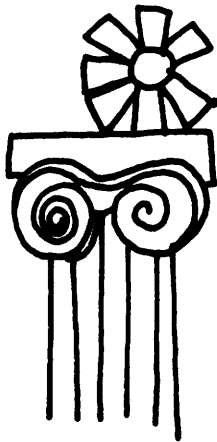
- April Construction continues throughout year on first 8 units.
- August Open house marketing begins.

1979

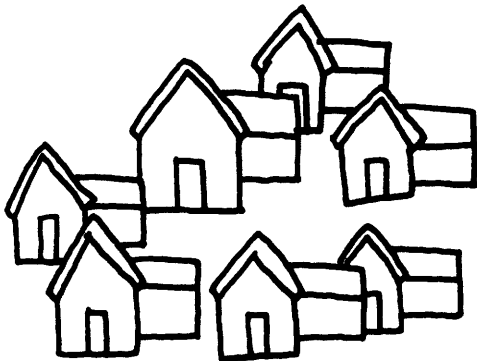
- January New marketing firm; different focus.
- March First unit occupied.



**PROJECT SOLAR
FOR
INDIANA**

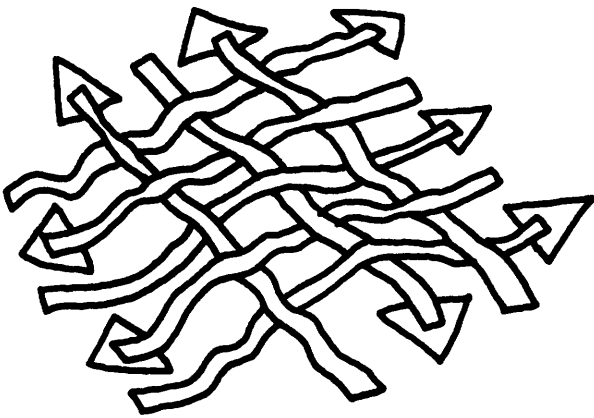


Innovations often encounter difficulty gaining acceptance even when there is interest and positive recognition of quality by potential users. For this reason, the linkage or association of an innovation with an existing institutional entity often enhances the acceptability of the innovation. Because these entities are known, their functions and activities both stable and understood, they can help mediate the instability which possible users fear the innovation might cause, making the innovation itself appear more comprehensible and "routine," so to speak. Also, to the extent that these entities are trusted, respected, or perceived in some favorable light, they help to 'legitimize' the innovation; the information they provide (and their viewpoints in general) will be respected and considered seriously. Thus, like a "seal of approval," legitimators validate the use of the innovation.



It is just this sort of mediating, legitimating, and generally supporting institutional network that characterized Project Solar of Indiana, a recipient of Cycle 3 funds. Project Solar of Indiana involved seven builders, each building a single family house, identical in terms of design, square footage, insulation factors and solar units, in seven different regions in the State. This group included builders Stan Peebles of Terre Haute, Malcolm Miles of Liberty, Harold Steinkamp of Batesville, Ron Smith of Greenwood, Alan Grabar of Auburn, Bill Leffel of Mexico, and John L. Reilly of Cumberland, each having his first experience with solar. Though the builders applied separately for the grant, their efforts were coordinated through the Homebuilders' Association of Indiana (HBAI) under the direction of the Association's President, Thomas Laycock, and the newly appointed chairman of the Association's Solar Energy Committee, Kenneth A. Puller. The applications were submitted under the common

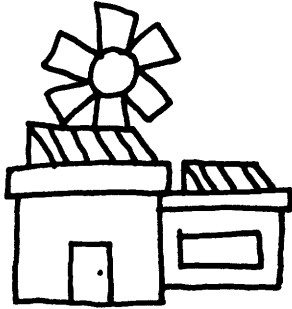
identity of Project Solar for Indiana. Each builder received a grant of \$8,500 in the spring of 1977. Presently, all seven homes are operational. To date, five have been sold, and two are being used by their builders as models.



This case illustrates the importance of supporting institutional networks to innovation acceptance in housing. Such a network was critical to getting the project started, to providing a means for coordination, information dissemination, guidance and reassurance of participants; in short, for making the innovation "comprehensible" to the builders. This supporting network included not only the HBAI, which assumed the formal supporting role, but also the Indiana State government, as well as a number of individuals who were able to serve mediating, legitimating, and other supporting roles because of their previous experience and positions in the local homebuilding industry.

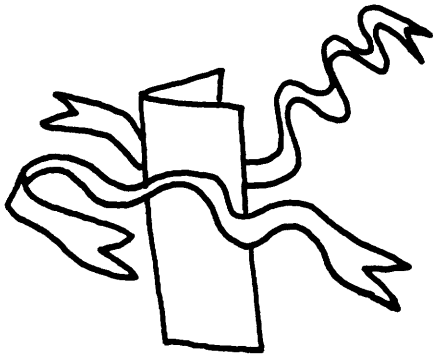
THE SUPPORT NETWORK FORMS

In 1975, architect Gordon Clark, in collaboration with the Indianapolis Center for Advanced Research (ICFAR), designed a solar heating system for the office of Dr. Thomas Bohnert, a prominent Indianapolis dentist. Also assisting was Lee Kennedy, Director of Marketing at the Hedback Corporation, Indiana distributors of heating and cooling equipment. Kennedy had been asked to help the team in integrating the solar unit with the conventional heating and cooling system.



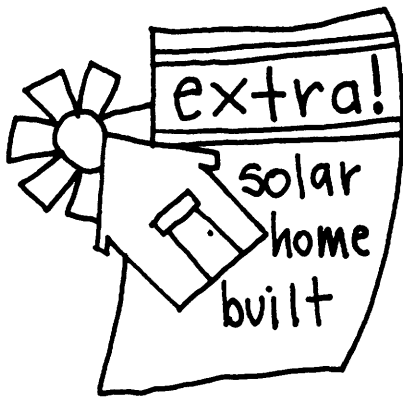
As the first solar installation in the area, the building drew the attention of local builders. Apparently, however, this interest alone was not sufficient to induce further involvement with solar. It was not until the Indiana State government stepped in to "push" the DOE-HUD Solar Heating and Cooling Demonstration Program that the next wave of activity with solar took place. Though the Program had been in operation since 1974, Tom Kibler (then Director of the State Energy Office) did not hear about it until after the first cycle grants had already been awarded. Kibler discovered the program in an ERDA publication. He in turn showed this publication to his supervisor, then Lt. Governor Robert Orr, who "hit the ceiling" because Indiana had received no funds. Orr was particularly disappointed because Indiana had provided a property tax incentive to encourage the development of solar energy. Together, Kibler and Orr decided that something had to be done to insure Indiana's involvement in Cycle 2 of the program.

Following his attendance at a ERDA-sponsored program for state energy officials in March of 1976 (in Huntsville, Alabama), Kibler's office (now with a staff person specifically assigned to solar) planned a seminar to publicize the availability of the HUD grants and to stimulate interest in the program. Over 4,500 invitations were sent out to trade associations, architects, developers, and other building-related professionals. Three hundred responses were received; however, of these, only twelve were builders. Many Hoosiers are quick to point out that Indiana is basically very cautious and conservative. Remarks John Chaille of the State Energy Office, "It's a particularly closed state when it comes to taking money from the federal government. Builders shy away from



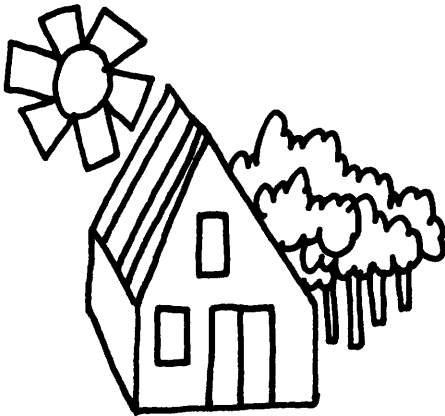
federal programs because of perceived delays, red tape, and, perhaps, some moral reservations . . . there's a hard work ethic out here . . . no one likes to think they (or anyone else) is getting something for nothing." As one builder put it, "Most builders didn't know very much about solar energy then, and most weren't in any great rush to learn. There didn't seem to be much opportunity or promise in it." Clearly, then, neither federal programs nor solar energy were very popular in the Indiana building community.

There was one notable exception, however -- Steve Moulder, of the Moulder Corporation of Greenwood, Indiana, a relative newcomer to the homebuilding field. An engineer by training, he had always been interested in architecture and building "in a special way." After building on a small scale, he entered the market as a full-time home-builder doing custom building in 1971. Moulder had been intrigued by the first solar installation at Dr. Bohnert's office. Then, upon hearing about the program at the seminar hosted by the Energy Office, he began to think more seriously about it. Says Moulder, "Although still somewhat skeptical like everyone else, after attending the meeting I contacted my heating contractor, who put me in touch with his equipment supplier, Lee Kennedy of Hedback. I was curious to see if solar was adaptable to the houses of the type I was used to building." Moulder spent the next 30 days learning about solar from Kennedy, and with Kennedy's assistance, Moulder applied for the HUD grant. As he explained, an important motivation was publicity: "...Because of the conservatism of Indiana builders, their skepticism, and reluctance to get involved in federal programs, I was nearly certain that no one else would apply; thus I could get the only Indiana grant."



Moulder's predictions were nearly correct. Of the few builders who applied, only Moulder received a Cycle 2 award. Later, he was to benefit significantly from this: coverage by all local stations, press releases, full coverage in the *Indiana Bildor* (the monthly publication of the HBAI), ribbon-cutting ceremonies with the Lt. Governor, and the like. As he summed it up, "I entirely capitalized on it and got twelve months of heavy publicity."

Though Moulder had been intrigued by the Bohnert office, it had not proved sufficient to prompt him to build with solar. However, after the state-sponsored seminar and his talks with Lee Kennedy, he was "very enthusiastic" about trying it. The provision of federal funds to pay for the additional costs of solar was the conclusive factor. Says Moulder, "More than likely, I wouldn't have done it otherwise." It should be emphasized, though, that Moulder's decision was not based solely on the availability of federal money; equally important in his decision were the state's active interest and the confirming technical reports from a trusted colleague. The connection with Kennedy was especially important. Here was someone with whom he had worked, someone he knew personally, and, as Moulder says, "someone for whom I have always had great admiration and respect." Thus, Moulder attached great importance to Kennedy's views on solar. Moreover, as his heating and cooling supplier, Kennedy was the one whom Moulder customarily turned to find out about heating and cooling equipment. In this case, it was heating equipment of a different kind, but nonetheless, the process conformed to Moulder's business routine. In sum, however risky and unconventional solar might have been, because of the manner



in which and the entities through which it was encountered (the State Energy Office and Lee Kennedy), solar was more routine, more comprehensible, and therefore more acceptable to Steve Moulder.

Thus we have the beginnings of the institutional support network: Kennedy, a local authority familiar not only with solar but also with the SHAC Program and its complicated application process; and Moulder, the builder, more and more enthusiastic ("hooked", as he put it) about solar. Together, the two reduced the risk and uncertainty of both solar and the DOE-HUD program. In these "mediating" roles, both Moulder and Kennedy proved to be of critical importance to Project Solar for Indiana.

ENTER HBAI

The Homebuilders Association of Indiana (HBAI) regards itself as the "voice of the building industry in the state." One in a national network of such associations, the HBAI includes in its membership a high proportion of the state's builders and related professionals. According to Bob Weiss, the HBAI's associate director, what distinguishes the Association is its high level of activity. "We sponsor a number of activities -- seminars, conventions, our monthly newspaper, for example. Most of our members take a real interest in these affairs. They want to know what's happening in the industry, and we try to keep them abreast." In addition to these formal activities, functions and services, the HBAI, like any formal association, is a place for personal interaction. "It's been a source of a good number of contacts and connections, both personal and business-related," says Weiss.

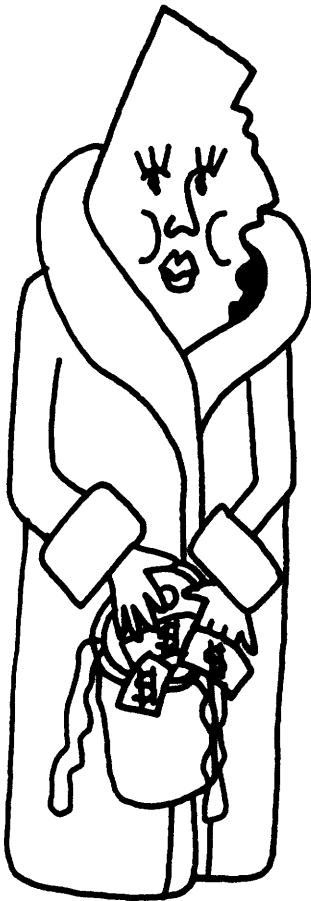
Thus, the HBAI seems a logical supporting structure. It is not all that surprising that the situation of disinterest in (if not outright resistance to) solar and in participation in federal programs could be turned around by means of Project Solar, when the project was proposed by the Association's President and promoted and directed by one of the HBAI's most respected members. Nor, given the Association's position and role, is it surprising that the project progressed so smoothly, even though the technology involved was one with which the builders (as well as the Project's directors) had so little experience. Finally, it is clear for these reasons why the group was able to coordinate effectively its activities, and to mobilize the necessary resources in so short a period of time.



Above all, the HBAI is a respected entity in the state's homebuilding community, a reliable and believable source of information. The HBAI is also a formal and understandable entity with internally shared norms and values, formalized social groups, and routinized patterns and relationships. Interpersonal contacts, information exchanges, work processes, and activities are regulated by rules and tradition. Thus, in associating the project with the HBAI and implementing this new technology through its normal procedures, it could be made to seem more routine. Because working with the HBAI is a familiar process, the newness of the technology is mediated and its acceptance accelerated. Finally, the HBAI is a linking pin, bringing together a complex of resources and capabilities with mechanisms both for specialization and coordination. Because of its diversity of resources, the HBAI has access to information as well as the means to disseminate it.

To better understand these roles and functions of the HBAI, Moulder, and Kennedy, we will review the chronology of Project Solar, highlighting some of the key events, and seeing how they illustrate the actions of this network.

PROJECT SOLAR FOR INDIANA: A HISTORY

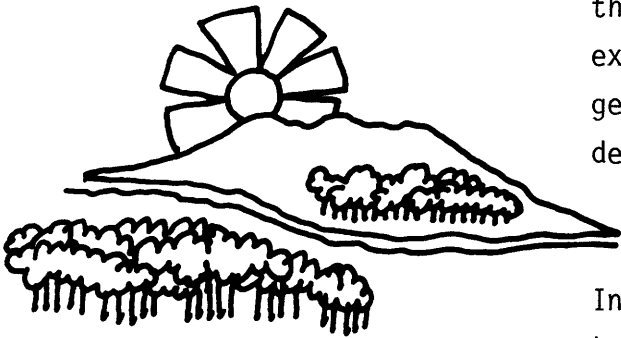


On assuming the Presidency of the HBAI in January, 1977, Thomas Laycock proposed that the HBAI sponsor a group of builders to participate in Cycle 3 of the SHAC Program. Presently, the owner/director of AHM Graves, Inc., Builders and Developers, Laycock is an architect by training; and, as he explained, he had always taken an interest in energy conservation in buildings. Thus, considering the energy situation, Indiana's very cold winters, and the availability of funds (which he knew about via Moulder as well as an ERDA publication), it sounded like "a good idea to get some solar activity started in Indiana." Laycock favored a group project, i.e., having a group of builders use the same house and the same solar unit, to allow the measurement of energy efficiency in different climatic regions of the State. As he explained it, "Because different builders do things in different ways, a group project of this sort would not only allow us to assess climatic variations, but would also be more meaningful, more visible. Also, in making the Project appear more unique, it might help in insuring grant awards for all builders in the group."

Thus, following approval of the proposal by the HBAI's Executive and General Boards of Directors, Laycock

turned to his friend and fellow HBAI member Kenneth A. Puller for assistance in exploring the matter, and shortly thereafter asked Puller to chair the HBAI's Solar Energy Committee, taking responsibility for the formal direction of the Project. Puller knew very little about solar energy at the time. Says Puller, "I knew absolutely nothing...As usual, with Tom's foresight and great wisdom, he picked someone who knows absolutely nothing about solar heat...Under Tom's direction, the blind were leading the blind." But Puller obviously had other areas of expertise, including a proven talent for getting people to work together, as well as an unusually long history of involvement in housing affairs. Currently, he is President of Puller Mortgage Associates of Indianapolis, a mortgage banking operation which Puller describes as a "one-stop clearinghouse." Puller has had extensive experience in real estate sales, management, and building development, as well as a diversified array of experiences during eight years at HUD. Puller has also been very much involved in local land development and housing affairs, assisting, for example, in the development of a growth policy plan for the city, as well as in the writing of the statute for the State's housing finance agency. Thus, Puller is seen in Indiana as an all-around housing expert, and one with access to inside information, particularly at HUD. Puller did not at first know exactly what the job would entail, but he agreed to take it, wanting, as he put it, "to help give the builders a start." Thus, we can discern another especially important supportive figure within the HBAI, someone to serve as consultant and overall facilitator.

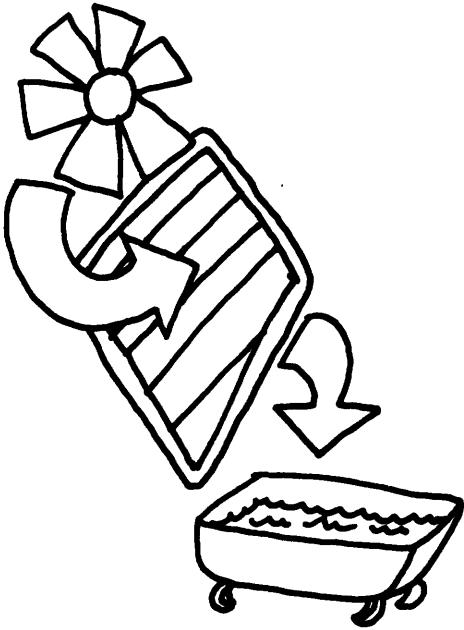
To notify the state's builders and get the project underway, Puller and Laycock turned to the internal structure of the HBAI. Laycock called a meeting of the six area vice presidents, asking them to publicize the effort. The intention at that time was to have one applicant from each of the six membership areas, but to the surprise of Puller and Laycock, over a dozen builders expressed interest in participating in the project. In general, the motives of the builders were two-fold: a desire for publicity, and a desire to learn about solar.



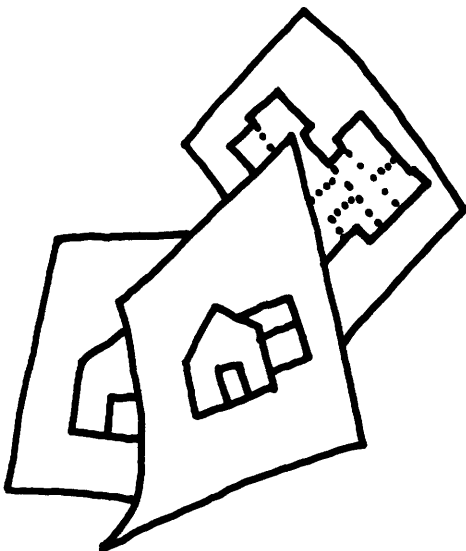
In the meantime (while preliminary discussions with the builders were being held), the members of the Solar Energy Committee, under the direction of Puller, were trying to become more familiar with solar and the working of the SHAC Program. But here, even after pooling their resources, they found themselves to be still sorely deficient. "No one in the group really knew anything about solar heating," says Puller. "So, naturally we turned to the only known expert, Steve Moulder, and asked him to join our committee."

From this point on, Moulder proved to be invaluable to the group. The first formal meeting was held in February (1977) with Laycock, Puller, Bob Weiss, A. William Carson (Executive Director HBAI), and the builders, now numbering eight. (After the preliminary meeting, only seven builders remained seriously committed to participation in the project.) Moulder recounted his experiences with solar in the SHAC Program. Recalls Puller, "Here we were with lots of unanswered questions and here he was with all the answers. His presence was

of great assistance to us at this point...here was someone who had been there before." Thus we see Moulder become a translator responding to the group's uncertainties with appropriately phrased information. After this first meeting, the group began to meet on a regular basis with the continuing assistance of Moulder. The first meeting had generated tremendous interest about the procedures and the requirements of the grant, and particularly about solar energy in the home. "But there were still many shaky areas. We knew, however, that we had many things to decide, and that we were going to have to proceed quickly if we were to meet a March 29th deadline." Notes Puller, "Moulder came to our rescue this time, taking the group on a trip to inspect his solar home. At this point, I believe, we became more convinced about the feasibility of our idea."

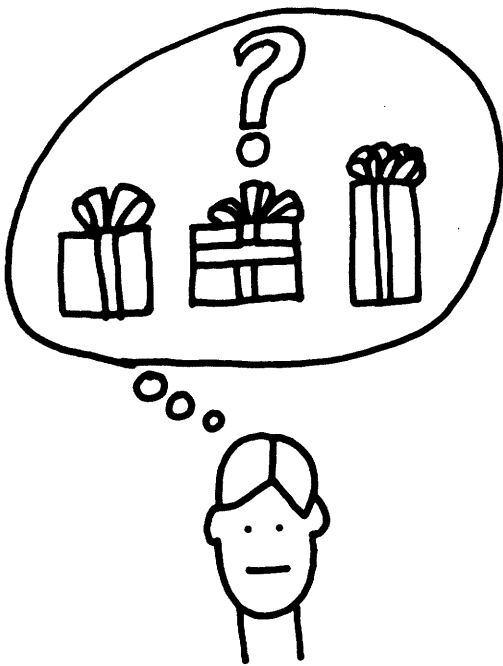


In addition to Moulder, the group was assisted at these early meetings by persons from Ball State University, who advised them on technical matters, as well as by Lee Kennedy. On a recommendation by Moulder, Kennedy had been contacted by the committee (one trusted source vouching for another). He, too, began to advise the group on the technical aspects of solar, and like Moulder began to help mediate and make solar understandable.



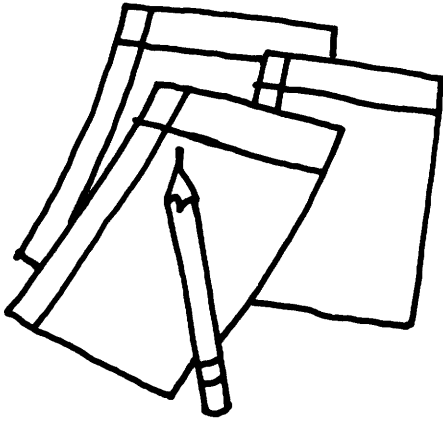
One of the earliest decisions to be made by the group concerned the design of the house. Each builder was asked to bring in a plan suitable for the project house. After some initial difficulties in agreeing upon a common design, a plan was selected. At this point, Al Vandermeer, Director of Sales and Marketing of

Davidson Industries (a large manufacturer/distributor of building components), was contracted to make the house "energy efficient," and to draw up blueprints and specifications. As an associate member of the HBAI, Davidson was selected, says Vandermeer, "most likely because of the firm's reputation as innovators and because of our previous experience with Moulder." Davidson Industries had little experience with solar at the time, but importantly, they had been involved with the Moulder house. (Again, one trusted source confirms another.)



Another major decision made by the group, executed concurrently with the house design, was the choice of a solar unit. This matter proved to be far more difficult because of the group's lack of experience. Remarks Puller, "The group had learned something from Moulder, Kennedy, and the professors from Ball State; they at least knew how the system was supposed to work and what they were supposed to look for. But when it came down actually to choosing a system, they didn't know what to do...so, when one day they heard presentations from three solar equipment manufacturer/distributors, Westinghouse, Solaran and Hedback, they didn't know who to go with." Says Puller, "Westinghouse had the best presentation... but because of our uncertainty, we pretty much had to go with our gut reactions here." So they chose Hedback. "First, Hedback was local firm, with a local reputation, and would be around when we needed them. But more importantly," notes Puller, "Hedback (i.e. Kennedy) had previous experience with Moulder and the SHAC Program." In short, because of this experience (as well as Kennedy's previous activities in advising

the group) there was a trust established; he was at this point a familiar and respected figure who, they knew, they could look toward for further assistance if and when it was needed. Moreover, Kennedy's solar unit (Romaine) could be trusted, not only because it was recommended by Kennedy, but because it was then working effectively in the Moulder home, something the group had seen personally.



Shortly after his firm's selection, Kennedy was to provide much additional assistance to the group by hosting a series of seminars for the builders and their respective heating and cooling contractors on the installation of the units. Although each builder was to use the same solar system, each was to use his own heating and cooling contractor, none of whom had any previous experience with solar. Thus, Kennedy's instructions were very important.

With these decisions reached, the group spent the remainder of the time compiling the necessary information and preparing the application. Here too, the supporting roles are notable. Bob Weiss (of the HBAI), for example, contacted government agencies and elected officials for support letters, assisted with news coverage, and helped keep everyone abreast of what everyone else was doing. Lee Kennedy prepared the technical areas in the application, as he had done for Moulder. Puller and his staff (notably Patricia Shure, Puller's assistant at the time) served as overall coordinators and packagers. Because, as his colleagues note, he specializes in paperwork (and especially paperwork of the sort required by HUD), Puller was instrumental at this stage, holding group

seminars to give the builders explicit instructions for preparing the application. He later reviewed, reworked, and substantially rewrote a large part of the applications so they would conform to HUD standards.

Thus concluded the planning stage for Project Solar. The good news of the grant awards came in late May, and by early summer work on the houses had begun. Here again, in the construction phase, we find that the support provided by Kennedy was critical. The individual heating and cooling contractors had been given prior instructions by Kennedy; and although there were no major difficulties, there was obviously still a good deal of uncertainty. The heating and cooling contractors did not know whether or not they were installing the systems properly and the builders couldn't help them. "So," notes Bob Weiss, "as one would expect, there were constant calls to Lee Kennedy, who, in his typically cooperative manner, provided ongoing assistance. One might even go so far as to say that Kennedy supervised the jobs, even if only informally."



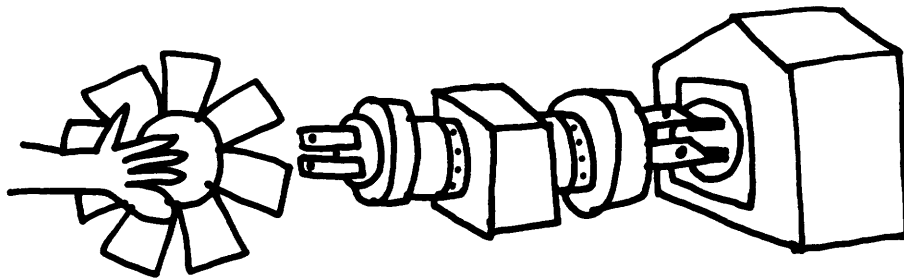
By the fall of 1977, all houses were nearly (if not completely) operational and the builders were preparing them for marketing. As they had hoped, the solar component proved quite an attraction for most. Hoosiers may be conservative about and even skeptical of solar, as one builder noted, but they are curious nevertheless, and at least a few were interested in buying. Says Steinkamp, the first builder to have completed his home, "I could have sold it twice before actually doing so. I kept it as a drawing card for a while." None of the

builders had any difficulty selling their homes. (In fact, as we noted earlier, two of the seven are holding their homes by choice, for publicity and related reasons). The second original objective of the builders, the desire to learn about solar, appears to have been satisfied as well.

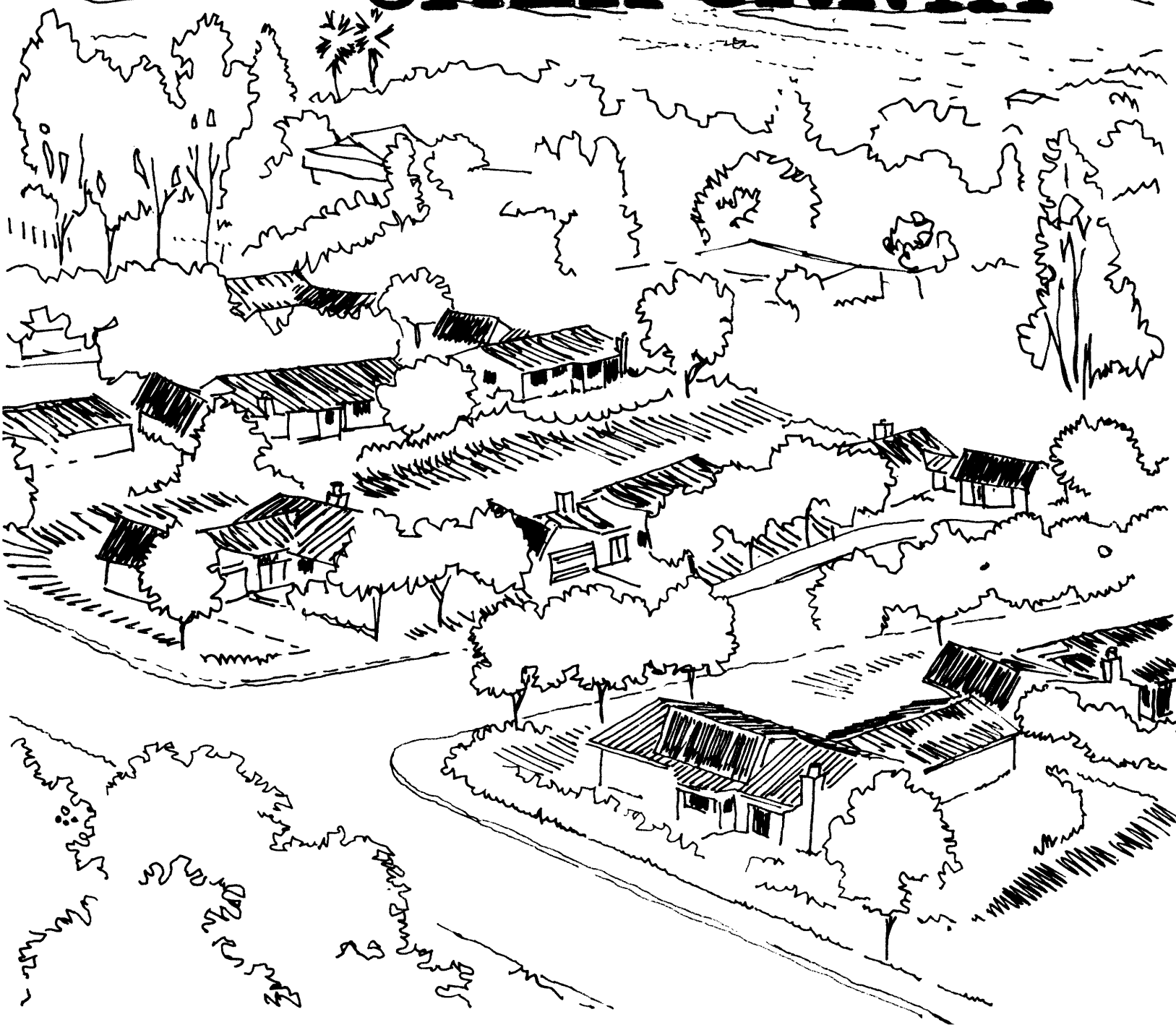
SUMMARY

Project Solar for Indiana illustrates the importance of supportive institutional networks to innovation acceptance in housing. In the first two cycles of the HUD Solar Heating and Cooling Demonstration Program, only one grant was given in Indiana, to a builder whom we have characterized as a "plunger." In the third cycle, seven builders were involved, encouraged by the interest and attention given the program by the Homebuilders' Association of Indiana. The HBAI's sponsorship was the critical mediating institutional force, legitimating the use of this building innovation as well as involvement in federal programs. The HBAI's sponsorship not only prompted the involvement of the seven builders, but also was the force which marshalled the resources of the supporting institutional network, including Moulder (the "plunger"), Kennedy (the translator), and Puller (the linking pin). As Bob Weiss of the HBAI says, "Without the HBAI's formal sponsorship, without Puller's supervision and packaging of the application, and without Moulder's and Kennedy's assistance in technical matters, there would have been no Project Solar for Indiana." What made it thinkable was that it was an HBAI activity, organized and run in a manner consistent

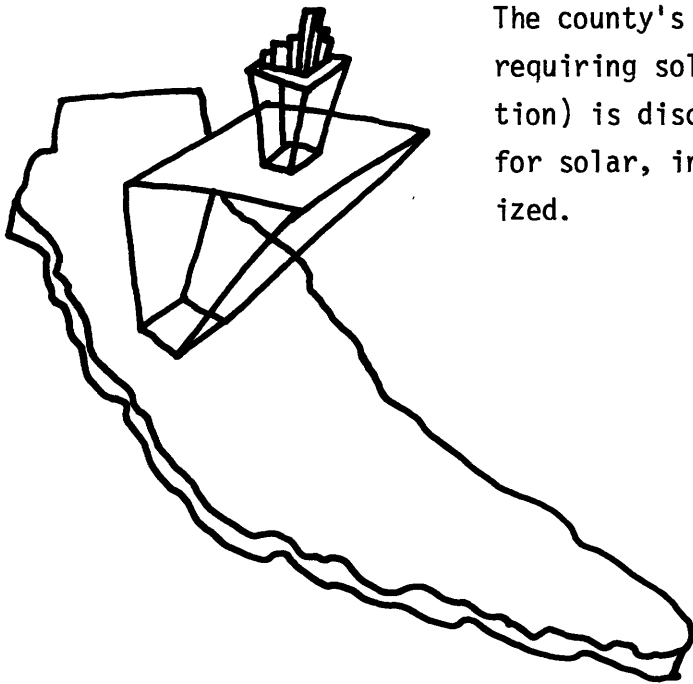
with other association projects. What made it understandable for the individual builders was the evidence of a colleague (Moulder) who could show that it worked and was profitable; and the interpretation of the innovation by an expert (Kennedy) in the technical area in which he was trusted. What made it happen in relation to bureaucratic complexity was the coordination of an expert (Puller), who acted in a manner consistent with other dealings the builders would have with him. Thus, what was otherwise complicated, mysterious, and confusing became an activity which was in many respects routine. The only new aspect was the solar; the rest was "business as usual." In short, the supporting institutional network was what made solar acceptable and accepted in Indiana.



SOLAR IN CALIFORNIA



California is generally regarded as the state most active in experimenting with forms of solar energy. Vigorous efforts at various levels of government have fostered a climate that supports switching to alternative energy sources. This case study illustrates how efforts at three levels of government -- municipal, county, and state -- can influence the acceptance of solar energy in the residential sector. Santa Clara, a city in the San Francisco Bay area with a municipally-owned electric utility, is the setting for the study on the local level. The city has a number of solar applications in public buildings, has a solar utility encouraging solar heating of swimming pools, and has supported a major northern California developer in testing solar home heating as part of the HUD residential demonstration program. San Diego is the setting for the county study. One development is reviewed with attention to the approach of the design firm involved. The county's support for solar (through an ordinance requiring solar hot water heating in new home construction) is discussed. Finally, various state supports for solar, including the solar tax credit, are summarized.



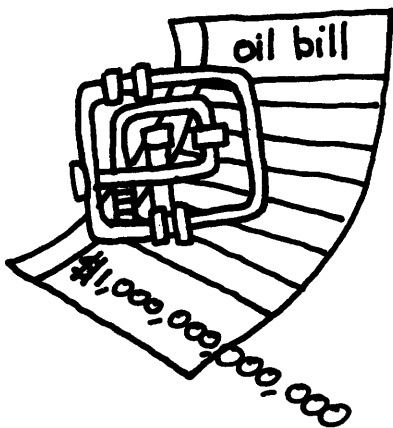
THE SANTA CLARA MUNICIPAL SOLAR UTILITY

THE SETTING

Santa Clara, California, is a largely suburban city of 93,000, located next to San Jose. Containing 18.8 square miles, the city has grown tremendously since the 1950's. (Its population was 83,000 in 1972.) It is expected that the city will be fully developed by 1984.

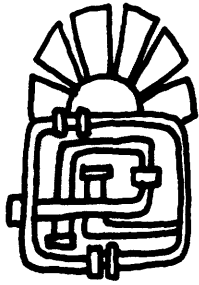
Santa Clara has a council/city manager form of government; the manager reports to the city council. It operates a municipal electric company, buying wholesale and supplying electricity within its borders. Natural gas is supplied by Pacific Gas and Electric Co., an investor-owned utility.

CITY MANAGER AS PLUNGER



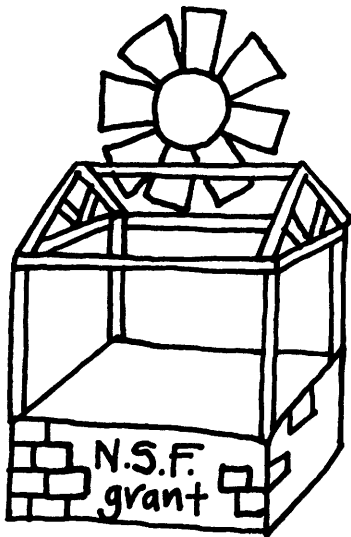
Donald Von Raesfeld has been city manager of Santa Clara since 1962, and has been working for the city since 1957. He has a degree in mechanical engineering and is a registered civil engineer. Von Raesfeld is an active participant in the American Public Power Association, representing the city and its electric utility.

At the time of the 1973 oil crisis, municipal electric utilities across the country were being hurt by the huge oil price increases. The crisis catalyzed Von Raesfeld's thinking:

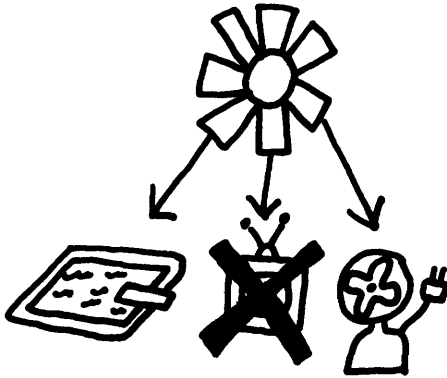


"I was uncomfortable with us being so dependent on the oil market, so I thought it would be a good idea to look at renewable resources. Solar energy seemed like a good choice. I thought Santa Clara could pioneer the concept of a municipal solar utility. I believed we had the capability and the expertise to do it and I wanted to show other cities it could be done."

Von Raesfeld's first effort (in 1973) was to try to interest the federal government in paying for a solar heating and cooling unit for a recreation center the city was about to build. With the assistance of Bob Mortenson, the city's Director of Water and Sewer Utilities, and Lockheed Palo Alto Research Laboratory, he applied for and received over a half million dollars from the National Science Foundation (NSF) for this purpose. The city's intention, as stated in the application, was to use the recreation center experience to establish a solar utility. Once the grant was received (in November of 1974), Bob Mortenson was given the responsibility for seeing that it was implemented.



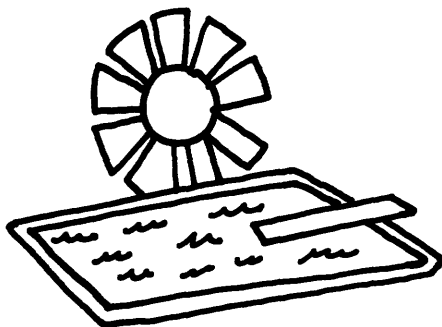
Bob Mortenson, a registered civil engineer, has been head of the Water and Sewer Utilities Department for fifteen years. He says that responsibility for the solar utility was given to his unit, rather than the electric utility department, for two reasons. First, solar energy involved mechanical-type plumbing similar to the type of work his staff does. Second, because more municipalities have water utilities than have electric utilities, placing Santa Clara's solar utility in the water department would increase the size of the pool that might adopt a similar solar utility program, based on Santa Clara's experience.



When the NSF gave Santa Clara the grant, it instructed the city to hire a Science Advisor. Ten other cities in California had NSF-funded science advisors, whose purpose was to aid their client cities in implementing innovative technological concepts. Santa Clara was the only California city with an NSF-funded solar grant; the function of the science advisor would be to help with the recreation center project and explore other applications of solar energy by the city. In April of 1975, Santa Clara hired Nick Davis as their advisor. Davis was a mechanical engineer by training, and a recent graduate of the Stanford University School of Business. He had never before worked with solar; for the three years preceding, he had marketed air pollution test equipment.

Ground was broken for the center in April, 1974. The building was completed in 1975; the solar heating and cooling unit was completed in March, 1977.

THE SOLAR UTILITY GETS UNDERWAY



Once the recreation center grant was received, Von Raesfeld and Mortenson decided to go ahead with establishing a solar utility on a larger scale. Mortenson and Davis developed ideas for selling solar energy to city residents.

In the summer of 1975, they brought the city into the business of heating swimming pools with solar energy. The concept was that the city would own and install the units, charging customers an installation fee and a monthly rental fee (April through September). The first unit was installed in March 1976. Presently,

the city has over 100 customers and the program is self-supporting.

HUD CYCLE 1 - A NEW VENTURE FOR THE SOLAR UTILITY AND A HOME BUILDER



Very shortly after planning for the swimming pool program began in the summer of 1975, the existence of the HUD solar heating demonstration project was brought to the attention of Mortenson and Davis. The idea of owning and renting solar heating units for homes looked like another feasible venture for the nascent solar utility.

Nick Davis went looking for a housing developer to work with the city on the project.

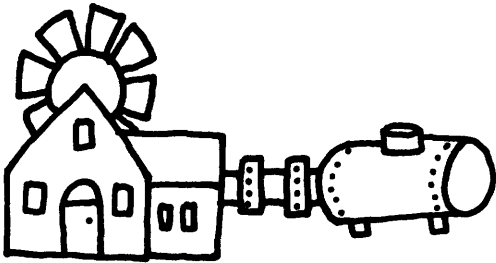
"I walked down the hall to the Planning Department to find out who was developing R-1 parcels in the city. It turned out there were only two undeveloped R-1 parcels left in the city, each with a different developer. I approached both about joining the project. Ditz-Crane said yes, the other said no."

Ditz-Crane is a residential development and construction firm founded in 1954 -- and based in Santa Clara. The company builds mostly single-family homes, although it has constructed multi-unit buildings. It averaged 600-650 homes/year from 1975-78; all homes are built on a speculative basis. The firm does most of its own

construction work, excluding plumbing and electrical installations.

Bob Crane, Ditz-Crane's president, has been with the company since its founding. Prior to the time Nick Davis approached him, he had been looking into solar on his own:

"I had done things like going to look at the Hemet house (a prototype solar home). I was going to do something with solar anyway, so I was happy the city came to me. I could learn about solar without paying for anything, and the city would take care of the problems."

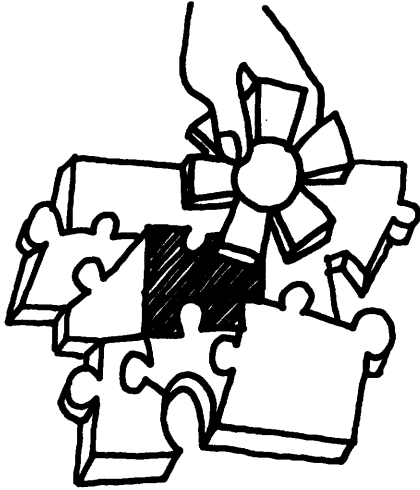


Crane, Mortenson, and Davis agreed that the project would involve five homes (2 one-story, 3 two-story) in Crane's Laurel Park East development. The homes would have gas backups and would not be significantly modified to accommodate the solar units. The city would provide expertise for solarfitting the homes. The city also agreed to handle the HUD-related paperwork and all post-construction problems with the solar systems.

CONSTRUCTION

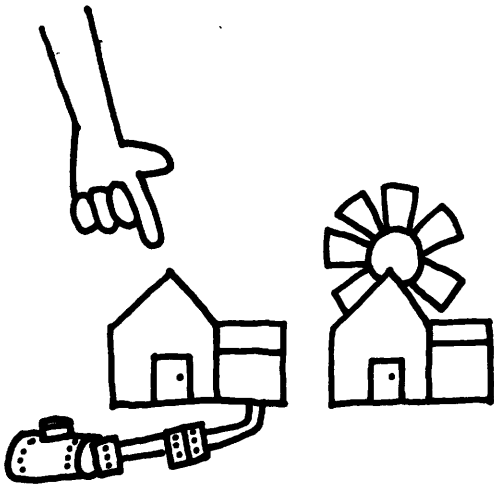
HUD approved the application in December 1975, awarding the city \$40,000. Construction began in March 1976.

All problems associated with the solar installation were handled by Mortenson's staff, as the local distributor of the equipment had dropped the solar portion of



his business and the manufacturer was providing only nominal on-site backup and installation information. (The manufacturer subsequently relocated from northern California to Texas.) The biggest difficulty was interfacing the solar system with the conventional heating system, an activity with which Mortenson's staff was unfamiliar.

One of Nick Davis' jobs was to handle public relations for the various solar utility projects. For a long period, the local newspapers gave good coverage to the recreation center, swimming pool, and solar home projects. The city was unanimously praised for its solar projects. At the time, there was a shortage of single-family homes for sale in the area. So as part of his public relations function, Davis set up a public lottery for the five solar homes, arranged to have the reigning "Miss Santa Clara" pick the winners, and invited the local press. The lottery was given wide coverage, and the city benefited from good press notices. This occurred in July, 1976; the homes were completed one month later.



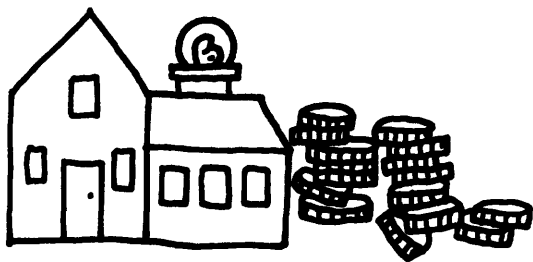
It is interesting to note that both Mortenson and Crane agree that the people buying the solar homes were simply interested in buying a home -- they either did not care about the solar system, or actually preferred a non-solar home but could not get one. Crane notes that the buyers were not convinced the system would actually work.

POST-CONSTRUCTION PROBLEMS



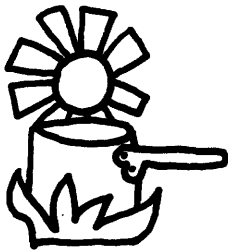
As it turned out, the buyer's fears were partly justified. Mechanical problems with the solar units appeared immediately after occupation (November 1976) and continue to the present, although most of them have been solved. Problems included undersized heat exchangers (replaced two or three times), wrong type of pump, stuck relays, and oversized storage tanks. Davis notes that problem-solving in the construction and post-construction phase was done "flying by the seat of our pants." Ironically, after the homes were built, he had many people calling on him as an expert. "Shows you what the state-of-the-art was then," he says.

AFTERMATH

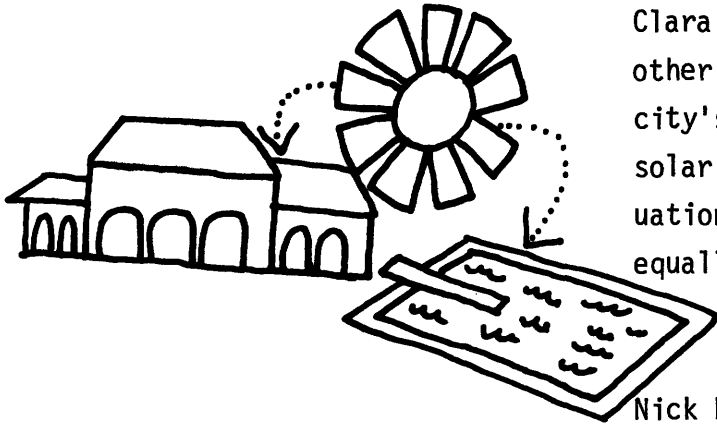


The city has been losing money on the five solar homes since their occupancy. The five homeowners have a contract with the city whereby they pay a monthly fee which equals the monthly bill they would have to pay if they did not have solar heating -- identical homes in the development are monitored to determine the monthly fee. Bob Mortenson says the average monthly fee is \$13-17/month, whereas the real cost to the city is \$85/month. Also as there is no charge for servicing, customers are not reluctant to call. Because the solar home

heating business has not been economically viable, Mortenson has no plans to expand this aspect of the solar utility beyond the five homes. He adds, "We also haven't found a system we want to put our name behind."



The economic failure of the solar home heating business by no means indicates the city has stopped pursuing solar energy projects. It is familiar with energy and with its role as an energy supplier, and has simply decided that solar home heating was a wrong direction for the solar utility to take. As mentioned earlier, the swimming pool business, with over 100 customers, is self-supporting. Mortenson figures there are another 300 potential swimming pool customers. One reason for the success of the swimming pool project (and also the failure of the home heating project) is the "lifeline" rate structure for gas supplied by PG & E. The base or "lifeline" rate (the rate for gas used in home heating) is very low; as a customer uses more gas, the rates increase steeply. Consequently, the rates for heating swimming pools are very high, so the cost of solar energy is competitive. On the other hand, the real cost of solar heating homes is much higher than the "lifeline" gas rate, and neither the city nor customers are willing to absorb the difference.



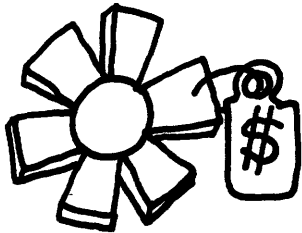
The city also is solar heating two city-owned swimming pools, one of which is the International Swim Center, site of the 1982 world championships. The swim center is next to the recreation center; Nick Davis, who designed the solar system for the swim center, calls the complex "solar Disneyland." He affirms that Santa Clara has done more work with solar energy than any other city in the country. Mortenson notes that the city's politicians get good mileage out of the city's solar business, and enthusiastically support the continuation of solar projects. He says the public is equally pleased with the city's involvement.

Nick Davis built up his own solar and energy conservation consulting firm after he began to work part-time for Santa Clara in September 1976. He left the employ of the city in December 1977 to work at his firm full-time, which does regional energy planning and analyzes buildings for solar heating/energy conservation purposes. He gives a large amount of credit to the HUD Cycle 1 project for providing him his first experience with residential energy conservation; he thinks that this experience was essential in helping him start his own business.

Bob Crane has been involved in several solar home projects during and since the one in Santa Clara. At about the same time that he was working in Santa Clara, he built a solar home in San Jose in partnership with PG & E. Again, he wanted to learn something about solar energy. For the next several years, he says, he read all the

information on solar he could find, wanting to make solar a routine part of his business. In 1977, he built two solar homes with hydronic systems in Sunnyvale. He had seen that the Santa Clara solar systems were not cost-effective, so he wanted to try another system; however the Sunnyvale homes did not prove cost-effective either. Finally, in a Sacramento development, he offered solar hot water heating as an option on 120 homes. No one bought the system. Crane thinks people were not convinced the system would work or be cost-effective.

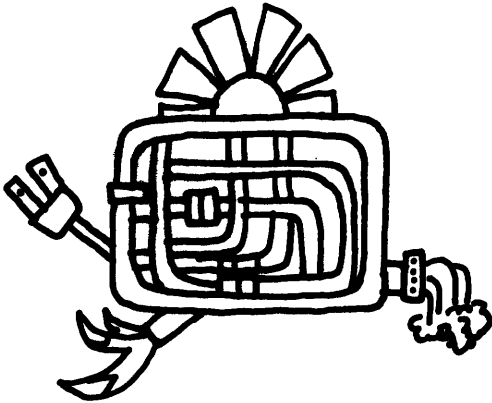
Based on his experiences, Crane has no further plans to build more solar homes or routinely to offer solar options:



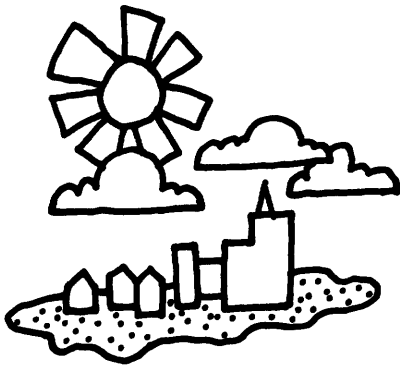
"People in this area are not willing to spend anything on solar. They don't believe it'll be cost-effective, and, finally, I can't find any savings in any of the homes I've monitored so far. When I was offering solar homes, I would never quote payback figures or say they saved money -- I couldn't prove it and I don't want to be sued for false claims. As I see it, solar technology is in its infancy and I don't see much improvement."

Crane also points out how the climate in his area is not conducive for use of active solar systems: "The weather in northern California is not good for these solar units. It doesn't get cold much, and when it does get cold the sun doesn't shine."

SUMMARY AND ANALYSIS



Von Raesfeld's vision was to have a multi-faceted municipal solar utility. Consequently, the HUD project was just one aspect of a larger program; solar home heating could be dropped without destroying the structure of the solar utility. The project, coming as it did early in the solar utility program, was useful in providing information and experience to Mortenson, Davis, and their co-workers. It convinced them that they did not want to routinize solar home heating, and helped them in the routinization of the swimming pool business and in setting up a structure to routinize solar hot water heating. The fact that the utility is municipally-owned is further incentive to find energy solutions in the public's interest, and to take risks that investor-owned utilities might not.



It is clear that both the economic and physical environment in which an innovation is utilized have an impact on its acceptance. The northern California climate seems less conducive to active solar systems than other areas of the state. It is very important to note, though, that solar home heating also was not cost-effective because it could not compete with the extremely low "lifeline" gas rates. On the other hand, solar heating of swimming pools could compete with gas heating and so was successful.

Finally, it appears that the HUD project was helpful in giving Davis and Crane the knowledge, experience and motivation to pursue solar energy activities once the project was completed. Crane has stopped because of the environmental factors noted above, but he appears ready to become involved again if the economics of the situation make it worthwhile.

Santa Clara - Chronology

1973

Donald Von Raesfeld, City Manager of Santa Clara, develops the concept of a municipal solar utility. He applies for a National Science Foundation grant to solar heat and cool a city recreation center then being built.

1974

November

NSF allocates grants over \$1/2 million for the proposal. Von Raesfeld asks Bob Mortenson to oversee the project.

1975

April

Nick Davis is hired as Science Advisor on solar activities to Santa Clara.

Summer

Mortenson and Davis begin planning for solar heating of private swimming pools. They also decide to apply for a HUD Cycle 1 grant. Ditz-Crane is hired as the builder, and American Solar King as the solar supplier.

September

Applications are submitted for five homes.

December

\$40,000 grant is approved by HUD.

1976

March

Construction begins on the five solar homes.

July

Lottery is held to select buyers.

August

Homes are completed.

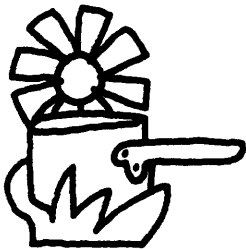
November

First home is occupied.

SAN DIEGO COUNTY AND THE ORTIZ-BROWN SOLAR HOUSES

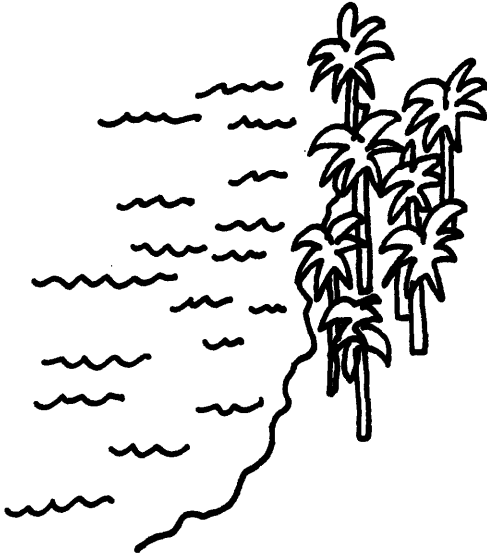
While the City of Santa Clara was directly involved in providing energy, the County of San Diego has adopted a more typical public strategy, the regulatory ordinance. This portion of the case looks at the impact this regulatory approach has had on the county. It examines specifically a solar development built with grant assistance from HUD in Escondido, San Diego County by Ortiz and Reill, Developers, a joint venture of Solar Architecture, Inc., (Alfonso Ortiz, President), and Reill Homes, Inc.

THE SOLAR ORDINANCE

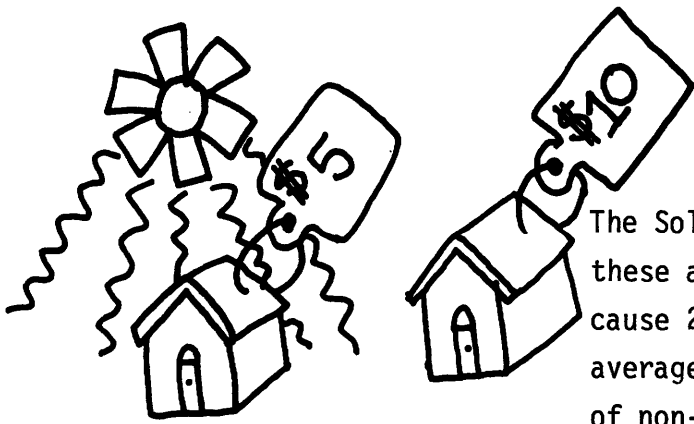


San Diego County Board of Supervisors unanimously enacted the Solar Hot Water Ordinance. This ordinance requires solar hot water heating in all new homes in the all-electric areas of San Diego County after October 1, 1979, and in natural gas areas after October 1, 1980.

Roger Hedgecock, 1979 Vice Chairman of the San Diego County Board of Supervisors, talks of the ordinance in terms much broader than the alternative energy "buzz words". To Hedgecock's thinking, San Diego County has many natural advantages, a number of which could be destroyed by a rush to solve energy crises through solutions such as nuclear power or off-shore drilling. For this reason, thinks Hedgecock, a lot of people are prepared to go the "soft" energy path.

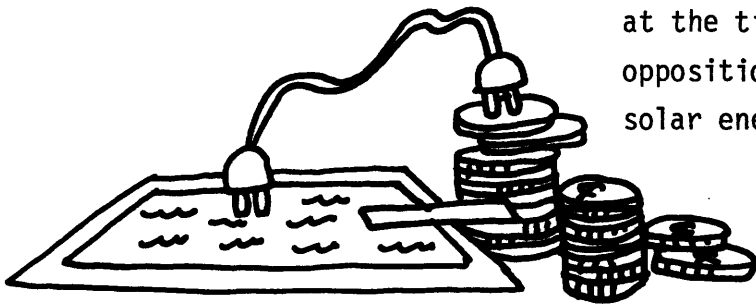


The move away from electricity in particular is part of this attitude. There is an anti-nuclear attitude in the county which is shared by most, if not all, of the members of the Board of Supervisors. There is also a concern about other negative aspects of conventional fossil fuel. There is a well organized opposition to the granting of off-shore drilling leases because of the effect oil spills could have on the magnificent coastline of the region, and the consequent effect it would have on the tourist industry.

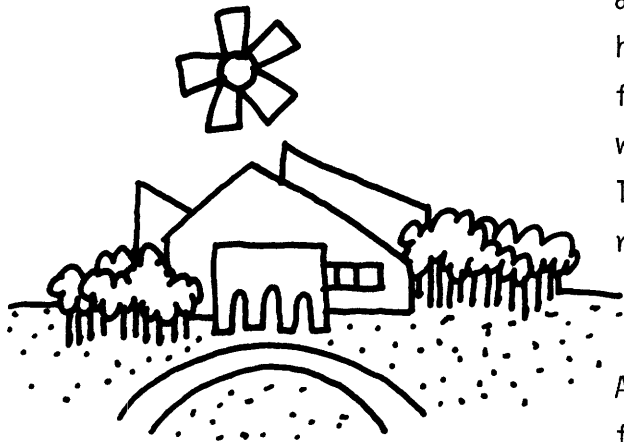


The Solar Hot Water Ordinance was an outgrowth of these attitudes. In a climate where hot water needs cause 20 to 30% of the energy consumption in the average house, it will mean considerable conservation of non-replenishable resources. At the moment, taking the state tax credit into account, the installation of hot water systems will mean a reduction in the out-of-pocket expenses of the home buyer at the time of purchase, rather than over a life-cycle basis.

The move to mandated solar hot water heating was substantially facilitated by San Diego's gas and electric rate structure. After a base of "lifeline" rate, one pays more per unit the more one uses. Thus, electric heating of swimming pools is financially prohibitive. Mandating the use of solar pool heaters by the county government will encounter only a philosophical opposition to government intervention (of the kind that surfaced at the time of the original ordinance), and not an opposition based on the economic effectiveness of solar energy.

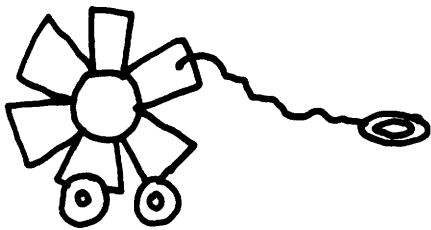


A BANK OFFICIAL'S VIEWS



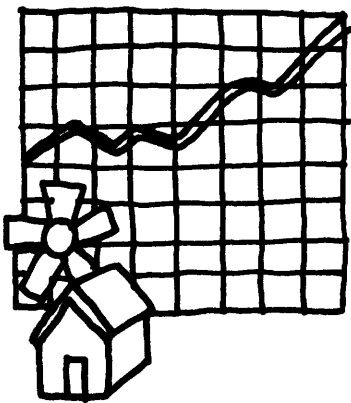
This positive view on solar energy has influenced the financial institutions in California. Bob Anderson, an official at the Bank of America in Escondido, illustrates the impact. He has been the bank's contact with a number of developers in the area, is enthusiastic about solar energy, and has a solar hot water system in his home. He feels that the savings which are available from solar energy, both now and in the future, together with the resale value of solar systems, make the life-cycle cost of solar systems attractive, even over relatively short terms.

Although he has been aware of solar energy for over four years, he was first introduced to it (in his capacity of bank official) about two years ago. His initial awareness was the result of articles in newspapers and magazines; but he was not asked to finance any solar systems until Ortiz and Reill approached him without support from HUD. At present, about 25-50% of the people who apply for loans for custom homes have solar systems in the original application (usually solar hot water systems). About half of these proceed with the idea.



To many, the solar alternative is a discretionary purchase - a new toy - which they often give up in favor of a chandelier or a countertop stove. But this will change, Anderson believes, not only because of the hot water ordinance, which applies to all electric areas of San Diego County including Escondido, but also

because the cost of electricity for heating will reach such levels soon that it will be obviously less expensive to "go solar."

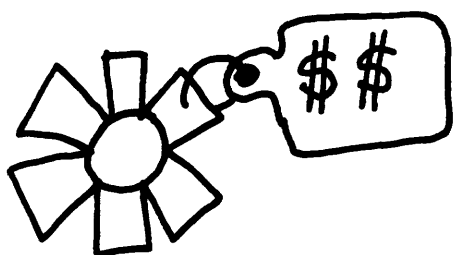


When the first applications came in, solar space heating systems were not included in the appraisal, because there had to be a complete electrical system as a backup. However, as soon as it became apparent that these sort of systems were becoming accepted, small systems simply "went through" without evaluation. However, a number of them demonstrated problems with the installation (usually the integration of components that had been acceptable in themselves), and it was obvious that the bank officials who evaluated the marketability of homes did not have the qualifications to evaluate the practicality of solar systems. The bank's head office, therefore, introduced the practice of having an external group (Berkeley Solar Group) evaluate the expected performance of the system, at the applicant's expense.

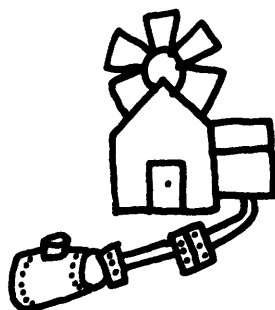
The support of public authorities, like the state and local government (both San Diego County and Escondido), helped the bank accept the idea of solar heating quite readily. This was the case even before formal measures like the county ordinance were being considered.

Originally, solar systems for domestic hot water and pools were the only systems that the bank considered in the lending process, but the success of these systems "rubbed off" onto space heating systems.

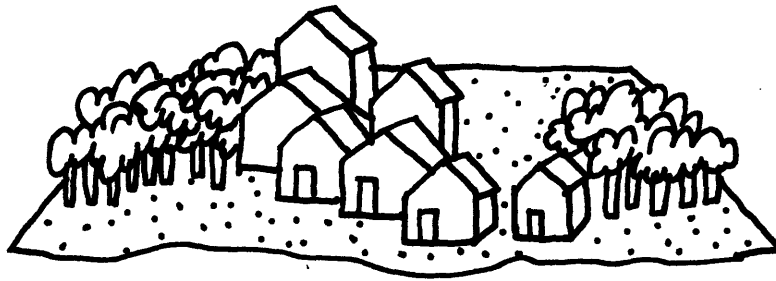
Anderson sees this process reflected in the way in which the population in general has accepted the concept.



To Anderson, there are two barriers to the acceptance of solar space heating systems. First, there is a continuing lack of information, exhibited in the widely held belief that such systems are too expensive. In part, this is due to the lack of awareness of life-cycle costs, and is also due to the fact that even when people are aware of their low utility costs when solar is included in the original application, they do not offset this against the increased initial cost of the house. To some extent, these are simply two aspects of the same problem, but solar (in terms of initial cost) is an "add on" expense, because the same sort of electrical system (or oil, or gas) is needed as a backup as would be installed if the house were non-solar. Perhaps this will be overcome by the inevitable increases in the cost of electricity, and the backup treated as an expensive "add on" to the solar system.



The second barrier seen by Anderson is that potential investors in solar space heating are negatively affected by the bad news of systems' breakdown, while the news of the many systems that do work is rarely brought to their attention. This can only be overcome by minimizing the number of failures, but even one breakdown - particularly if it is catastrophic, causing damage to the house rather than simply not providing enough heat until it is corrected - can offset the success of ten other systems.

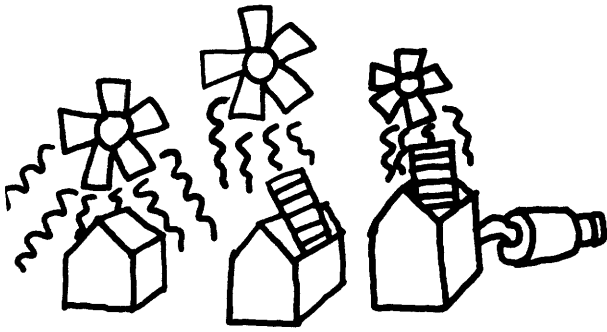


SOLAR DEVELOPMENT ACCEPTANCE IN ESCONDIDO AND SAN DIEGO COUNTY

Ortiz and Brown (formerly Ortiz and Reill) is an architectural firm in Escondido, a town of 25,000 located in San Diego County, about 40 miles northeast of San Diego. The firm has completed a 12-unit development, Patterson Estates, with a grant from HUD's Cycle 3. Patterson Estates is a good example of solar development acceptance in San Diego County, an acceptance accelerated by various public actions at the county level. Ortiz's firm itself provides an interesting illustration of how the designer/developer becomes involved in innovation in the housing industry.

ORTIZ AS DESIGNER/DEVELOPER, AS PLUNGER

The HUD-funded Patterson Estates development does not mark the beginning of Ortiz's interest in and involvement with solar. Ortiz has been involved in

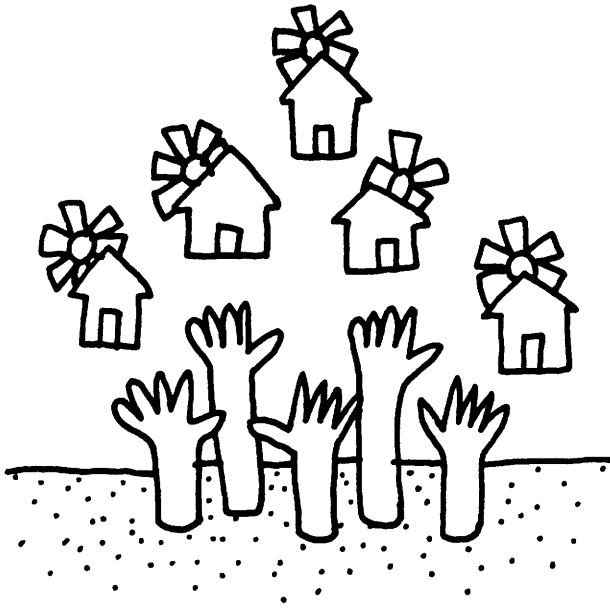


the marketing of solar homes for so long that his experience is well beyond that of the one unit solar architect. Because of his experience, he has been able to generalize about the market. His firm is basically two operations. Solar Architecture Associates is a design office, involved in the design of houses using passive, active, and hybrid applications of solar energy, with attention to conservation features as well. The other branch of the firm, Solar Architecture, Inc., deals with development and contracting. Thus, Ortiz is in a particularly good position to talk about the market, for he has within his firm a group of people who deal with all aspects of solar energy, from theory to design to development to sales.



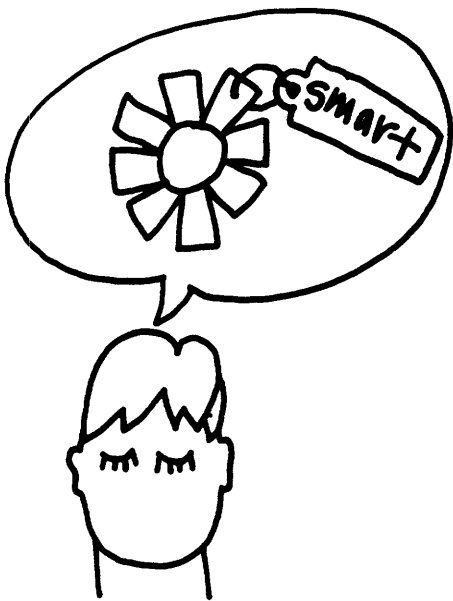
Ortiz and his designers, including his "solar advisor" George Mobus, have succeeded in producing a set of homes which differ from the standard California house only in that they have solar collectors. He has allowed the market to dictate constraints to his designers. Where the collectors could not be mounted on the steep garage roof, the shallow "bungalow" slope (which the home buyer in this area is used to) has remained, and supports the steeper sloping collector. A steep roof is not a California tradition, and imposing the constraint of the collector slope onto the form of the building, while an 'ideal' solution to some, would not have been acceptable to his market.

The impact of solar energy on house form has manifested itself only in the addition of flat plate collectors to houses. The design process has been used in such



a way as to conceal the impact of changes necessary to satisfy solar or other energy interests. In fact, the Southern California housing market is particularly receptive to the solar alternative. The support of state and county governments has heightened public consciousness of the need for an alternative to oil, gas, and electricity, and the positive attitude of local financial institutions has reinforced this.

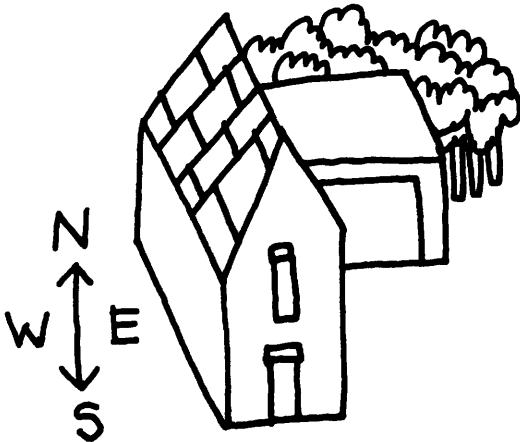
Ortiz sees his market as broken into three groups, on the basis of both age and income. The first group is financially secure, in the 35-45 year age bracket. The members of this group tend to regard solar energy as "innovative" or "smart." Ortiz's banker, Anderson, supports this opinion when he says that many of these people decide for or against a solar heating system by "trading off" against other discretionary items, as was mentioned previously. They buy the house because it is designed for them, or because the development is aimed at this sort of person. In both cases, however, solar is chosen, or accepted, because it is one of the "things to do."



A second group, in the same age bracket, is less well off financially. This group exhibits what Ortiz calls "a sensitive concern" about many of the implications of a possible energy shortage and "goes with solar" to minimize some of its potential effects.

The third group is composed of younger people about to enter the market, but who are often prevented from

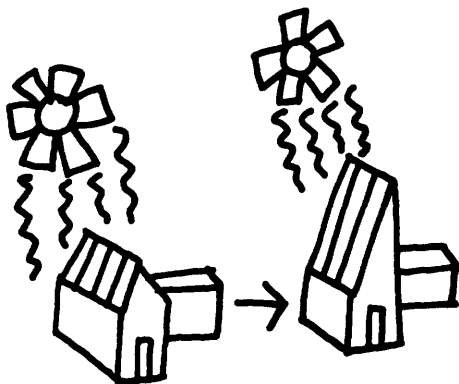
purchase because of the average cost of a home in the area (\$80,000 to \$90,000). They are aware of the problems which might attend an energy shortage, especially cost, and are considering all means to limit the impact. Passive design alternatives will appeal to these people, primarily because of cost-effectiveness, and secondarily because they are prepared to accept the more stringent design constraints on housing form, which in turn affect lifestyle.



Ortiz has been able to capitalize on years of interest in and experience with solar, and to move quickly into its marketing because of this background. He was graduated as an architect from the University of Mexico City, and relocated to Ensenada, about 60 miles south of Tijuana. He spent four years there working on low income housing, and came to the U.S. to continue in the same field. From 1970 to 1975, he worked with a firm involved in HUD's Operation Breakthrough on the industrialization of low income housing. After the oil embargo in 1973, he incorporated solar features into his work.

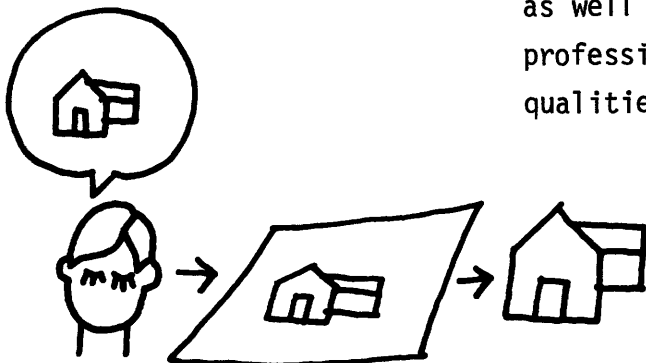
His involvement with solar has been far from superficial, for he has been involved in the theory as well as its actual application. His firm is a rare example of a group of people who stay close to the leading edge of technical innovations in solar, not simply waiting until they have been integrated by the profession and presented in the "glossies."

This sort of involvement is illustrated by the staffing of the firm, in particular by the employment of George

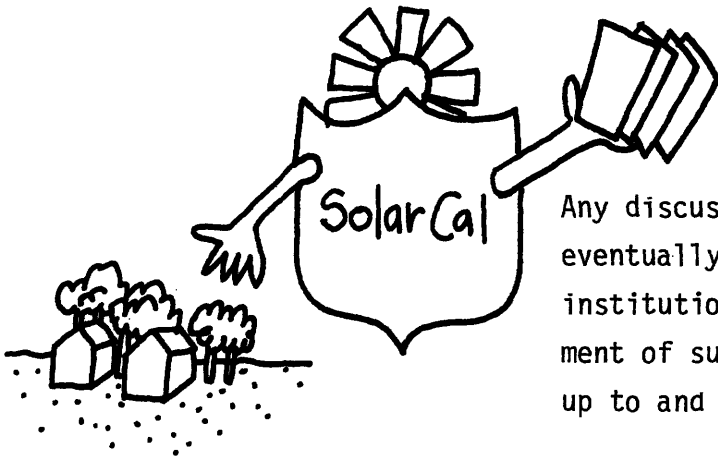


Mobus as "solar advisor." Mobus (an associate of the firm) is actually a zoologist, with substantial experience in solar architecture. He majored in physics and chemistry, and now works on theory and design with Ortiz, who is himself quite sophisticated about technological issues. Ortiz is unusual in his commitment to internal research; but to him, this commitment is consistent with his concept of good design. Limiting design to aesthetic manipulation is totally inconsistent with his idea of architecture. His experience with technological issues, implicit in his involvement with industrialized housing and, of course, with solar, reflects this. His involvement with George Mobus -- about which he has said, "The abrasion of contrasting disciplines multiplies the capabilities of any one contributor by unknown factors" -- is illustrative of the extent to which his firm is ahead of most in its ability to capitalize on, and contribute to, the context of support for solar in the county.

It also illustrates the difference between the architect-developer and other types of developers. His interest in, and commitment to, solar could not be sustained by the one-dimensional approach to the market by most developers. For an architect committed to real innovation, the only way for this innovation to be presented to the market is to plunge into development. It is a question of commitment and capability, as well as a question of the ability to redefine professional roles and Ortiz's firm exemplifies these qualities.



STATE SUPPORT FOR SOLAR ENERGY

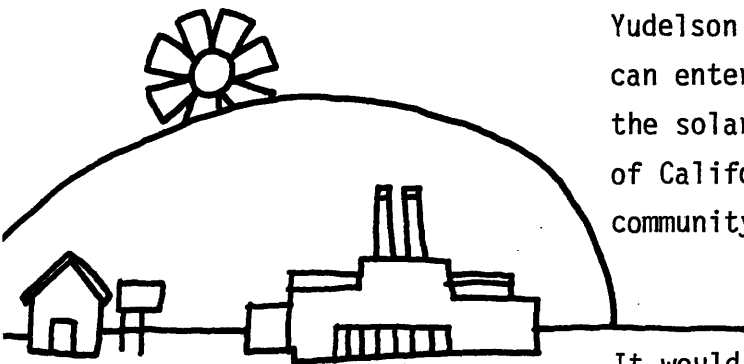


Any discussion of solar development in California eventually arrives at a consideration of state-wide institutional support for solar energy. The environment of support extends from the individual citizen up to and including the governor.

To coordinate support for solar energy, Governor Jerry Brown set up (in May of 1978) the SolarCal Office and Council, a body whose primary concern is the development of solar energy. The SolarCal Office attempts to facilitate successful commercialization of solar energy by using the power of the state government as "catalyst and coordinator."

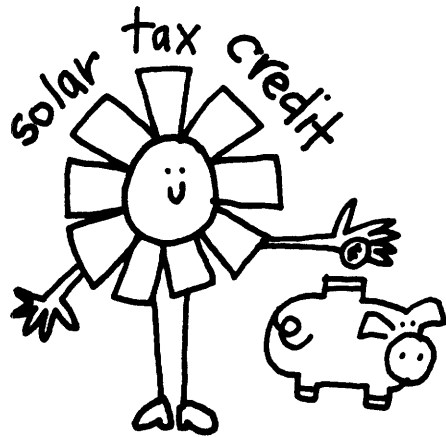
SolarCal Council, as an advisory body to the governor and the SolarCal office, is composed of representatives of local government, business, financial bodies, labor unions, low-income and consumer groups, and utilities. Directed by Jerry Yudelson, the SolarCal office has turned to its task with great vigor.

Yudelson says, "Because it is a field that many people can enter at varying levels of skills and experience, the solar industry promises to be a diverse, vital part of California's economy, embracing backyard tinkerers, community workshops, small and large companies alike."

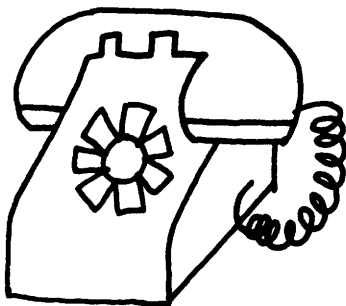


It would appear that part of the reason for the success of solar power in California, compared to other states, is the integration of the concept into the consciousness of the Californian. Solar power is not a new idea in California. Solar hot water heaters were first used

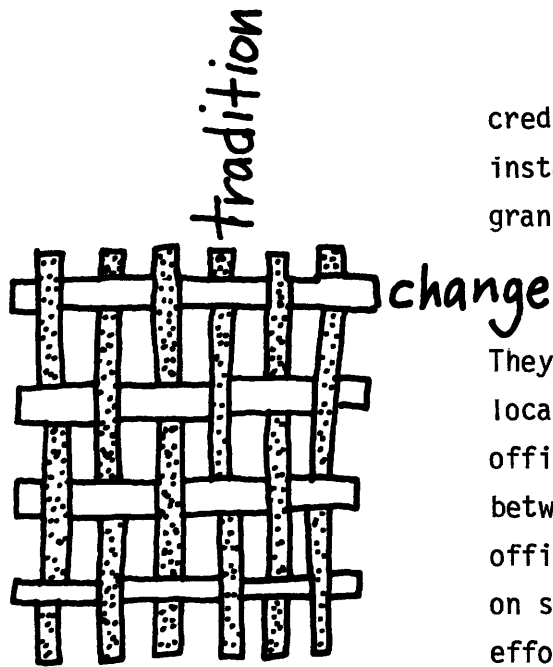
in California in Pasadena in 1895, and continued to sell well into the twenties when gas and oil were found in the Los Angeles area. In 1920, solar hot water systems were selling at a rate of 1000 a year, to a population which was considerably smaller than today's. There are now 30,000 solar installations in California. Of these, three thousand are for space heating, 17,000 are for swimming pool heat, and 10,000 are for domestic hot water.



In addition to the solar consciousness of the state, the active support of solar by Governor Brown, coupled with the backing of the legislative leadership, has been very important. Perhaps the best known example of state government support is the California Solar Tax Credit. When a solar system is installed in a single family home, the state allows a state income tax credit (deducted from tax, not from taxable income) of 55% of the system cost, up to a total credit of \$3,000. In other than a single family residence, if the cost is greater than \$6,000, the tax credit is 25% or \$3,000 per unit, whichever is greater. This tax credit covers passive and active solar, wind, photo-voltaics, industrial process heat, solar pumps, and solar ponds.



While this is the best known example of state support, the government has gone much further, and has not concentrated exclusively on assistance to the home buyer. The following are further examples of the involvement of the state government. There is a Solar "Hot Line" service for builders only. By calling SolarCal, builders can be given information on tax

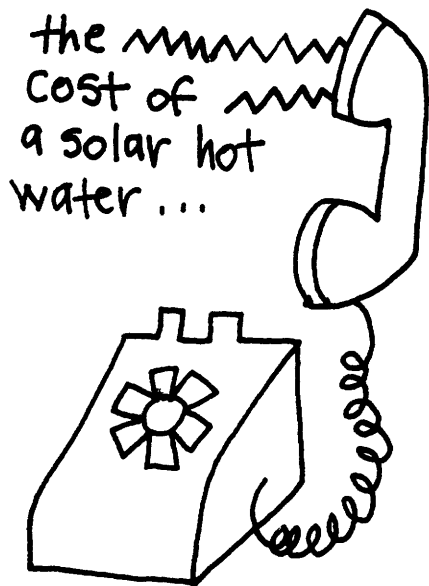


credit guidelines, certified equipment, qualified installers, technical assistance, and state and federal grant assistance.

They can also be helped in coordinating their work with local officials. The SolarCal Office approaches these officials in quite informal ways. The Office mediates between builders of solar developments and code enforcing officials by using an appropriate political "grease" on sticky official wheels. Though this mediation effort between developers and officials covers all builders and self-help organizations, SolarCal Office focuses primarily on the tract builder. The Office also supports the efforts of the California Housing Advisory Service, which focuses on the other groups. In this way, the promotion of the solar alternative is linked to the institutionalization of other innovations, in a way which interrelates change with traditional mechanisms; and change combining with tradition creates a matrix, which enable innovation to be carried into society by established processes.

The support for builders is carried further, to an even more ad hoc system, whereby solar developers are given priority in getting a government report which "describes" the building to the buyer, and which is necessary before a sale can be made. Solar developers simply go to the head of the line. Over the last six months of 1978, seventeen tracts with 900 solar units were begun with this help. SolarCal Office has also started an awards program for builders who use solar, to help them market their homes.





The "Hot Line" service goes even further and provides marketing studies and market data, publicizes housing developments with solar, carries out a continuing media campaign to promote residential solar use, and makes demonstration projects of new state buildings. Handled by the state's Department of Consumer Affairs, the consumer information solar "Hot Line" fits in with other state government services directed to consumers. They are provided with information on how to finance a solar energy system for their homes. This information tells them how much their system will cost, where they can get financing for retrofits and new homes, with lists of banks and savings and loans that offer reduced interest rates for solar and energy conservation home improvement loans.

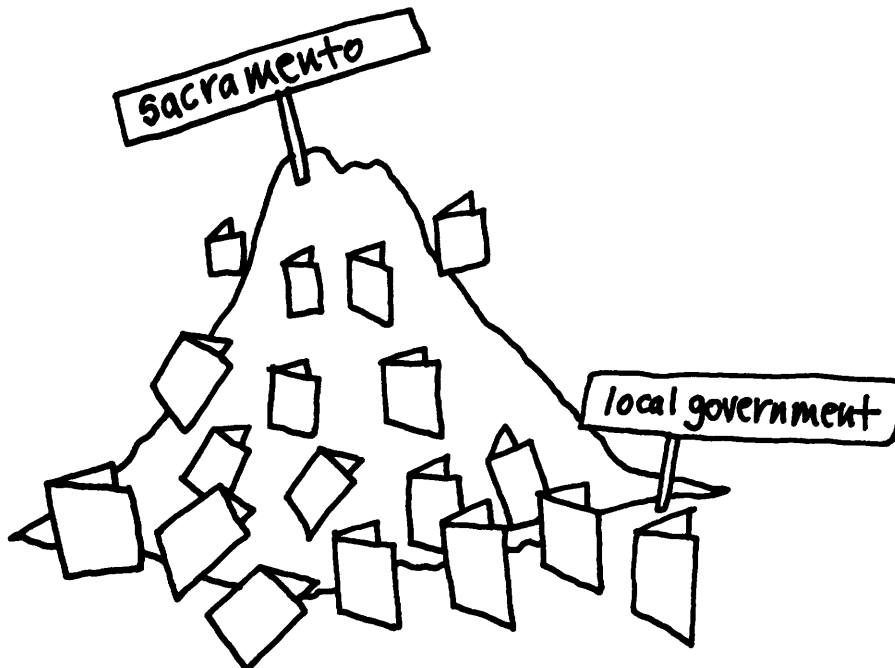
There are other state solar energy programs in which many state agencies are cooperating. The Energy Resources Conservation and Development Commission is working on a three-year effort to promote water and space heating, with benchmark goals of 200,000 water and 150,000 space heating systems by 1981.

The Department of Housing and Community Development is working on mediation between officials and builders, and provides small loans to encourage energy efficient utility systems in low and moderate income households, and including retrofit on existing structures.

The Department of Consumer Affairs is establishing a mediation service for consumers, a consumer protection

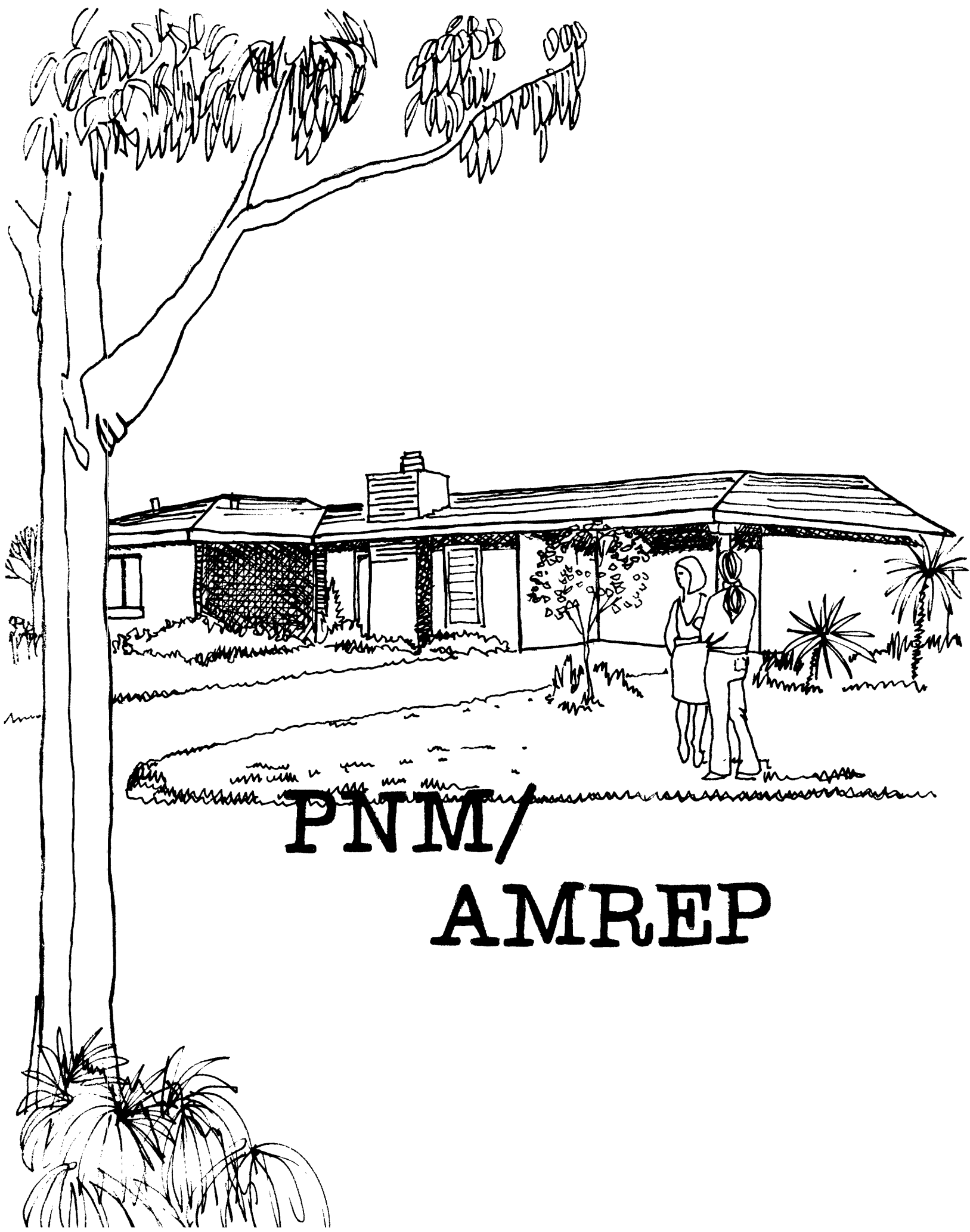
service, and a system for ensuring substantiation of advertised claims. It also is involved in the dissemination of information about the results of testing and about the inspection and certification program established by the Energy Commission. A consumer protection program is being developed to improve consumer information, to provide reliable procedures for complaint handling, and to examine the impact of licensing solar installers.

Given that this is only part of the climate of support for solar energy, it is not surprising that solar energy has been so successful in California. This intervention at the level of the state government has been a particularly good example of the influence of instructions or imperatives from the peak of the institutional hierarchy on the process of information dissemination among the individuals who make up the building industry. It has not, however, been restricted to intervention at the state level.



SUMMARY

California is regarded quite correctly as a solar energy leader. A municipally-owned utility develops solar capacity as a means of serving its consumer/owners. A county requires solar energy for hot water heating as a means of cutting through developer resistance to higher initial costs of the technology. The state provides direct tax credits for solar installations, as well as numerous formal and informal facilitation programs, helping residents of the state shift their energy use patterns to solar. The political climate at all levels combines to legitimate solar innovations, providing a context within which the individual choice to purchase becomes not only possible, but desirable. These institutional supports are not always sufficient, as the reluctance of Ditz-Crane to offer solar options shows. But such supports are necessary to move an innovation into the routine category, as the Santa Cruz pool heating and the San Diego banking examples illustrate.



PNM/

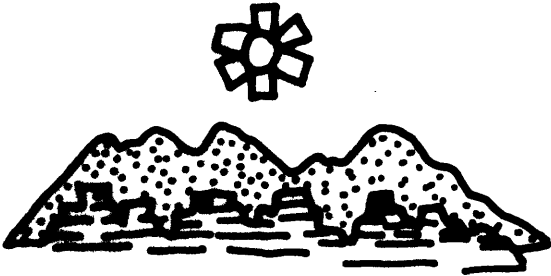
AMREP

PNM/AMREP is a case involving the collaboration of a major utility -- PNM -- and a major developer -- AMREP -- in the development of 25 solar homes. 23 of these homes are located at AMREP's Rio Rancho development near Albuquerque, N.M., with the other 2 at its El Dorado development near Santa Fe, N.M.

The case illustrates four institutional dynamics:

- (1) How innovatively disposed organizations find a common vehicle to serve their separate objectives;
- (2) The role of linking-pins;
- (3) The importance of a threshold density of information exchange in innovation acceptance; and
- (4) The role of the translator.

THE SETTING

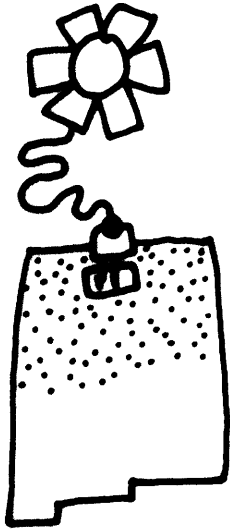


The state of New Mexico has an excellent climate for solar heating. The air is dry; sunlight is received 75% of the year; it is far enough north to need winter heating. New Mexico's political climate is also very favorable to solar energy, with liberal tax credits for solar homes and significant funding for the promotion, research and development of solar energy.

The AMREP Corporation is a major New York-based land developer, with large-scale operations in New Mexico and Florida. Founded in 1961, it also owns a paperback book and magazine publishing company. Total assets for fiscal 1978 were \$94 million.

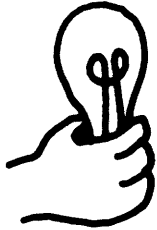
Rio Rancho Estates, comprising holdings of 91,000 acres and bought in the early 1960's, is one of two AMREP developments in New Mexico. Approximately 70,000 acres will be used for homes; about 10,000 have been developed thus far. AMREP serves as the general contractor for many of the homes. It also sells lots to outside builders. The AMREP-built homes are mainly between 1100 and 1500 sq. ft. and are aimed at the lower end of the housing market (under \$40,000 at 1978 prices). Some of the independently built homes sell for over \$100,000.

The Public Service Company of New Mexico (PNM) is



an investor-owned utility with 190,000 customers. Based in Albuquerque, it provides electric service for the northern two-thirds of the state. PNM is experiencing very rapid expansion in service demands due to increasing population and a large increase in uranium mining in western New Mexico.

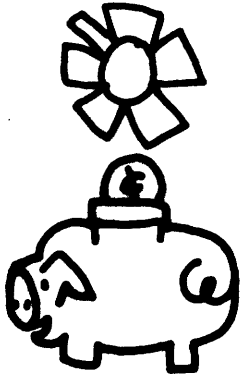
PRELUDE: AMREP'S FIRST EXPERIENCE WITH SOLAR ENERGY



AMREP's interest in solar energy, which led to its decision to join with PNM in pursuing a Cycle 3 grant, can be traced to a series of interactions it had with the General Electric Co. and the MITRE Corporation in 1973-74.

In late 1973, Dr. S. Fred Singer, a professor of environmental sciences at the University of Virginia, was simultaneously senior energy consultant to the MITRE Corporation and environmental consultant to the AMREP Corporation. His role with AMREP was to provide expertise on water quality and conservation at the AMREP developments in New Mexico and Florida. He had been hired by Howard Friedman, president of AMREP, primarily because of his work on water resources as a U.S. Assistant Secretary of the Interior from 1967 to 1970. Friedman, an accountant by training, was initially introduced to Singer by a mutual acquaintance.

In his role as MITRE's energy consultant, Singer had broad knowledge of the federal government's endeavors in the field of solar energy, including knowledge of the work of federal contractors other than MITRE, such as General Electric. Regarding AMREP as innovative and forward-looking, he thought it would be worthwhile to arrange for AMREP to meet with GE and MITRE to see if projects of mutual benefit could be worked out. Friedman agreed to the meetings, and now recalls, "I wanted to explore solar for two reasons. One, I thought it could strengthen



the attractiveness of our homes if we could show the buyer that he or she could save money. Second, I had a personal concern about the country's energy situation and thought incorporating solar into our product would be helpful to society as well."

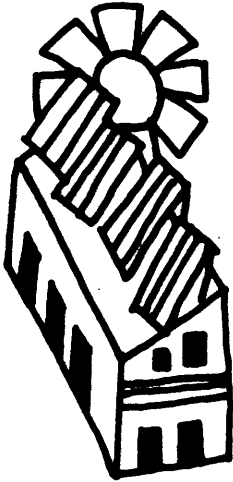
AMREP's orientation to incorporating innovations into its housing is institutionalized in a special department with the single function of developing and researching new designs and products in home building. Says Larry Perlmutter, current president of AMREP, "We want to be the best in the business within a certain price range. This department researches what other builders in the country are doing, looking for things we can incorporate into our homes to make them more attractive and acceptable to the public."



In 1973 and 1974, GE had a contract with the National Science Foundation (NSF) to provide advice on research regarding the utilization of solar energy for heating and cooling of buildings. As part of the contract, GE was to recommend candidates for Proof-of-Concept Experiments (POCE's) to be funded by NSF. In March of 1974, Singer arranged for Friedman and Alfred Dellentash, AMREP's construction manager, to meet with representatives from GE to discuss the possibility of AMREP applying for POCE funding.

At about the same time Singer set up the GE meeting, he also arranged for Friedman to meet with Charles Zracket, senior vice-president of MITRE. Although MITRE had no solar energy contracts at that time,

they did talk generally about applying for NSF funds to subsidize a solar development.



In April 1974, Friedman was excited enough about the possibilities with GE and MITRE that he could write Floyd Bailey, his manager at Rio Rancho:

"As you know, I have been doing a fair amount of investigation concerning the feasibility of using some form of solar heating at Rio Rancho. Some of the study has been devoted to putting a solar heating unit into our commercial facilities and some of it relates to condominiums and single family homes."

Friedman's memo continued to the next practical step:

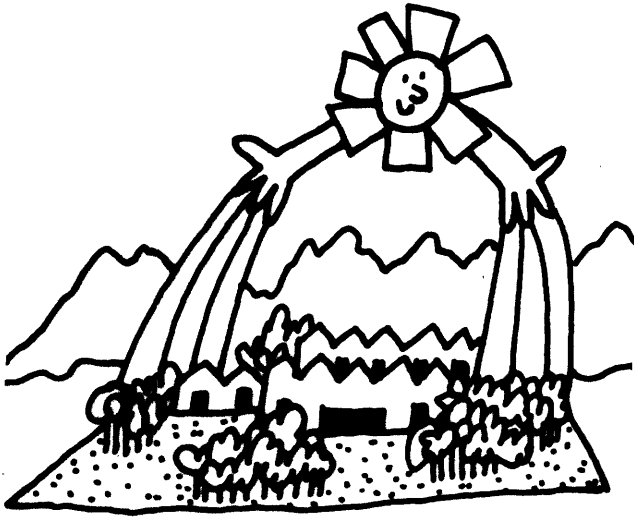
"Could you explore with (AMREP's local bank) what their reaction would be with respect to mortgage financing if we were to construct homes with solar heating. Would the cost of such installation be included in the cost of the home so that the purchaser would be able to mortgage at least part of that cost?"



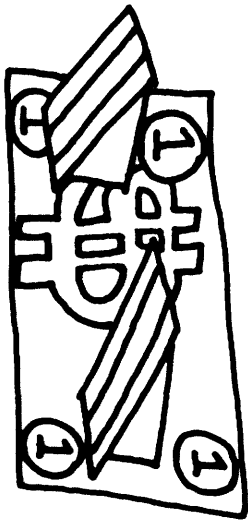
At this point, Singer was helping MITRE plan a symposium, "Overcoming Institutional Constraints to the Use of Solar Energy for the Heating and Cooling of Buildings" to which MITRE was inviting representatives of government, the energy and housing industries. Singer arranged with Friedman for Dellentash, AMREP's construction manager, to be a member of one of the panels.

The symposium, held in May 1974, was significant for

several reasons. Firstly, Dellentash met Robert Berks, a noted sculptor who had been hired by MITRE to develop innovative design approaches for a "solar community." Much of the symposium's time was given over to a discussion of Berk's concepts regarding ways in which aesthetics could be used to enhance the acceptability of solar heating. Dellentash, with over 25 years of highly responsible building experience and an active interest in innovative concepts in the building industry, became quite excited by Berk's ideas, an excitement he transmitted to Friedman.

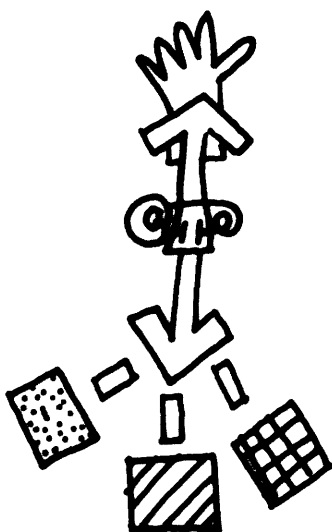


Secondly, Dellentash asked one of the discussion leaders for the names of solar manufacturers he might contact. The discussion leader supplied him with 8-10 company names, located mostly in the West and Southwest. This list of names was to become important more than a year later.



Though the GE-NSF connection did not develop (perhaps the consequence of NSF's perception that it would no longer have a lead role in solar energy development should solar-related legislation then pending before Congress be approved), MITRE, Berks and AMREP were actively exploring the possibilities for building a prototype solar development in Rio Rancho. In August, several MITRE personnel, Berks and Dellentash visited Rio Rancho to explore sites for the development. Subsequently, a brief proposal was submitted by MITRE to NSF for funding of solar collectors. If the project were funded, MITRE was to provide the systems engineering and AMREP was to supply the homes.

However, as with the GE-NSF effort, the MITRE-AMREP proposal did not have a favorable outcome. NSF turned down the proposal, apparently, according to Dr. Richard Greeley, then Associate Technical Director at MITRE, because it was "too close to development activity, not sufficiently research focused" and "too expensive for NSF's limited resources." This second setback, coupled with the unresolved state of the federal solar program and a series of court suits then being faced by AMREP, led Friedman to suspend efforts in solar at the time.



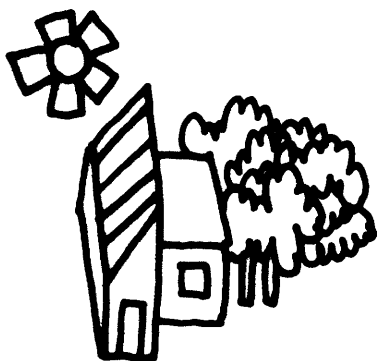
Though this first experience with solar did not lead to its use in any of AMREP's developments at the time, it did set the stage for a second round of solar endeavor. This first experience also illustrates three elements which contribute to institutional readiness to pursue utilization of an innovation: (1) the disposition of the organization (here AMREP) to use innovations as a means to enhance its competitive position; (2) the importance of a linking-pin (here Singer) in bringing together an innovation user (here AMREP) with those organizations (here the federal government and its contractors) interested in encouraging use of innovations; and (3) the importance of creating situations where there is density of exchange (here the MITRE symposium) sufficient to prompt a shift from thought to action.

PROTOTYPE DEVELOPMENT: AMREP STARTS AGAIN ON ITS OWN

By the fall of 1975, Friedman was ready to consider

solar once again:

"I believed there was a broad market out there for low-cost solar-heated homes, and that government or no government, we were going to go after it. So I called Al Dellentash into my office and told him four points. First, most solar homes have been built by kooks. Second, the solar homes have not been cost-effective -- the owners of solar homes are usually wealthy and do not care about costs. Third, the people who could really use cost-effective solar heating are buyers of lower-priced homes. Fourth, there is market resistance to solar homes because the collectors are ugly. So then I told Al 'Take our basic model in Rio Rancho, come up with a design for a solar home for the lower-priced market, under \$40,000, and see what you can do about the collectors.' My idea was to at least build a couple prototypes. I figured it wasn't much of a risk -- the worse that could happen would be we'd have to sell the solar homes at the non-solar price. All we'd lose would be the cost of the solar units."



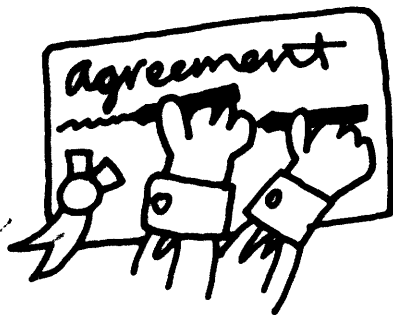
Given the broad outlines of a job to do, Dellentash first dispatched an assistant to visit the solar companies on the list he had received at the MITRE symposium the year before. It was on this trip that contact was first made with Dr. Ed Redding, then Director of New Projects for Solaron.

PUBLIC SERVICE COMPANY OF NEW MEXICO JOINS THE PROJECT

Because of AMREP's activities in New Mexico, Friedman

sat on the board of directors of a local bank. Also sitting on the board was Jerry Geist, the president of the Public Service Company of New Mexico (PNM). In January 1976, at the monthly bank board meeting, Friedman asked Geist if the latter would like to have PNM participate in the building of any prototypes.

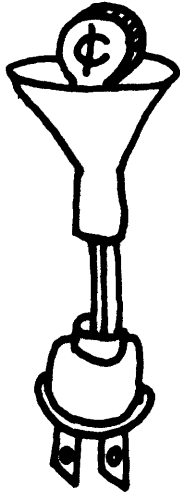
"I knew they were interested in and had done some research on solar energy. I wanted their expertise and I thought their involvement would lend stature to our project."



Geist was interested and the two men developed the broad outlines of an agreement concerning the building of one prototype solar home in Rio Rancho. They agreed that PNM and AMREP would split any financial loss on the home. Al Dellentash and Lou Hoffman, a PNM market analyst, then worked out the details of a contract, which was signed in May 1976.

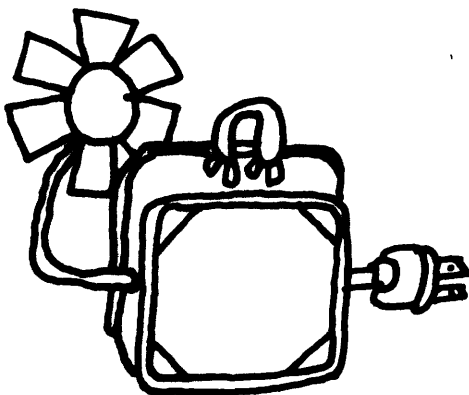
PNM's interest in solar dated from 1974. By the time Friedman had spoken with Geist, the company had explored a number of problems in the provision of solar energy, had participated in the design and construction of a "wet" solar system in Albuquerque, and had applied to the Electric Power Research Institute (EPRI) to be a participant in an EPRI-financed study of solar home performance in two different geographic areas.

According to Jerry Neal, PNM's Commercial Energy Management Supervisor, PNM has two overall reasons for wanting to participate in solar and other alternate energy projects.



"First of all, we want to reduce the consumption of scarce natural fuel, that is, gas and oil. Reduced consumption means fuel adjustment factors can be lowered and we can hold the rates down for our customers. Our goal is to provide reliable electric service at the lowest possible cost.

Secondly, there is a direct business reason. The utility spends more than its revenues for capital expansion -- we're very dependent on the money market. Consequently, we're also motivated to promote energy conservation and the proper use of alternate energy sources because these activities ultimately will enable us to defer capital investment, thus reducing our dependence on outside financial sources and the need to pay interest on huge loans. Conservation, load management, and the proper use of alternate energy sources help the company to be in a more stable financial position."



PNM also had a more specific objective in working on a residential prototype with AMREP. After studying solar heating applications in Colorado in 1975, it became aware of a major problem. As long as the sun is out, homes can be heated with solar units. However, if the sun is not shining for any significant length of time (beyond a home's solar storage capacity), solar-heated homes tend to switch to their backup electric heating system at about the same time, producing a major draw on the utility. This draw usually occurs at peak-demand periods in the morning or early evening. Thus, PNM was looking for a way to use the backup electric system to automatically heat the solar storage box during off-peak hours if stored heat went below a certain

temperature. This scheme would insure that these systems would not cause any unnecessary peaking problems and would help demonstrate the relationship existing between load management and time-of-day rate structures.

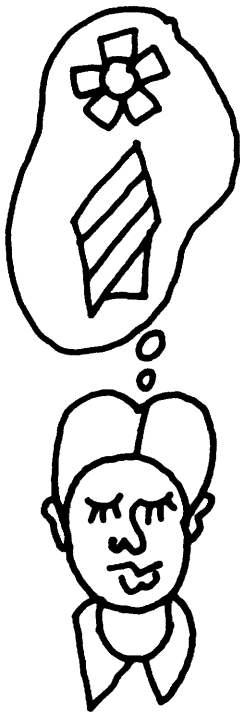
When AMREP offered to work with PNM, PNM engineers thought the prototype home presented an excellent opportunity for testing an off-peak system. Lou Hoffman of PNM, with the help of Jerry Neal and David Summers, worked out the performance specifications that an off-peak system should meet.

A TRANSLATOR JOINS THE TEAM

While negotiations were being carried out with PNM, Dellentash set out to secure a solar supplier. In March, he called Solaron and asked for Redding, whom Dellentash's assistant had met and liked on his trip a half-year earlier. When Dellentash visited Redding to discuss the possibilities for Solaron to work with AMREP, Redding explained that he was about to join a new solar manufacturer, Solar Seven (based in Denver), as its technical director. Dellentash, who had been given the authority by Friedman to select the solar supplier, decided he wanted to work with Redding, whichever company he worked for, because Redding could give adequate time to the project and because of the positive impression Redding made on the previous visit. Consequently, Solar Seven became AMREP's solar supplier.

The compatibility between the two men may have occurred in part because their careers paralleled each other in several respects. In his 25 years of highly varied building experience, Dellentash had overseen

the construction of a number of major commercial and residential projects, including One Charles Center (Baltimore), UN Plaza, Lincoln Towers, Park West (all in New York City), and part of the New Jersey Turnpike. He also had significant experience building single family houses. Prior to joining AMREP, he had been a Vice-President of the Reston (VA) new town development.



For quite a while, Dellentash has seen himself as an innovator in the building business. "I believe in trying innovations. There are too many people in the building industry who are too conservative, and don't play with ideas. I'm always trying new things. I once even tried out steel trusses for houses instead of lumber when the price of lumber got too high."

From his work over the previous 18 months, Dellentash had become quite committed to the concept of solar-heated homes: "The more I read about solar energy, the more I wanted to find out, and the more I wanted to do something about it, not only because I thought it was good for the company, but also because I thought the country had to go that route and I liked working on housing innovations."

Redding also had a number of responsible and geographically varied positions over a 30-year period, and enjoyed playing with new ideas and technical innovation. After receiving a Sc.D. in Chemical Engineering from M.I.T. in 1942, Redding worked on the development of a nuclear airplane

as well as on guided missile activities. From 1948-53, he ran the Charles F. Kettering Foundation, which was primarily involved in funding research attempting to create energy via photochemical reaction. For the next twenty years or so, he ran his own businesses (water purification company in Houston, manufacturing firm in Chicago, consulting firms) or worked for others (e.g., Crown Cork and Seal Co. in Baltimore). He was about to move to Egypt to open a Schwepps franchise in late 1974 when on the introduction of a friend, he joined Solaron.



"I worked at Solaron as Director for New Projects in the Marketing Department. Among other things, it was my job to 'sell' HUD/DOE applications for our clients. HUD and DOE approved nine of eleven of our clients' applications in Cycle 1 and 2. Also, I was the only one in the company with any business experience, so I had to set up the price structure."

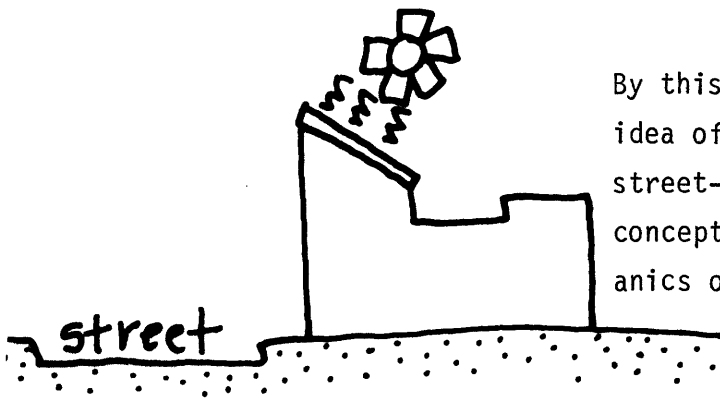
"When I joined the company I knew very little about solar. The field had changed tremendously in the previous twenty years, so I read everything about solar I could get my hands on. After three or four months, the mist cleared and I felt I understood solar from a technical point of view."

THE PROTOTYPES GET UNDER WAY

After reviewing the situation with Dellentash,

Friedman decided to build two prototype homes, the PNM/AMREP home in Rio Rancho and one other home in AMREP's El Dorado development in Santa Fe. Both homes were to be built on speculation. Although PNM was not involved in the Santa Fe home, the home did incorporate the off-peak system. It was built in order to test the performance of the solar system in a colder climate. (Later, a third prototype was built on a customer's order.)

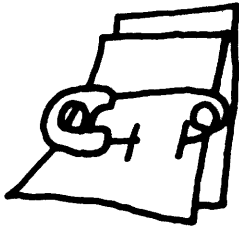
Dellentash and Redding met to work out the design of the solar unit and its interface with the house. Dellentash and his aides had come up with the basic system design -- system location, duct work and sizing. Redding worked out the details. Bob Matthews, a Solar Seven employee, designed the control system.



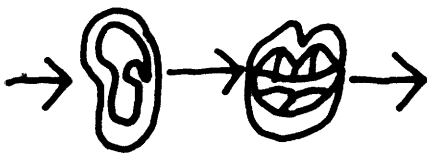
By this time, Dellentash had developed the innovative idea of a solar well to hide the collector from street-level view. Redding ascertained that the concept was indeed feasible, and designed the mechanics of the solar well subsystem.

Also, Dellentash, Redding and PNM engineers met to review the off-peak heating system. Lou Hoffman presented the performance specifications developed to that point, Redding added several ideas, and a sketch was developed on the spot which became the basic design for the off-peak system. Redding later worked out the details. In effect, Redding was acting as a "translator", providing the technical expertise to allow the concepts of both AMREP and PNM to become reality.

The two prototypes, started that summer and completed in the fall, received a large amount of positive publicity. Friedman, without waiting for the prototype to be completed, decided it would be worthwhile to expand the experiment and began looking into the HUD/DOE SHAC demonstration program.

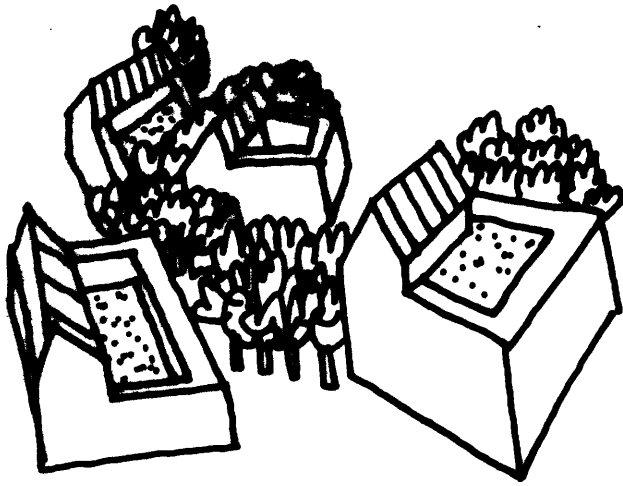


As with the first phase of this case, the prototype phase reflects a number of important institutional dynamics. First, AMREP's disposition to innovate and its belief that such innovation would enhance the firm's profitability coupled with its initial experience with solar and the view that New Mexico was a market in which solar could be profitable, led the company to undertake a prototype development on its own initiative. Second, Friedman's position on the bank board enabled him to play the linking-pin role with PNM's Geist, enabling these two major organizations to join together on a project which would serve as a vehicle for meeting their respective, essentially separate objectives. Third, the personal compatibility of Dellentash and Redding and the technical compatibility of Redding and the PNM engineers enabled Redding to play the role of translator of the two sets of objectives (AMREP's for marketability; PNM's for load management).



THE SHAC DEMONSTRATION PROGRAM - APPLICATIONS TO HUD - CYCLES 2 AND 3

In June 1976, one of Friedman's assistants informed him of the HUD/DOE Solar Heating and Cooling Demonstration program. Friedman, believing it would be worth-



while to expand the experiment in a situation where HUD would pay for the cost of the solar systems, instructed Dellentash to develop a proposal for SHAC Cycle 2. With HUD paying for the innovation he thought he had little to lose. That summer Dellentash filed an application for the funding of solar units for six homes in Rio Rancho.

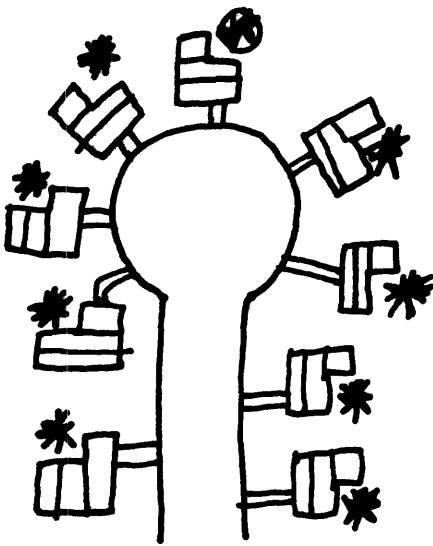
In October, AMREP was informed by HUD that the application had been turned down. Friedman and Dellentash feel that the rejection was a result of AMREP's legal problems. Friedman expressed such an opinion in a memo to AMREP's directors. However, after the positive publicity generated by the prototypes, Friedman had an even stronger desire to pursue a SHAC grant. In fact, he wanted to apply for a grant for solar units on twenty-five homes.

"We wanted to expand to twenty-five homes because there were better economics in constructing many copies of the same home and we would get much more information regarding the marketability of the homes. Also, we figured there was no downside risk as HUD would be paying for the cost of the solar system. We didn't feel we were taking much of a chance."

Friedman perceived the major problem as being AMREP's low popularity with HUD. After much thought, he developed the idea of asking Jerry Geist of PNM if the utility would act as the sponsor, with AMREP being the general contractor. The project was attractive to PNM because the utility could get

involved in solar research and development on a large scale project without having to build the homes.

An agreement, signed in March 1977 and submitted as part of the application to HUD, designated PNM as Project Sponsor and AMREP as solar equipment supplier, project builder and primary developer. Also PNM agreed "to provide trained technical manpower to coordinate the solar energy project, to monitor installed instrumentation, to analyze data, and to prepare necessary reports." AMREP subcontracted with Solar Seven to supply the solar heating systems. PNM agreed to use the grant to reimburse AMREP for the costs of the solar units, less a portion for administrative and management expenses.



The building plans in the HUD application showed twenty homes around two cul-de-sacs in Rio Rancho, three homes elsewhere in Rio Rancho, and two homes in El Dorado. According to Al Dellentash: "We wanted to show that you didn't have to site homes in a solar development in a straight line on the north-south axis, but could make a typical siting arrangement, like a cul-de-sac, all solar. We put two homes in Santa Fe because we wanted to see how the homes would perform in the colder climate." The homes in the application were similar to the prototypes, but with a number of technical improvements resulting from the initial experiment.

The application, submitted in late March, asked for \$2000,000. HUD approved it in late May, awarding PNM \$170,000.

CONSTRUCTION



Preparations for construction took place in the summer and fall of 1977, with construction beginning in late fall. Both Redding and Neal spent a great deal of time on site, indicative of the importance they attached to the project. With Dellentash making on-site reviews for AMREP every few weeks, Redding oversaw the installation of the solar units. Neal and his engineers kept a close eye on the details of construction and monitored quality control. Through this oversight function, Neal alerted AMREP to a number of construction errors. Redding and Neal also worked out a number of solar system modifications on site in response to certain problems which became evident.

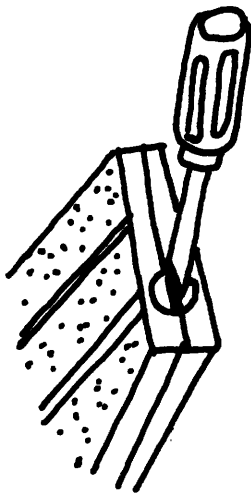
Meanwhile in Santa Fe, the New Mexico Bureau of Revenue held hearings on tax rebate regulations for solar heating units. A representative from PNM, Dan Peck, went to the hearings requesting special provisions regarding off-peak storage units. Peck and M.L. Morton, the Bureau's solar expert who was running the hearings, ended up spending the better part of a day discussing the off-peak storage units and the AMREP development -- this was the first that Morton had heard about the development.

The AMREP project carried a lot of importance with Morton because it was the largest solar development at that time in the state. He was quite interested in seeing that the project was a commercial and technical success, hoping that it would encourage similar developments. Therefore, he made several trips to Rio Rancho to work out a simple method for Rio Rancho

solar customers to request tax rebates. Further, he routinized the handling of the rebates within his bureau so that they would be processed without delays.

The first home was occupied in February 1978. However, all the homes were not completed until August, nine months after the first home was started. All of the homes had been sold by early 1979. Sixteen are now occupied; the rest apparently were bought as retirement or second homes.

POST-CONSTRUCTION PROBLEMS



1978-79 was the first full winter of occupancy. It was then that, as Redding puts it, "bugs began showing up in all directions." At that point Redding was working for AMREP to set up a solar research and development center in Rio Rancho, so he was available, as was another former Solar Seven employee, to seek solutions. (Solar Seven folded in August 1978.)

PNM also brought in its engineers because homeowners were calling PNM (the grantee) as well as AMREP, and PNM wanted to insure that the homes functioned properly. Owners were aware that PNM was involved because its name was in the advertising. The calls to PNM may indicate that the owners made the solar heating units comprehensible to themselves by identifying the units with PNM, an energy company; this identification was strengthened by their knowledge that PNM was involved in the project.

Although PNM and Redding have made much progress in reworking the systems, the problem-solving continues at present.

AFTERMATH

All of the participants in the PNM/AMREP project believe they learned a great deal about solar because of their involvement. Their activities to the present seem to indicate that most of them are highly committed to pursuing solar energy projects and that the project catalyzed this commitment.

Overall, AMREP has been quite pleased with its solar venture, and has decided to undertake a number of new solar projects. "AMREP is sold on solar," in the words of Larry Perlmutter, its current president. Firstly, it has hired Ed Redding to oversee the testing of five experimental solar homes at Rio Rancho, each home heated by either passive solar or a combination of passive and active. Once tests are complete, AMREP may decide to routinely produce and market solar homes.

Secondly, Redding also has been given the responsibility for setting up a solar-powered solar research and development center at Rio Rancho. AMREP hopes to attract to the facility various firms working with solar, such as architects, engineers, and manufacturers. Thirdly, the corporation hopes to establish a passive solar test

facility in conjunction with Los Alamos or Sandia Laboratories (U.S. government facilities in New Mexico).

The Cycle 3 solar homes seem to have benefitted the Rio Rancho development as a whole. Jim Wall, Vice President of Rio Rancho Estates, thinks many people have bought AMREP's conventional homes in the development after being exposed to the solar homes. In fact, he thinks the solar units have brought in twice as many conventional buyers as solar buyers.

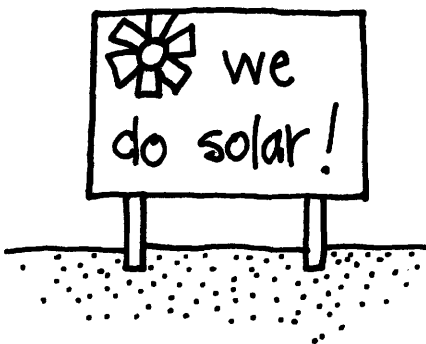
PNM has been continually increasing its involvement in solar activities. It will be monitoring all 25 of the demonstration homes. Twenty of these will be master-monitored and compared with twenty identical conventional homes, also master-monitored. Funding for the master-monitoring is being supplied by EPRI.



PNM will be partially funding (with its own and EPRI funds) solar/load management equipment for a new mechanical engineering building at the University of New Mexico. The company has committed itself to working with a number of firms should any of these get a grant from DOE for photovoltaic demonstration projects. PNM also jointly submitted with a local construction company a Cycle 5 HUD application for funds to construct one house incorporating active and passive solar collection. Other solar activities include a solar water heating experiment in 30 homes, and monitoring 10 homes which are partially solar heated.

Jerry Neal feels that the Cycle 3 project, particularly the aspect of technical problem-solving, has given the utility invaluable experience in understanding the dynamics of solar heating systems.

Ed Redding, as mentioned previously, is working on new projects for AMREP. In addition, he is setting up his own solar equipment company (design and manufacturing), and expects to subcontract some assembly work soon. On his own, he continues working on design of active and passive solar systems.



Al Dellentash left AMREP in June 1978 and has set up a construction company in New Jersey with his son. He remains actively interested in solar. "We're not advertising solar, although I'd like to do some. I think the solar market will be good in New Jersey. We'll see how it goes. Solar homes are a good way of getting people to know who you are."

"I'm playing around with a solar idea on the drafting board right now. It's a collector plate that would be set flat, horizontal to the ground. That way you wouldn't have to worry about north-south siting, and people couldn't see it from the ground. Everyone objects to seeing the collector. I'm looking to sell the idea. I hope to build a prototype. I've been working on it and thinking about it for a year and a half."

SUMMARY AND ANALYSIS

There are a number of key elements in the PNM/AMREP case which help explain how it unfolded and are useful for generalizing about innovation dissemination and acceptance in the housing industry. Four elements in particular can usefully be examined at this point:

- * Innovatively-disposed organizations finding a common vehicle to serve their separate objectives.
- * The role of linking-pins.
- * The importance of a threshold density of information exchange at critical decision points.
- * The role of the translator.

INNOVATIVELY-DISPOSED ORGANIZATIONS

Both AMREP and PNM can be characterized as innovatively-disposed organizations, AMREP because large-scale developers seek a "new twist" which will yield high market visibility to establish a competitive advantage, and PNM because its rapid growth in service demands (especially at peak hours) coupled with increased production costs forced it to consider new ways to service its customers at a reasonable cost. The objectives of the two organizations did not necessarily need to be met using a solar solution. However it is clear that, once identified, each felt its needs could be met by promoting solar-heated homes. Indeed the prototype phase proceeded without any governmental involvement, a reflection that the solution was attractive independent of federal incentives. That the needs

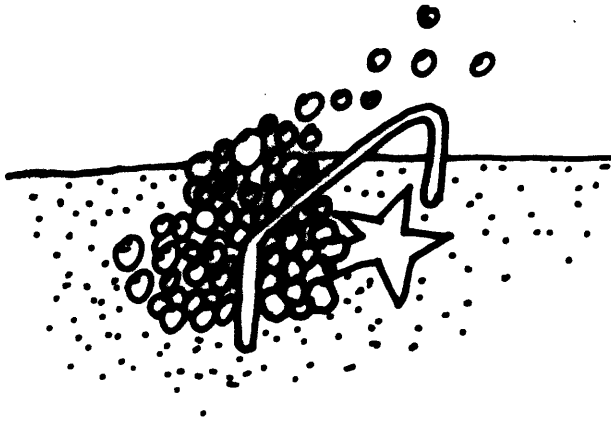


of the two organizations are met in the SHAC program is evidenced in the quarter-page newspaper advertisement announcing the Rio Rancho solar homes. AMREP's market position is enhanced by phrases such as "So Advanced, Even the United States Government Has Taken Notice" and "This 'Sunsational' Solar Home is Specifically Designed To Take Advantage of Our Sunny Area", while PNM announces that it "has committed itself to make certain its customers will be able to effectively utilize energy sources of the future at the lowest reasonable cost."

THE ROLE OF LINKING-PINS

The nature and timing of the involvement of both AMREP and PNM in solar were substantially influenced by persons here characterized as 'linking-pins.' As an environmental consultant to both MITRE and AMREP, Fred Singer was able to link together emerging technical trends with an organization disposed to implement them, at an early stage of the development of the technology. Similarly, Howard Friedman was able to link AMREP's residential development interests with the load-management interests of PNM's Jerry Geist through their common positions on a bank's board of directors. In both instances the information brought by the linking-pin was deemed worthy of review because of the exchange context/carrier, because the information itself was initially new, and therefore without clear meaning for the receiving organization.

DENSITY OF INFORMATION EXCHANGE

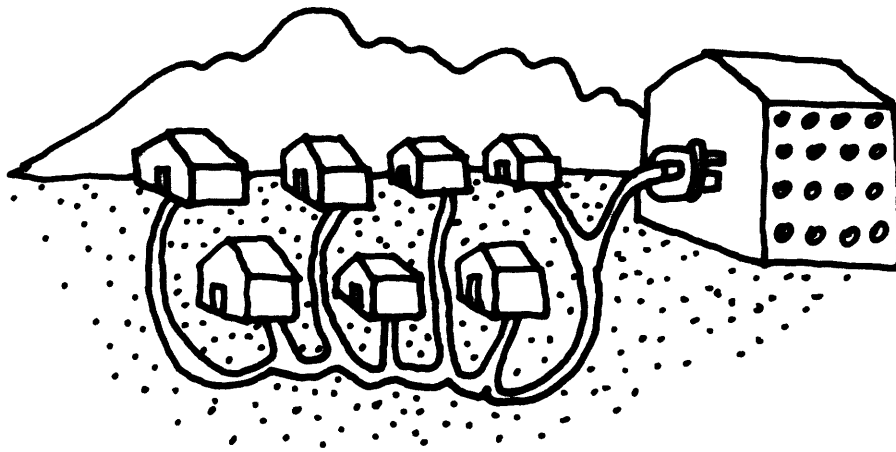


The last point above leads to this third element, the importance of a threshold density of information exchange at critical decision points. Because the information being conveyed by a linking-pin (in this instance) is new, and its meaning not clear for the receiving organization, it is critical that there be an adequate density (volume and content) to get over a decision threshold. In the case of AMREP a critical density was achieved at the MITRE symposium, with the perspective and knowledge from a variety of sources (for example, Berk's solar community design concept, and the list of solar manufacturers obtained by Dellentash) providing the impetus to move AMREP from the periodic considerations up to that point to actively moving toward making Rio Rancho a demonstration site. In the case of PNM the critical density came at two points. The first was the personal connection between Friedman and Geist, with Friedman providing the information. The second came at the staff level, in working out the initial agreement on the prototype.

THE ROLE OF THE TRANSLATOR

If Berks was the early translator for AMREP (solar energy translates to solar community), Redding fulfilled the critical translator role for both AMREP and PNM in moving from concept (AMREP's for an aesthetically satisfactory house and PNM's for a load management system) to a solar energy reality

at the Rio Rancho site. Redding's personal compatibility with Dellentash and technical compatibility with the PNM engineers enabled him to readily translate the desires and objectives of each into a single design.



PNM/AMREP Case - Chronology

- 1962 AMREP purchases lands for Rio Rancho Estates.
- 1974
- Winter Dr. S. Fred Singer, consultant to AMREP and MITRE Corporation, arranges for Howard Friedman, president of AMREP, to meet with representatives from General Electric and MITRE to discuss possibilities for solar homes projects.
- Spring Friedman sends Al Dellentash, AMREP construction manager, to MITRE symposium on solar energy. Dellentash meets Bob Berks, a noted sculptor who is consulting for MITRE regarding solar communities.
- Summer Dellentash, Berks, and MITRE personnel visit Rio Rancho to explore sites for development of solar homes. MITRE applies to National Science Foundation (NSF) for funds to support project.
- Fall NSF turns down proposal.
- 1975
- Fall Friedman instructs Dellentash to undertake development of prototype solar homes. Dellentash sends an assistant to visit several solar manufacturers -- at Solaron, the assistant meets Dr. Ed Redding.
- 1976
- Winter Friedman asks Jerry Geist, president of PNM, to join AMREP in the development of a prototype solar home in Rio Rancho. An agreement between AMREP and PNM is signed.
- Dellentash brings Redding (now with Solar Seven) on to project.
- Summer Construction commences on two prototypes. (One is built by AMREP alone.) AMREP submits SHAC Cycle 2 application to HUD for six homes.
- Fall Prototypes completed. Cycle 2 application rejected by HUD.
- 1977
- Winter Friedman asks Geist if PNM will join with AMREP in a 25-home Cycle 3 application, with PNM acting as the applicant and project sponsor and AMREP as the general contractor. An agreement is worked out and the application for \$200,000 is submitted to HUD.

1977

Spring HUD approves the application, granting \$170,000.

Fall State holds hearings on solar heating tax rebate; construction begins.

1978

Winter First solar home at Rio Rancho is occupied in February.

Summer Last homes completed in August.

Fall Many problems appear in solar heating systems. Redding, PNM begin to "de-bug" homes.

1979

Winter Sixteen homes occupied, all twenty-five sold.

REFERENCES

- DOE (1978) NATIONAL PROGRAM FOR SOLAR HEATING AND COOLING OF BUILDINGS:
ANNUAL REPORT
Washington: DOE/CA-0007.
- Furlong, Michael and Nutt-Powell, Thomas E. (1979) INSTITUTIONAL ANALYSIS
OF RESEARCH AND SOCIALIZATION IN HOUSING: A PRELIMINARY
EXPLORATION
Cambridge: MIT Energy Laboratory.
- McDaniel, Patricia and Nutt-Powell, Thomas E. (1979) INSTITUTIONAL ANALYSIS OF
GOVERNMENTAL INVOLVEMENT IN HOUSING: A PRELIMINARY EXPLORATION
Cambridge: MIT Energy Laboratory.
- Nutt-Powell, Thomas E. with Landers, Stewart, Nutt-Powell, Bonnie R. and
Sorrell, Levi (1978) TOWARD A THEORY OF INSTITUTIONAL
ANALYSIS
Cambridge: MIT Energy Laboratory.
- Nutt-Powell, Thomas E. (1979) RESEARCH DESIGN FOR INSTITUTIONAL ANALYSIS
OF HUD'S SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM
Cambridge: MIT Energy Laboratory.
- Parker, Barbara and Nutt-Powell, Thomas E. (1979) INSTITUTIONAL ANALYSIS
OF STANDARDS SETTING IN THE UNITED STATES: A PRELIMINARY
EXPLORATION
Cambridge: MIT Energy Laboratory.
- Reamer, Andrew, Heim, Steven and Nutt-Powell, Thomas E. (1979) INSTITUTIONAL
ANALYSIS OF ENERGY PROVISION IN HOUSING: A PRELIMINARY EXPLORATION
Cambridge: MIT Energy Laboratory.
- Swetky, Carole and Nutt-Powell, Thomas E. (1979) INSTITUTIONAL ANALYSIS OF
HOUSING PRODUCTION: A PRELIMINARY EXPLORATION
Cambridge: MIT Energy Laboratory.