INSTITUTIONAL ANALYSIS OF SOLAR HEATING AND COOLING OF HOUSING: SUMMARY REPORT

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ABSTRACT

This paper is one of a series resulting from institutional analysis of photovoltaic (PV) acceptance. It is the summary report on a study of several residential projects which are part of the DOE-HUD Solar Heating and Cooling Demonstration Program. Other papers in this series look in detail at aspects of the residential institutional arena, and more fully present the cases. The study of solar thermal applications in housing provides useful guidance in structuring programs for PV acceptance in the residential sector. The five cases illustrate one or more institutional forces which influence the acceptance of solar energy in housing. The cases involve residential developments of various sorts, located in Massachusetts, Maryland, Indiana, New Mexico and California. It is determined that each actor in the residential sector has different, and complex motivations for considering, using and continuing to use an innovation such as solar energy. The choices of any given actor are a function of the type, source, density and continuity of information exchanges found within the institutional arena in which he/she operates. Finally, the probability of rate and extent of innovation acceptance will be increased to the degree that the innovation is made comprehensible.

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The research assistants for this project were most diligent in their efforts, and deserve more than mere acknowledgement. They were Michael Furlong, Patricia McDaniel, Barbara Parker, Andrew Reamer and Carole Swetky.

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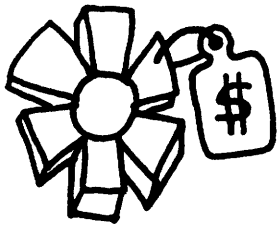
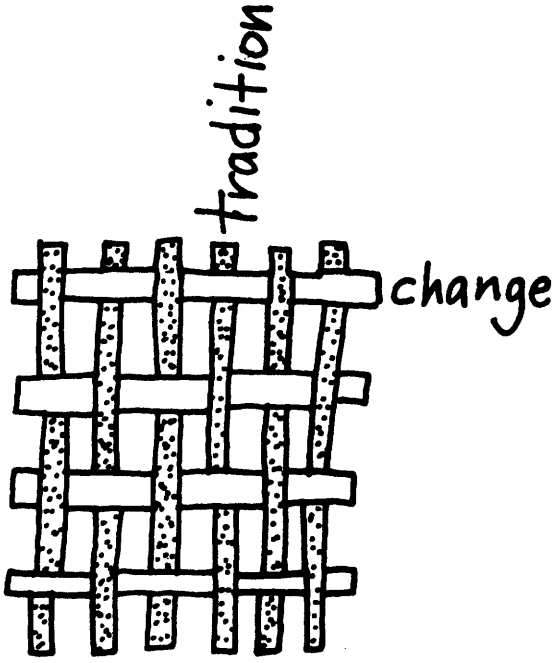
This paper is one of a series resulting from institutional analysis of photovoltaic (PV) acceptance. These studies are undertaken with sponsorship of the US Department of Energy (DOE) as part of its Photovoltaic Program. In addition to institutional questions, DOE is interested in economic, marketing, 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

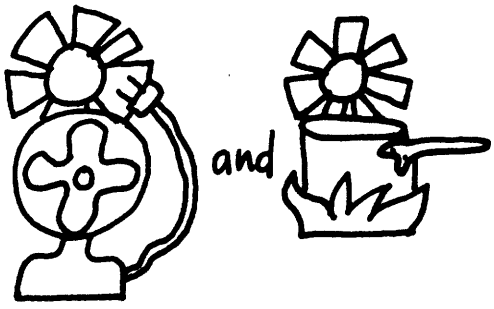


undertaken in order to ascertain means of facilitating innovation acceptance, particular attention is directed to 'routines' in the sector, so that the possible meaning and impact of an innovation is understood in context. An institutional analysis proceeds in a series of steps, beginning with sector 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

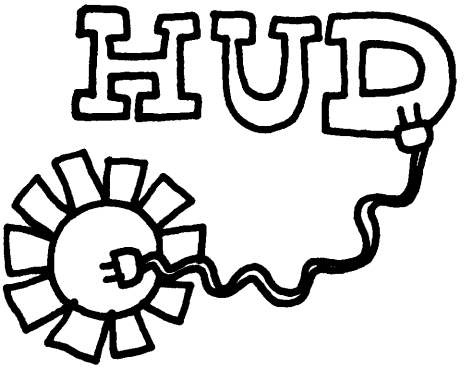
DOE is anxious to introduce PV into the residential sector. Though the technology is yet not fully developed in terms of efficiency or cost competitiveness, these barriers should be overcome within a very few years. Thus studies to understand the institutional dimensions of PV acceptance are appropriate 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 analagous 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).

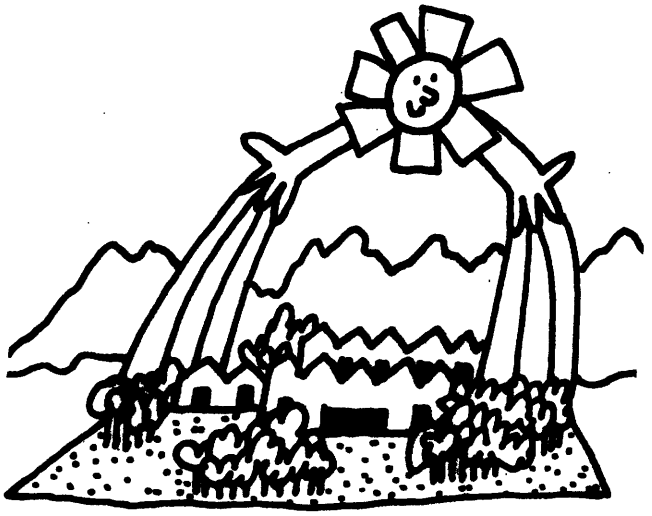


The structure of HUD's residential demonstration program was reviewed, and a specific research design developed. (Nutt-Powell, 1979). The HUD program uses a single-focus intervention strategy--financial grants to developers. Grants have been awarded to types of developers. The research design eliminated 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.
From the eleven projects initially selected for study, six were chosen for detailed analysis. The results of this analysis are set forth as five institutional analysis case studies. (Nutt-Powell et al., 1979.)

This summary report has two sections. In the first section the five case studies are presented in brief form. The case studies are:

* Friends community, a 160-unit semi-detached single-family housing development in North Easton, Massachusetts;

* Reservoir Hill Solar Houses, a 15-unit single-family attached development in the Reservoir Hill urban renewal area of Baltimore, Maryland;



* Project Solar for Indiana, in which seven builders in different parts of the state each constructed a single family house, identical in terms of design, size, insulation factors and solar units;

* Solar in California, reviewing how public efforts at the municapal, county and state levels influence acceptance of solar energy;

* PNM/AMREP involves the collaboration of a major utility (Pubilc Service of New Mexico) and a major developer (AMREP) in the development of 25 solar homes in New Mexico.

The second section of this report presents the implications of these studies for the consideration of institutional factors in facilitating the acceptance of photovoltaic solar energy in the residential sector.

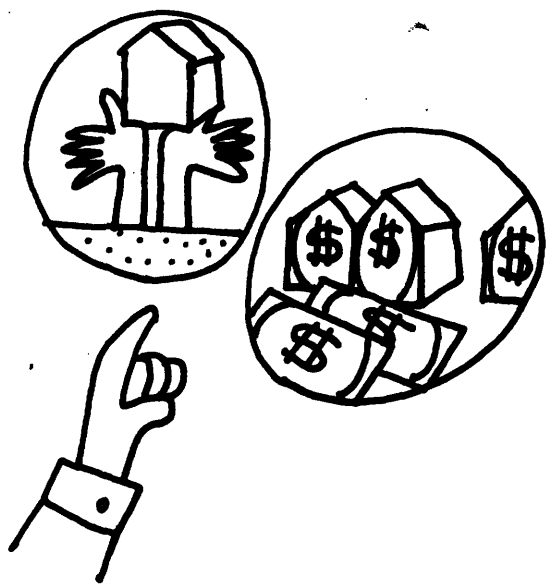
FIVE CASE STUDIES

FRIENDS COMMUNITY

Friends Community is a 160-unit semi-detached single family housing development in North Easton, Massachusetts. 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.

Friends Community is different from most housing developments. It is developed by a non-profit corporation created for this purpose by the New England Society of Friends. As such the motivation for involvement in housing development is strongly normative. The project 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 financial profit. Moreover, 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.

Friends Community began with the expression of a 'sense of concern' about the treatment of the elderly in this country by the 1971 New England Yearly Meeting. A subsequent series of actions lead to a 1972 workshop, at which a set of ideals for a community was articulated. Funds were raised to cover planning and development costs and a non-profit development corporation created.

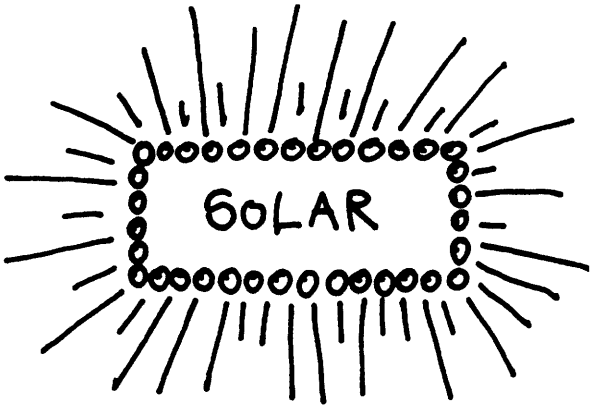


The search for professional assistance was conducted in a manner consistent with the normative motivation for developing the housing. Inquiries were made to architectural firms regarding their willingness to be involved in housing development consistent with the ideals stated in 1972. The Architects Collaborative (TAC), a successful and prestigious Cambridge-based firm, accepted the assignment. Doing so was a new venture for them not only in the solar aspects but also the aspect of creating an intentional community. However the approach was in general consistent with TAC's emphasis on 'collaborative' professional activities.

The need for congruence of values among the key development participants is evident in the time period required for the design and development stages. That TAC joined the project in 1973; the groundbreaking did not occur until November 1978. Much of the time committed to the project by TAC staff was non-reimbursable, given the fixed fee arrangements typical between architects and developers. TAC stayed with the project (as did the key lending

institution, and other development consultants) illustrates the importance of normative motivation in certain forms of housing development. Indeed, all of the key actors were active in obtaining the HUD solar grant, submitting letters of support giving evidence of their own normative acceptance of this energy source even in the face of the time and financial costs its use had occasioned.

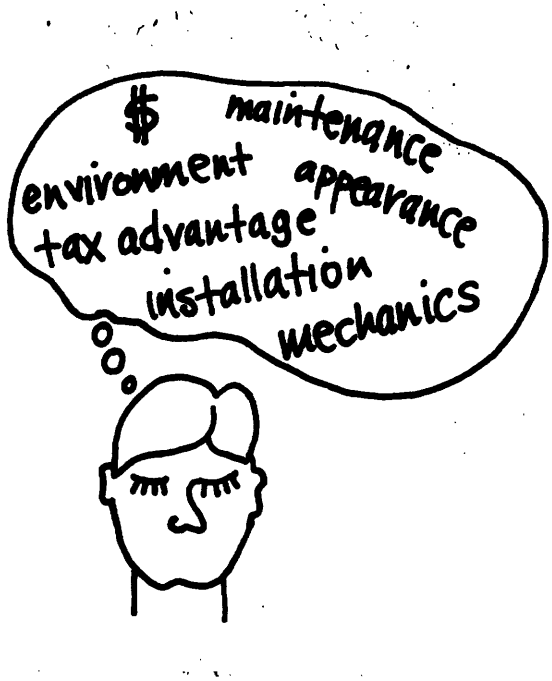
RESERVOIR HILL SOLAR HOUSES



Reservoir Hill Solar Houses is a 15-unit single-family attached development in the Reservoir Hill urban renewal area of Baltimore, Maryland. This is the first development project of Centennial Building and Development Corporation (CBDC) which, as a result of the success of this venture is now involved in housing development valuing over $20 million, both inside and outside Baltimore City.

CBDC was formed in 1976 by Melde Rutledge, a dynamic young black entrepreneur. Seeking development opportunities, Rutledge was able to receive designation as developer on two small parcels in the Reservoir Hill area. Though adjacent to a very successful "Georgetown-esque" renewal project begun in the early 1960's, the Reservoir Hill area had not "taken off." Thus Rutledge's first problem was to "create the perception of bankability." By chance Rutledge met an architect who had worked on a HUD-funded solar project. As Rutledge said, "It gave us the 'fancy' thing we needed for bankability. I didn't care one way or the other about solar,

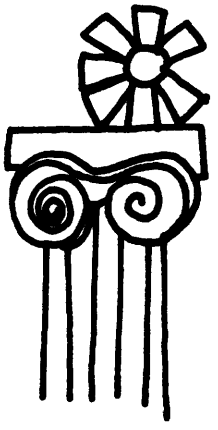
but thought the grant would help." Indeed solar was the key. CDBC's financer, a local saving and loan association, though oriented toward community reinvestment, said that "solar heating was the item that helped us make the decision to finance the project in its proposed form."



Even more interesting than the process of getting into solar development was CBDC's experience with it, experience which has resulted in a decision against further use of solar. Factors influencing this decision included confusion of roles, uncertainty of work activities and unfamiliarity of plans and requests. CBDC found that in using solar builders were involved with sub-contractors they had never dealt with before. "Everything is different," they said. "A builder can't walk in and know whether or not the sub is doing the job properly." Similarly CBDC was frustrated by what they called the "weak" infrastructure of the industry. Inventory turned out to be a big issue. "The subs on the job were small. They have small staff and cash flow problems. There is no purchasing power for inventory; no cash to maintain a stock, plus there is no interchangeability of parts." Many of these difficulties can be categorized as problems which result from "labelling." Because something is differently labelled, it must be different, and therefore confusing, difficult, even mysterious beyond comprehension. In this case the label was solar, thus one needed a "solar sub." Using a solar sub led to encountering the problems

noted above, though as Rutledge pointed out, "most everything is just plumbing, and everything interfaces. We would do it with our plumbing sub now."

PROJECT SOLAR FOR INDIANA



Project Solar for 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 of the state. Though the builders applied separately for the HUD solar grant, their efforts were coordinated as a special project of the Homebuilders Association of Indiana (HBAI).

This case illustrates the importance of supporting institutional networks to innovation acceptance in housing. Such networks were 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. Within the networks in this case were 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.

Upset over Indiana not receiving any of HUD's Cycle 1 solar grants, Lt. Governor Robert Orr

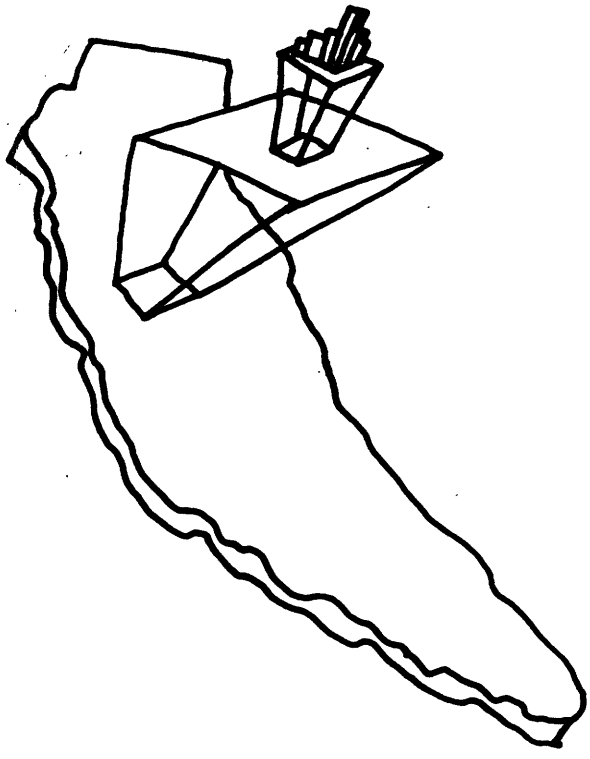
and State Energy Office Director Tom Kibler decided to stimulate interest in the program. In 1976 a seminar was sponsored for members of trade associations, architects, developers and other building-related professionals. Though builder response was low, one, Steve Moulder, a relative newcomer to homebuilding, did apply for and receive a HUD Cycle 2 grant.

On assuming the Presidency of the HBAI in January, 1977, Tom Laycock, an architect by training and owner/director of a building and development firm, proposed as a special project HBAI sponsorship of a group of builders to participate in HUD's Cycle 3. Following approval of the proposal by the HBAI's Executive and General Boards of Directors, Laycock asked Ken Puller to formally direct the project. Puller, president of a mortgage banking operation and with extensive experience in real estate sales, management and building development as well as eight years on HUD's staff, is seen in Indiana as an all-around housing expert, and one with access to inside information, particularly at HUD. At an initial meeting over a dozen builders (many with extensive HBAI service in either appointed or elective roles) expressed interest. Eventually seven participated.

With help from HBAI staff, Moulder, Lee Kennedy (the heating equipment supplier who had assisted Moulder), academics from Ball State University, and Al Vandermeer (director of sales and marketing of a large, local manufacturer/distributor of building

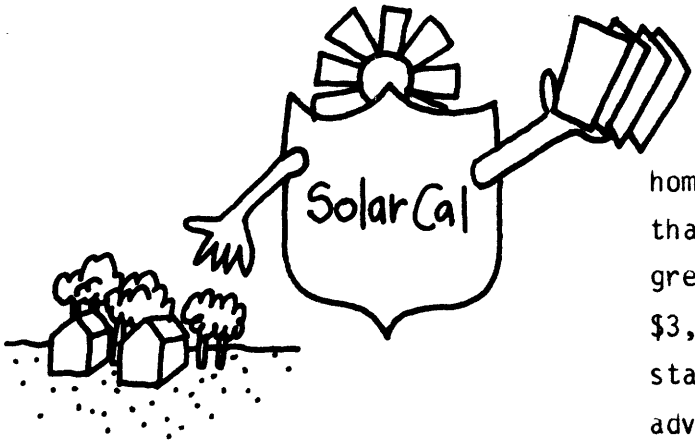
components), the group settled on a house plan, and on solar equipment. HBAI staff obtained support of government agencies and elected officials, Lee Kennedy prepared the technical areas of the applications, Vandermeer and Puller and his staff did building specifications, and drawings, and put the final proposal package together. As one project participant put it, "Without 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."

SOLAR FOR CALIFORNIA

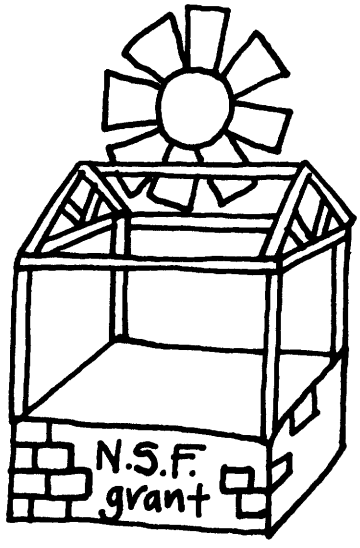


California is generally regarded as the state most active in experimenting with forms of solar energy. Vigorous efforts at various levels of government have fostered a climate that supports switching to alternative energy sources. This case looks at a municipality--Santa Clara--and a county--San Diego--to understand how their actions have influenced the acceptance of solar energy in the residential sector.

Solar energy is not new to California. Solar hot water heaters were first used in Pasadena in 1895, and continued to sell well into the 1920s, when gas and oil were found in the Los Angeles area. When fossil fuels became more costly and less abundant, California created a Solar Tax Credit, providing a state income tax credit of 55% of system cost in a single family



home, up to a total credit of $3,000. In other than a single family resident, if the cost is greater than $6,000, the tax credit is 25% or $3,000 per unit, whichever is greater. The state also has created a solar office and advisory council, SolarCal. There is a solar hot line service for builders, and informal assistance in development facilitating. There are also programs by the Energy Resources Conservation and Development commission, the Department of Housing and Community Development, and Department of Consumer Affairs. It is within this environment that the Santa Clara and San Diego County cases are considered.



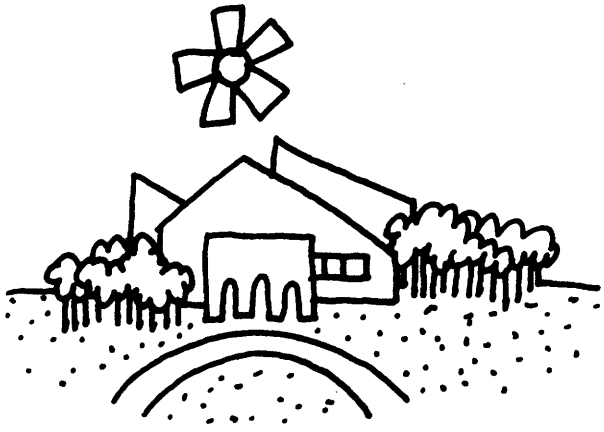
Santa Clara is a largely suburban city of 93,000 in the San Francisco Bay area. A council/city manager form of government, Santa Clara also operates a municipal electric company. Donald Von Raesfeld, city manager since 1962, is a registered civil engineer and, representing the city and its electric utility, an active participant in the American Public Power Association. With the 1973 oil embargo, Von Raesfeld decided that Santa Clara could pioneer the concept of a municipal solar utility. In 1974 a National Science Foundation (NSF) grant was obtained to support a solar heating and cooling unit for a new city recreation center. NSF also provided funds to hire a Science Advisor.

Based on this initial success, Santa Clara moved into solar heating for swimming pools. The municipal utility owned and installed the

units, charging customers installation and monthly fees. The HUD program provided yet another opportunity for the municipal solar utility. Nick Davis, the Science Advisor, approached the developers of the two remaining large single-family housing parcels in the city about applying for HUD funds. Ditz-Crane, a large residential development and construction firm based in Santa Clara, agreed. The city would own the solar units in the five demonstration house, with homeowners paying monthly rates. The homes were occupied in November, 1976. Though the swimming pool application has worked, the home heating effort has not been economically viable. Costs have exceed revenues by a factor of five. Technology limitations are one factor, but more important is the inability to compete with the rate structure for natural gas. There is a "lifeline" rate structure in which, as the customer uses more gas, rates increase steeply. Thus basic home heating is relatively inexpensive, while add-on heating (such as swimming pools) expensive. Solar is not competitive on the base rate, but is less expensive than the above-base costs. Though Ditz-Crane was offering solar hot water heating as an option in other northern California developments, there were few takers. The company no longer offers a solar option, concluding that buyers are not convinced solar systems work or are cost-effective.

San Diego County has taken a different approach to public sector support for solar. Rather than directly providing solar energy, the

county has required the private sector to move to this alternative. A county Solar Hot Water Ordinance requires solar hot water heating in all new homes in the all-electric areas after October 1, 1979, and in natural gas areas after October 1, 1980. Here the lifeline rate structure facilitated the adoption of the ordinance. As a southern county, San Diego has more swimming pools and better insolation than the Bay area.

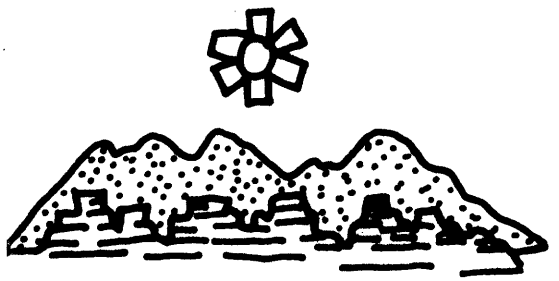


The governmental support for solar has prompted acceptance in other parts of the county. In Escondido, site of a HUD-grant project, bankers report from 25-50% of loan applicants for custom homes have solar systems in the original application, usually for solar hot water systems. The bank now has a routine procedure for evaluating such applications. One bank official commented that a factor limiting broader acceptance is a continuing lack of information on solar, including an inability to calculate actual and projected costs of energy, comparing sources.

Also in Escondido is the architectural firm of Ortiz and Brown, which developed the 12-unit single-family home Patterson Estates with support from a HUD Cycle 3 solar grant. The firm's president, Alfonso Ortiz, has prior experience in both low-income and industrialized housing. He has subdivided the Escondido market, and is attempting solar designs to meet each need. The firm's approach is unusual in a commitment to internal research; the solar ideas used in Patterson

Estates were developed welll in advance of the HUD program. In this respect Ortiz' firm has been able to capitalize on, as well as contribute to, the context of support for solar in the county.

PNM/AMREP



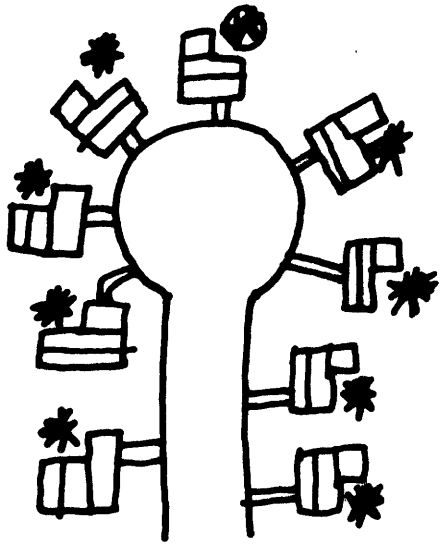
PNM/AMREP is a case involving the collaboration of a major utility--Public Service of New Mexico--and a major developer--AMREP--in the development of 25 solar homes. 23 of these homes are located at AMREP's 91,000 acre Rio Rancho development near Albuquerque, with the other 2 at its El Dorado development near Santa Fe.

AMREP Corporation is a major New York-based land developer, with large-scale operations in New Mexico and Florida. PNM provides electric service for the northern two-thirds of New Mexico, and is experiencing very rapid expansion in service demands.

AMREP's interested in solar dates from 1973, when their environmental consultant, brought AMREP together with MITRE Corp and General Electric, both of which were conducting preliminary research on solar energy utilization. AMREP was interested in possible applications at the Rio Rancho development. MITRE and AMREP ultimately did submit a proposal to NSF for funding for a solar residential development, though the proposal was not funded. Despite this setback, AMREP continued its interest. In fall, 1975, AMREP's

construction manager was directed to develop prototype solar homes for the lower-priced market. His investigation of possible solar suppliers established a liaison with Dr. Ed Redding.

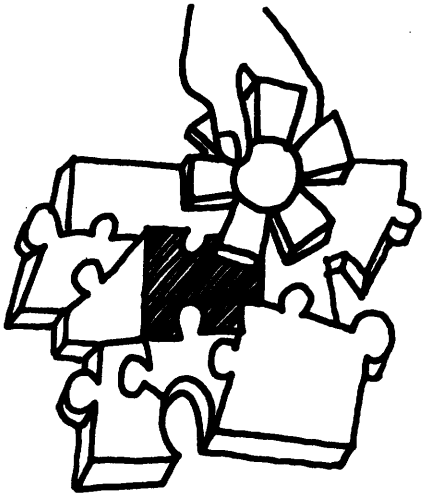
Both PNM's and AMREP's president sat on the board of directors of a local bank. AMREP's president proposed a collaboration on the prototypes, to which PNM agreed, as the utility was interested in reducing dependency on fossil fuels, and holding down energy costs for consumers. Further study also prompted PNM's interest in solar as a mechanism to level demand.



In the development of the protype effort, Redding acting in the solar supplier, served an important translating role between developer and utility staff, including working out a system design meeting the objectives of both.

With the success of the two prototypes, AMREP decided to expand the experiment to 25 homes, testing economies of scale and marketability. A Cycle 3 grant was obtained, with PNM as the project sponsor and AMREP as the primary developer. Again Redding's solar firm supplied the equipment. The results of this collaboration were again positive. AMREP is undertaking additional solar projects, including a solar-powered solar R&D center at Rio Rancho. PNM has expanded its solar activities, with involvement in additional solar R&D efforts.

IMPLICATIONS

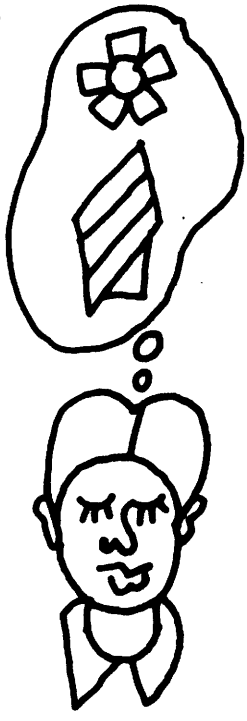


The five case studies presented in the preceding section, taken separately and as a set, provide good evidence of institutional factors influencing the acceptance of a solar technology in the residential sector. The DOE-HUD Solar Heating and Cooling Demonstration Program uses direct federal grants to prompt developers to incorporate solar thermal approaches into their residential developments. In only one of the four cases focusing on devlopers can it be concluded that the availability of the grant was the motivating force to use solar, and in that case (Reservoir Hill Solar Houses) the developer decided against further use of the technology. The fifth case, involving city and county government in California, provides evidence of altogether different public intervention strategies to prompt innovation acceptance.

This section identifies and discusses the institutional factors which did prompt use of solar thermal technologies in each of the five cases. Certain implications for addressing institutional factors in a effort to accelerate acceptance of photovoltaic solar energy in the residential sector are set forth based on this discussion. Three general observations are made. First, each actor in the residential sector has different, and complex motivations

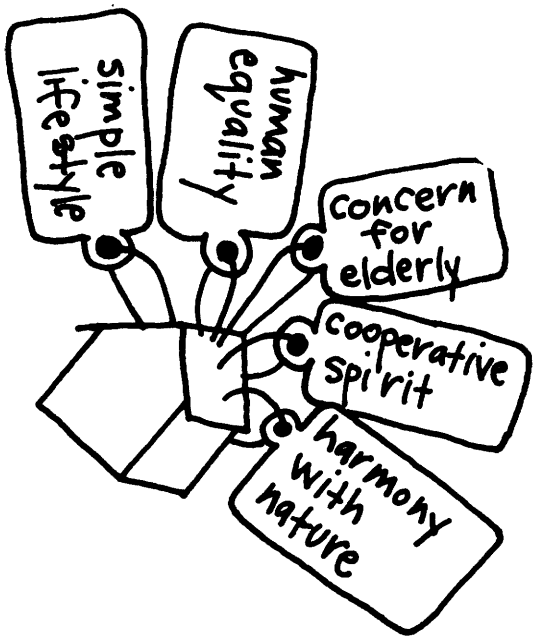
for considering, using and continuing to use an innovation such as solar energy. Second, the choices of any given actor are a function of the type, source, density, and continuity of information exchanges found within the institutional arena in which he/she operates. Third, the probability of rate and extent of innovation acceptance will be increased to the degree that the innovation is made comprehensible.

DEVELOPER MOTIVATIONS



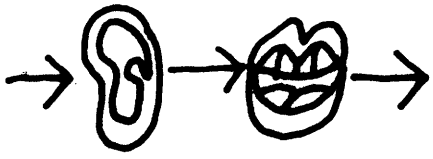
The DOE-HUD Solar Heating and Cooling Demonstration Program provided grants to developers to cover the costs of using solar thermal technologies in their residential developments. The assumption underlying this demonstration program strategy is that all of the considerations which a developer might give to using an innovation ultimately come down to the "bottom line," cost. Providing funding to prompt use of an innovation responds to this "bottom line" and, presumably, facilitates innovation acceptance.[1]

The five case studies reported here do not sustain this view. Rather they provide evidence of very complex motivations on the part of developers, motivations which differ when considering use of, using, or considering continued use of an innovation. Though in no case did a developer turn down the solar grant, its existence was neither necessary nor sufficient to prompt consideration of use of solar by any of the deveopers studied.



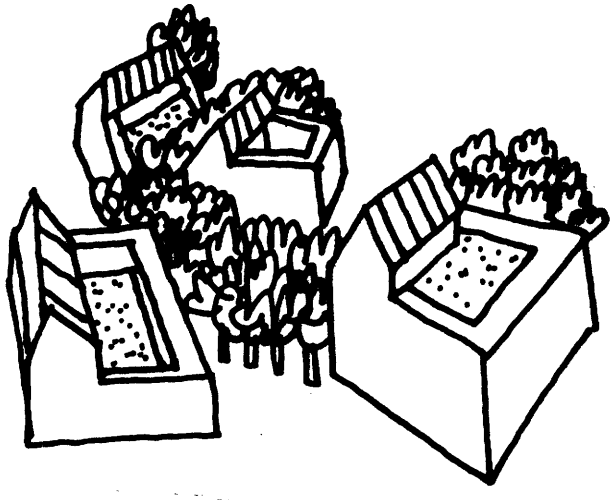
Friends Community is an especially good example of other factors influencing choice. A normatively-motivated developer, the Friends were more concerned with meeting the objectives for their community than with issues of cost. The 1972 statement of ideals included an emphasis on operation in harmony with nature, conservation, minimal use of natural resources and simplicity in development. In many respects the selection of solar energy was inevitable. Indeed, solar was chosen over wood for heating, in spite of cost disadvantages, because of the simplicity standard; it was determined that getting fuel for and operating wood stoves would be a burden on the elderly for whom the development was being planned.

The Indiana case is an interesting example of how little the solar grants themselves had to do with the project. Rather, Project Solar for Indiana was the cornerstone special project for Tom Laycock's term as President of the Homebuilders Association of Indiana. None of the seven developers involved would have undertaken the project without HABI's sponsorship; all of the key actors involved (Laycock, Puller, the seven developers, Moulder, Kennedy) participated solely because it was an HBAI special project. It is interesting, for example, that the developers involved were active HBAI members, having held high-level elected or appointive positions in the organization. What made this project feasible was the orgainizational priority it received.



In Baltimore, Melde Rutledge incorporated solar into his Reservoir Hill townhouse development because the "image" it provided made the project "bankable." Though he clearly would not have used solar had there not been the accompanying grant (and at that he lost money), the grant without the accompanying bankability would not have been sufficient for him to use solar.

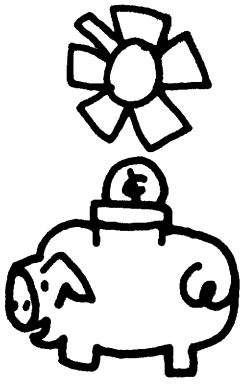
AMREP had begun consideration of solar well in advance of the solar grant program. The important factor in this early consideration was its trusted environmental consultant, who argued that the New Mexico location of the Rio Rancho development and the increasing costs of energy made solar a logical option. The 1973 oil embargo confirmed the wisdom of the observation, such that AMREP was willing to commit its own resources to developing prototypes. Here the "bottom line" entered, but was not influenced by the solar grant program. Rather, Dr. Ed Redding's role as a translator, linking technical solutions with housing realities, was the critical factor. Had AMREP been unable to understand what doing solar in its developments meant, it could not have even made a calculation of the bottom line. Once calculated, however, it was possible to commit its resources to the development of the two prototypes, and then use the solar grant program for the larger twenty-five unit development.



EXCHANGES IN THE INSTITUTIONAL ARENA

As described in the foregoing paragraphs, each of the developers had different motivations in

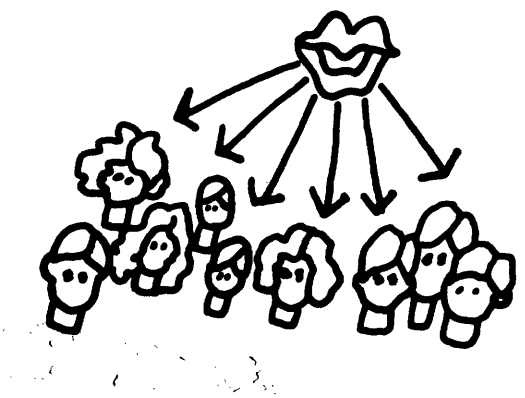
making a decision to use solar with the aid of the demonstration program grant. The choice made by each actor is a function of the type, source, density and continuity of information exchanges found within the institutional arena within each developer operates. None of the developers made the same choice for the same reasons. Indeed most decided to use solar for reasons quite apart from the solar grant.



Melde Rutledge's decision to use solar is an example of how the type of information is important. As he himself presented it, he did not care one way or the other about solar. What he did care about was the 'bankability' of his development. Thus the important information was not that the HUD grant would be awarded, but that the lending institution found the use of solar sufficiently attractive to be prepared to make a financing commitment. The bank's determination that the project would have been bankable on some others grounds undoubtedly would have led Rutledge to eliminate solar from his plans.

The Indiana case illustrates how the source of information in an institutional arena influences action. During the time period for solar grant applications for Cycle 2 funding, the state's energy office had conducted a very active campaign to involve the building community in using solar. It was, by and large, an unsuccessful venture, with few builders evidencing interest. By comparison, when HABI made solar its priority project for Tom Laycock's presidency, the response was much

stronger. The information had been presented by a legitimator--HBAI. Of course HBAI does not carry this same role with all builders, but it clearly did with those seven who participated. That each had had a position of influence and responsibility in the organization increased to them the legitimacy of any information from HBAI. This legitimacy was furthered by the personal attention the project received from such key institutional actors as Laycock, Puller and Kennedy.

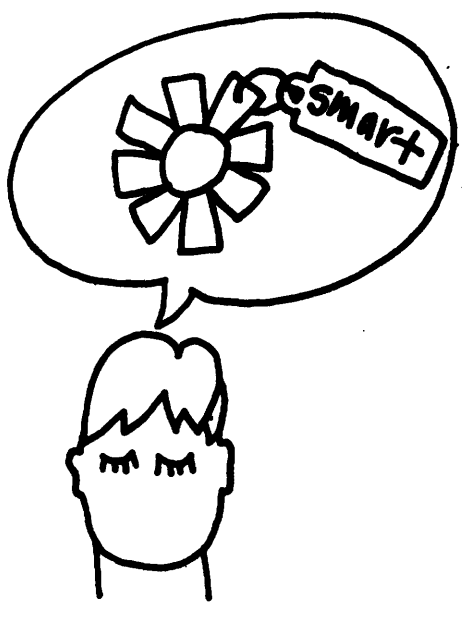


Density of information exchange is a frequently overlooked factor. An important element in AMREP's acceptance of solar occured when its construction manager was a panelist at a May 1974 conference on the use of solar energy for heating and cooling of buildings. The density of information exchange here was critical in prompting the succeeding steps in AMREP's participation in the AMREP-MITRE solar development proposal. This in turn established a sufficient base density of institutional knowledge to prompt AMREP to undertake prototype development itself. (A separate example of the importance of information density is the role played by the 1st National Conference on Solar Standards in prompting innovation in the standards setting process in the US. This is reported in Nutt-Powell and Wagner, 1979)

The Santa Clara case is a good example of the importance of continuity of information. The city's ownership of the electric utility provided, in the first instance, a continuing

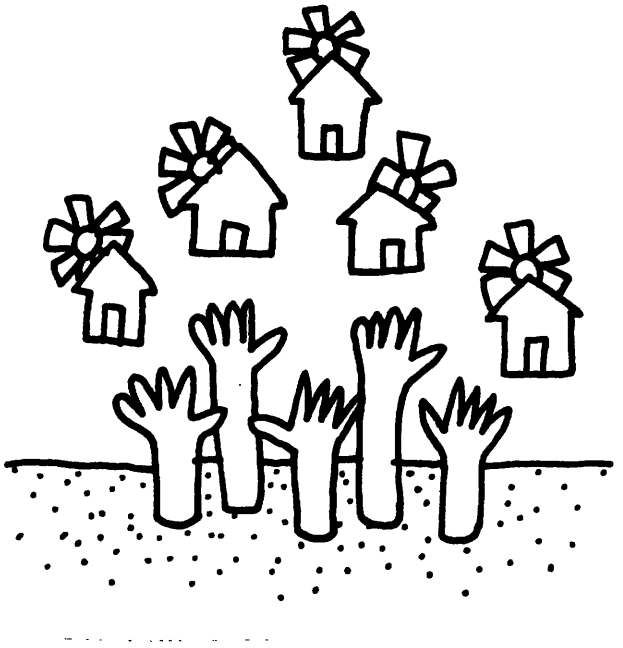
focus for information exchange in energy issues. The continuing, active participation in the American Public Power Association was a prompting mechanism for consideration of new technologies. But most important, in terms of a continuity of information exchange, was the appointment of a Science Advisor as a condition for the NSF grant. As distinct from either the City Manager or the director of the municipal utility, the Science Advisor had the sole, continuing responsibility to look for new energy applications. Institutionally, this provided for a continuity of information exchange on possible solar energy uses.

COMPREHENSIBILITY AS A CONDITION FOR INNOVATION ACCEPTANCE



An innovation is by definition new. Typically we think of an innovation as a new thing. But it is important to recognize that a new thing also implies new actions. What is done with the new thing is also new. Thus, as regards an innovation one asks not only--What is it?--but also--What do I do with it? To extent that one is able to answer the two questions the innovation can be said to be comprehensible. The actor comprehends what the innovation is, and what can be done with it, in the context of that actor's institutional arena.

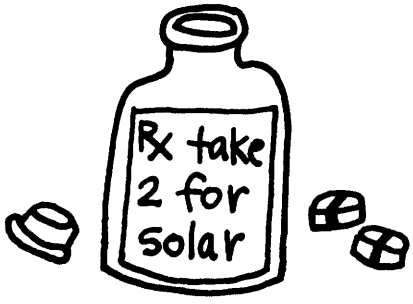
Each of the information exchange attributes described above is an instance of comprehensibility of an innovation by an actor in the residential institutional arena. For Rutledge because the information was about bankability, it was comprehensible; for the



Indiana developers because the information came from the HBAI it was comprehensible; for AMREP because the information was obtained in adequate density at the MITRE sponsored conference it was comprehensible; and for Santa Clara because there was a continuity of information via the Science Advisor it was comprehensible. In each of these cases the innovation and/or its use was linked with an existing institution. Because these existing institutions are known, their functions and activities stable and understood, they help mediate the instability which possible users fear the innovation might cause, making the innovation itself appear more comprehensible and "routine."

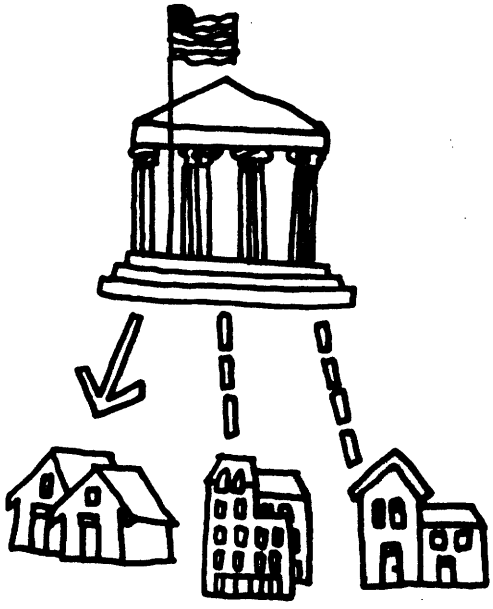
Where there are several mediating institutions, one can speak of a supporting institutional network. The Indiana case is an illustration of how the existence of a supporting institutional network made the innovation comprehensible to possible adopters. The state's energy office first gave solar publicity, bringing it into the information content of the institutional arena. Moulder took the "plunger" role, reaped rewards of publicity, and latter served as a legitimator to other builders, translating his experience into specific information on what a builder does with the innovation. Kennedy provided a key translator role, helping builders comprehend solar heating within the terms of their experience with existing HVAC technologies. HBAI and Laycock legitimated the undertaking, making it the year's special

project, while Puller did what he always does for Indiana builders, package the deal. In each case the connection of the innovation to a routine made solar comprehensible to the Indiana developers in Project Solar for Indiana.



By comparison, the experience of Rutledge's Centennial Development and Building Corporation in Baltimore illustrates how the absence of supporting institutional networks retards innovation acceptance. Once Rutledge had committed to using solar in the Reservoir Hill development, he encountered difficulties at each step of the way. In the actual construction, CBDC encountered confusion of roles, uncertainty of work activities, and unfamilarity with plans and requests. In part this was a 'labelling' problem. Simply calling something "solar" confused workers; what this new thing was and what should be done with it was not readily understood. Interestingly, on completion Rutledge felt the job was basically plumbing; in short, it became cmprehensible once more closely connected with an existing and understood building activity. Not only was there an absence of comprehensibility at the construction site, the weak "infrastructure" of the solar industry limited comprehensibility. The absence of local materials suppliers and the inability to interchange parts from different national suppliers meant major time delays. CDBC anticipates similar problems with the solar system operations in the first year or two of use. Said one staff member, "Take services. It isn't like calling the plumber for the toilet. Here they will call the

builder back for repairs." Their fears are probably justified. In Albuquerque, PNM is getting a substantial number of calls for servicing the solar systems. It is not surprising that the utility rather than the builder gets the calls, as the homeowners' routine when something goes wrong with either natural gas or electric energy is to call the local utility company!



The California case provides two illustrations of focusing on the institutional arena in its entirety. (By comparison the DOE-HUD strategy has a case by case approach.) In Santa Clara the utility servicing the entire city is the institutional entity through which the innovation is being introduced. It is providing energy for swimming pool heating on the same basis as it provides electricity, via a monthly use charge. The difference is in having the energy generating source at the same site as the user. In San Diego County, the passage of a solar heating ordinance covering all new development establishes a major change in the existing institutional envelope. The information is impacting all developers at the same time, and is disseminated through a routine source. Here the routine of local government is regulation; and the mechanism chosen to accelerate solar energy acceptance is regulation.

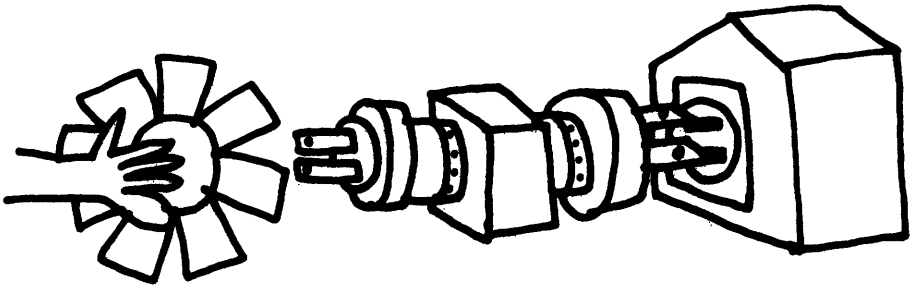
CONCLUSIONS

The first, and perhaps most important conclusion to be drawn, is that the motivations of developers are complex. Not only do motivations differ among developer types, they will also differ by location. What prompted acceptance of solar by Friends was absolutely without interest to Rutledge. What motivated San Diego County to approve its ordinance was not interesting to Santa Clara public officials. What was geographically compelling in New Mexico was not in Indiana. It is not possible to reduce motivations to simple, bottom line decisions.

Rather than being simple, decisions are a function of any given developer's role in a residential institutional arena, and the type, source, density and continuity of information exchanges within that arena. Thus any program which is aimed at accelerating innovation acceptance must attend to these attributes of information exchange, as understood within each institutional arena.

Finally, developers do not act in isolation. Housing especially is characterized by interdependencies among actors. There must be a simultaneity of information exchange to a sufficient number of actors in a given institutional arena for any actor in the arena to even begin considering initial and continuing innovation acceptance. It is this simultaneity which allows the buildup of supporting institutional networks. Thus not

only must an intervention program consider information exchanges for developers, but also for the other key actors in the residential institutional arena.



NOTES

[1]It can reasonably be argued that the DOE-HUD Solar Heating and Cooling Demonstration Program devised this strategy as a consequence of the institutional arena within which the program was created. Though there is not sufficient time or space in the context of this paper to present an adequate analysis, the argument, in essence, is: (1) the program was devised in a crisis atmosphere (2) in an institutional arena--Washington, DC--where (3) the currency of exchange is money. When pressed to resolve an issue rapidly, institutional entities fall back on established routines. In this instance the response of Congress is to "throw money at the problem." HUD, which administered the residential program, has traditionally used the financial incentive approach. The two routine responses--Congressional funding for HUD-administered incentive programs--institutionally combined for the solar grant strategy.

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