ENERGY LABORATORY

MASSACHUSETTS INSTITUTE
OF TECHNOLOGY

AN INSTITUTIONAL ANALYSIS OF THE SOLAR HEATING AND COOLING RESIDENTIAL DEMONSTRATION PROGRAM

Thomas E. Nutt-Powell

MIT Energy Laboratory Report No.
MIT-EL 80-024

April 1980

AN INSTITUTIONAL ANALYSIS OF THE SOLAR HEATING AND COOLING RESIDENTIAL DEMONSTRATION PROGRAM

Thomas E. Nutt-Powell

Joint Center for Urban Studies of MIT and Harvard University

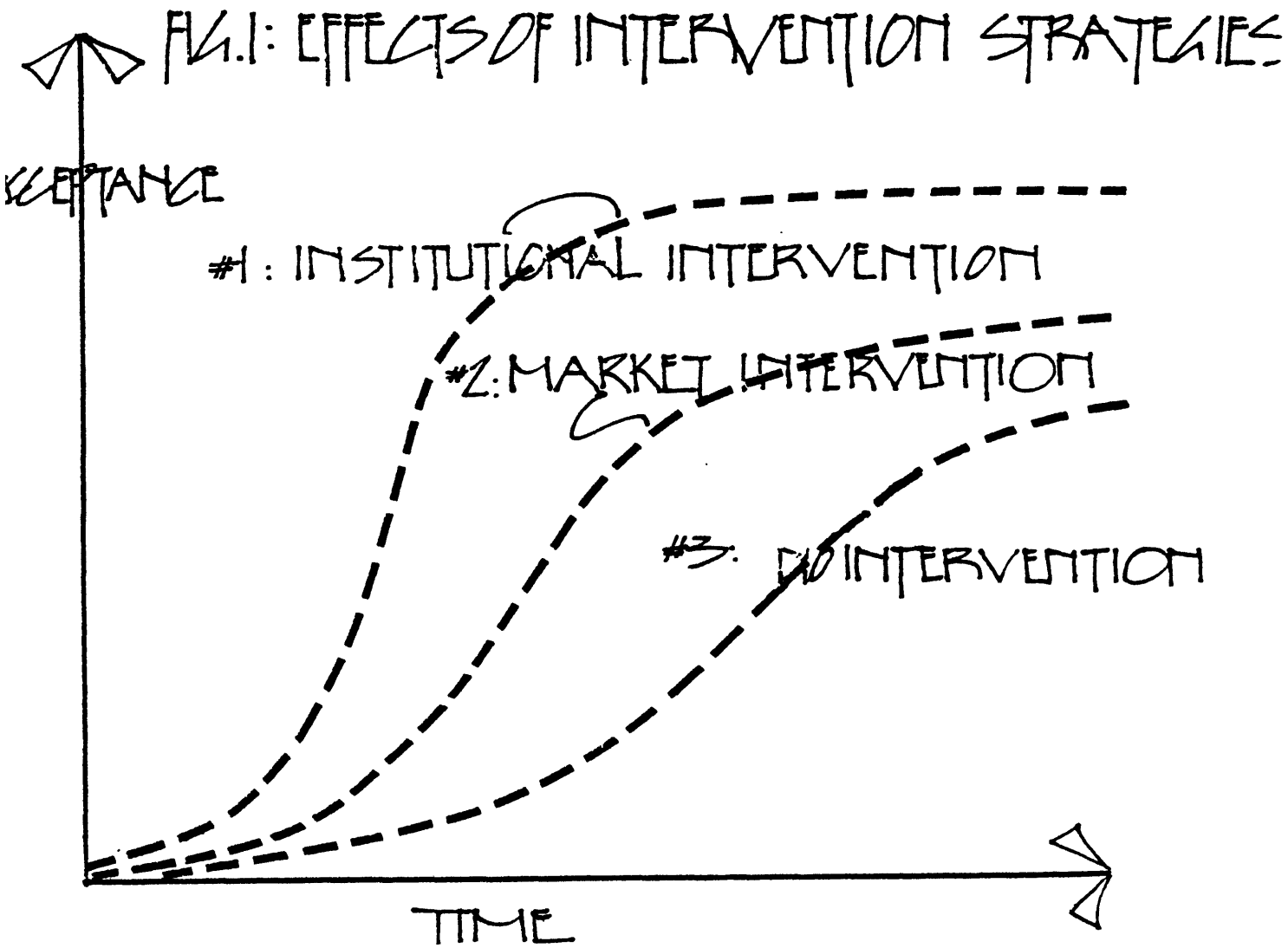
In 1974 Congress passed and the President signed Public Law 93-409, the Solar Heating and Cooling Demonstration Act. This act represented a major public initiative to promote widespread solar energy utilization. A major goal of that program was acceptance of solar thermal technologies in the residential sector.

This paper summarizes the results of nearly three years of study of the institutional factors influencing solar acceptance in a variety of settings. In particular it presents an institutional analysis of the Solar Heating and Cooling Demonstration Program in the residential sector. The paper presents a coherent picture of the program's design, implementation, and outcomes in order to promote an understanding of the implications of each for the design of programs to facilitate rapid acceptance of innovations such as photovoltaics in the residential sector.

THE ANALYTIC APPROACH

Institutional analysis assumes the existence of a variety of institutional entities and holds that the data on factors influencing innovation acceptance (and, by implication, resistance and/or rejections) lie in the exchanges between and among those entities (nature, rate, force,

frequency, etc.). Such exchanges occur within institutional arenas, which are described by the range and inclusiveness of the exchanges. Institutional analysis assumes that there are multiple currencies of exchange, each of which must be noted and is, to some extent, a factor in decision behavior. This is contrary to market analysis, which operates on the assumption that decision behavior can be adequately modeled in terms of willingness to make monetary exchanges. An understanding of the full range of institutional issues allows for a program design incorporating activities aimed at multiple exchange relationships. Such a program is more likely to be effective than market or any nonintervention approach.



STAGES, ACTORS, CONSTRAINTS

IN THE HOUSING PRODUCTION PROCESS

	ACTORS	CONSTRAINTS
BUILDING CONCEPT *the generation of an idea*	DEVELOPER ARCHITECT ENGINEER PLANNER CONSULTANT	ZONING LAW USER NEEDS MARKET CONDITIONS
BUILDING DESIGN *establishing uses, design, specifications*	DEVELOPER LAWYER REAL ESTATE BROKER TITLE COMPANY ARCHITECT ENGINEER SURVEYOR PLANNER CONSULTANT ZONING & PLANNING OFFICIALS	REAL ESTATE LAW RECORDING REGULATIONS & FEES BANKING LAW ZONING LAW SUBDIVISION REGULATION PRIVATE DEED RESTRICTION PUBLIC MASTER PLANS
BUILDING FINANCE *price estimation and obtaining of funds*	LENDING INSTITUTIONS FHA/VA MORTGAGE COMPANIES INSURANCE COMPANIES INDIVIDUALS PENSION FUNDS REIT'S/MIT'S	BANKING LAW FHA/VA STATE LAW GNMA/FNMA
CONSTRUCTION *physical production*	DEVELOPER CONTRACTOR SUBCONTRACTOR TRADE UNIONS MATERIALS MANUFACTURERS & DISTRIBUTERS BUILDING CODE OFFICIALS INSURANCE COMPANIES ARCHITECTS ENGINEERS	RULES OF TRADE AND PROFESSIONAL ASSOCIATIONS BUILDING & MECHANICAL CODES SUBDIVISION REGULATIONS UTILITY REGULATIONS UNION RULES INSURANCE LAW MATERIALS TRANSPORT LAW
SERVICE AND OCCUPANCY *maintenance, management, repair, improvements, additions*	DEVELOPER LENDERS MORTGAGE COMPANY MAINTENANCE FIRMS PROPERTY MANAGEMENT FIRMS INSURANCE COMPANIES UTILITY COMPANIES TAX ASSESSORS REPAIRMEN UNIONS ARCHITECTS ENGINEERS CONTRACTORS SUBCONTRACTORS ZONING & BUILDING OFFICIALS MATERIALS SUPPLIERS REAL ESTATE BROKER	PROPERTY TAXES INCOME TAXES HOUSING & HEALTH CODES INSURANCE LAWS UTILITY REGULATIONS UNION RULES ZONING LAW BUILDING AND MECHANICAL CODES MATERIALS TRANSPORT LAWS BANKING LAW RULES OF TRADE & PROFESSIONAL ORGANIZATIONS
DISTRIBUTION *sale and subsequent resale and refinance*	DEVELOPER REAL ESTATE BROKER LAWYERS LENDERS TITLE COMPANIES FHA/VA/PRIVATE MORTGAGE/INSURANCE COMPANIES BUYER	RECORDING REGULATIONS & FEES REAL ESTATE LAW TRANSFER TAXES BANKING LAW TAX LAW
TEAM SELECTION *a continuous changing of actors*	DEVELOPER ARCHITECT ENGINEERS CONTRACTORS FINANCERS	DEVELOPMENT REGULATIONS RULES OF TRADE AND PROFESSIONAL ORGANIZATIONS

SOURCE: Carole Swetky and Thomas E. Nutt-Powell, Institutional Analysis of Housing Production: A Preliminary Exploration (Cambridge, Mass.: MIT Energy Laboratory, 1979).

TABLE 1

Curve 1 in Figure 1 shows innovation acceptance without deliberate intervention. Curve 2 shows acceptance using a market intervention strategy. Basically, a market strategy moves the initiation of the acceptance curve ahead in time, but does not influence the rate or volume once it has begun. Curve 3 shows acceptance using an institutional intervention strategy. Acceptance activities begin sooner, at a more rapid rate, and with a higher final proportion of acceptance.

Table 1 describes housing as a sector characterized by multiple stages, actors, and constraints. Housing activity is very time- and place-specific, more so than other sectors, which have a relative uniformity of behavior regardless of time or location of activity. Therefore, while the stages, actors, and constraints shown on Table 1 represent the sector in general terms, specific manifestations of housing activity vary enormously from place to place and from time to time.

If "acceptance" means making something new a routine, then a measure of general acceptance of a solar technology in housing would be that it appears in the notation of routine of each of the actors, from the four-year-old's rough crayon drawing of "my house" to the architect's elegantly presented grand scheme for a home or from the contractor's back-of-the-envelope notes for a materials order to the supply company's annual catalogue.

The goal of the institutional analysis of housing, in relation to the design of a program to facilitate an innovation's acceptance as routine, is to understand just what is considered routine in the residential sector.

THE SOLAR HEATING AND COOLING DEMONSTRATION

Before the early 1970s Congress paid little attention to solar energy. (The chronology in Appendix I presents key dates and events associated with the SHAC program.) In 1971 the House Committee on Science and Astronautics (S&A) organized a Task Force on Energy which operated parallel to an NSF/NASA Solar Energy Panel. Both organizations reported positively on solar potential by late 1972 and made favorable reference to the state of existing solar thermal technology and its adaptability to residential use.

S&A's Subcommittee on Energy conducted hearings on solar energy technologies in June, 1973. These led to support for expanded federal solar programs; and in October, 1973 the Subcommittee's chair, McCormick of Washington, submitted a technology-oriented solar bill. The bill provided key roles for several agencies including NASA, NSF, NBS, DOD, and HUD. In November Senator Cranston of California, whose primary committee was Banking, Housing, and Urban Affairs, submitted a housing-oriented solar bill.

The oil-embargo energy crisis of that winter prompted rapid consideration of the bills. An amended version of McCormick's bill passed the House in February, 1974. The bill called for a demonstration of the potential for commercialization of solar energy from the point of view of technology development. It provided that NASA take a key role in guiding that development. In March the Senate Committee on Aeronautical and Space Sciences reported the House bill to the Senate. The new bill substituted similar technology development language from a companion Senate

bill which had been introduced by Senators Moss and Weicker. The House bill was then referred to four Senate Committees: Commerce; Banking, Housing, and Urban Affairs; Labor and Public Welfare; and Interior and Insular Affairs. The multiple referrals reflected the bill's several policy dimensions as well as considerations of jurisdictional controls. Subcommittees of the first three Senate committees conducted hearings. By May the language for a Senate version, which emphasized the housing dimensions of the program, were agreed upon; and on May 21 the bill passed the Senate. By the end of August, both houses had concurred with a Conference Committee report, and on September 3, 1974 President Ford signed the bill.

In its final form the Solar Heating and Cooling Demonstration Act emphasized both technology development and use in the housing sector. Points that could not logically entertain both objectives were glossed over by appropriately vague language. NASA and HUD were both given key roles, and ERDA was named in anticipation of its imminent creation.

SHAC Program Design

From September through December, 1974 NASA and HUD collaborated with NBS, DOD, and NSF to prepare the program plan required by the legislation. In January, 1975 ERDA was established. Two months later, in March, the new agency issued ERDA 23, its national plan for the Solar Heating and Cooling Demonstration Program (Appendix II). SHAC identified a number of major activities -- research and development; development in support of demonstrations; residential demonstrations; commercial demonstrations;

data collection; and solar energy use in federal buildings -- and a number of participants. HUD would take the lead in residential demonstrations; ERDA and NASA were assigned direct responsibility for most of the remaining tasks. Especially important was NASA's assignment for instrumentation, data collection, and analysis. The range of activities and the division of responsibilities reflect the effort to serve simultaneously two Congressional intents -- technology development and housing.

SHAC-Residential Demonstration Program

The strategy that guided HUD's residential demonstration program design can be readily summarized by the following syllogism:

- The developer/builder is motivated by the bottom line.
- The bottom line is dollars.
- Induce the developer/builder with dollars.

HUD used two types of demonstration approaches, site-system and integrated-system projects. Site-system projects involved matching a number of different systems designed for technology development purposes with a variety of climates and housing types. HUD decided upon this approach as a way to address the technology development goal. The choice meant, however, that HUD had to find developers willing to install NASA-prompted solar systems. Builders and developers did not readily accept the site-system approach, and HUD abandoned it after the first year of program operation.

The integrated-system approach had been discussed during hearings on both the House technology-oriented bill and the Senate housing-oriented

bill. It was an approach with which HUD was familiar, both through its on-going housing programs and from its experience during Operation Breakthrough, an earlier effort at the development of industrialized housing. In the integrated-system projects, a builder-developer selected a currently marketed system and integrated it into an existing or proposed single- or multi-family housing project. Applications for grant funds to cover the cost differential caused by the use of the solar system were accepted in a series of cycles initiated by nationwide solicitations. Through 1979 HUD had awarded over 750 grants totalling approximately $23 million for about 12,600 housing units.

HUD collected data on housing from projects using both approaches. HUD also provided certain of the projects with instrumentation to monitor technical performance. Though most of HUD's efforts were directed toward management of the demonstration approaches, it also incorporated provisions in the programs for developing performance criteria and standards and other, related studies.

A review of charts illustrating program organization and data flow provides interesting and revealing information. (See Appendix II.) Boeing, an organization with limited housing but considerable technological and engineering experience, was the major program contractor and is at the center of each chart. Organizationally Boeing was responsible for program management, data collection and analysis, and technical and grant management. Data, which are distinguished by their computer compatibility, flow to and through Boeing.

A look at the nature of the data collected (in grant applications, progress reports, instrumented houses, and so on) reveals the extent to

which this effort was driven by the technological orientation of the original bill, the emphasis of NASA/ERDA in this direction, and the inevitable mesh of Boeing's background with this orientation. Despite HUD's proclivities to put existing solar systems into housing and, thus, to develop a commercialization demonstration program in the residential sector, the instrumentation, data collection, and analysis orientation characterized the program as one of experimentation for technical development. The SHAC residential program, then, can be described in the following manner:

- The intent: a housing demonstration program illustrating the commercial feasibility of existing solar systems in various residential settings;

- The reality: a research and technology development program, pulled in that direction by the density of institutional forces (NASA/ERDA/Boeing/computer compatible data, for example) disposed to engineering experimentation;

- The outcome: a muddled program, serving the intended objectives neither clearly nor effectively.

The HUD SHAC residential demonstration program is muddled because it does not meet either the housing or the technology development objectives clearly or effectively. The program does meet some aspects of both objectives; and HUD, and its various contractors, approached and implemented their tasks responsibly. However, the very nature of the program's genesis and the constraints resulting from the manner and crisis atmosphere in which Congress created the enabling legislation left a residue

of nearly impossible conditions for implementing a program that was successful in achieving its objectives.

The Reasons for the SHAC Outcome

During a period of crisis, institutional entities fall back on routines which, by their very familiarity, provide confidence in the legitimacy of the activity about to be undertaken and the acceptability of its outcomes. In the winter of 1974, the Congress, NASA, HUD and the other primary institutional entities involved in the solar heating and cooling residential demonstrations program faced the oil embargo. A brief review of the arenas in which these institutional entities acted provides insights into the routines they adopted to create and implement the program. As shown in Table 2, the SHAC program involved four major institutional arenas -- federal policy, program administration, technology development, and housing.

In Arena 1, Federal Policy, Congress is a major actor and money is the currency of exchange. Congress's major routine is to propose and enact enabling legislation, authorize activities to implement the legislation, and appropriate specific funds to pay for at least some of the authorized activities. Congress created the SHAC enabling legislation in an atmosphere of the national energy crisis. In response to this atmosphere Congress followed a typical routine, "throwing money at the problem." What is more, a Conference Committee, which was quickly called

Table 2

THE FOUR INSTITUTIONAL ARENAS IN THE SHAC PROGRAM

ARENA 1

Institutional Arena: Federal Policy

Currency of Exchange: Money

Atmosphere: National Energy Crisis

Routine: Propose, Enact, Authorize, Appropriate.

ARENA 2

Institutional Arena: Federal Program Administration

Currency of Exchange: Status

Atmosphere: Turf Protection

Routine: Obtaining and Running Programs

ARENA 3

Institutional Arena: Technology Development

Currency of Exchange: Quantifiable Data

Atmosphere: Engineering Crisis

Routine: Instrument

ARENA 4

Institutional Arena: Housing

Currency of Exchange: Marketability

Atmosphere: Market Risk, Mitigated by Interdependencies

Routine: Word of Mouth

upon to resolve differences in language in legislation, used another typical routine. It combined language from both bills, despite inherent contradictions, and skillfully structured the language to obfuscate any differences.

In Arena 2, Federal Program Administration, the currency of exchange is status and federal agencies are primary actors. The routine in this arena is to obtain and run programs with the purpose of achieving status. Each program yields a different level of status. The atmosphere in which the routine is carried out is turf protection -- keeping programs, especially those that yield a high level of status, and working to acquire additional programs. Status in this context is not equated with level of funding although in some cases funding may have some influence on it. Rather status represents the perceptions of importance among the particular institutional entities in the arena. In the case of SHAC, HUD clearly stood to gain some status if it ran the residential component, and even more status if the language of the enabling statute were consistent with the definitions of HUD turf. Conversely, HUD would lose status if neither of those situations obtained.

In Arena 3, Technology Development, the currency of exchange is quantifiable data. The routine adopted to trade in this currency is instrumentation. In the case of the SHAC program NASA and ERDA perceived that existing solar thermal hardware was underdeveloped enough to generate an engineering crisis. At the very least the stage of development did not meet the claims made during the Congressional hearings. Reacting to the atmosphere of crisis surrounding the legislation, NASA and ERDA pushed for a technology development effort even greater

than envisioned by the original technology-oriented House bill. The heavy emphasis on computer compatible data, even in the housing demonstrations, is evidence of the forcefulness of this effort.

In Arena 4, Housing, the currency of exchange is marketability. As mentioned in the opening section of this paper, the housing arena is highly disaggregated and very responsive to conditions in the local markets. Activities in the housing arena take place in an atmosphere of market risk; that risk is mitigated by the interdependencies of all the actors in the market. The routine in the housing arena through which these entities interact is word of mouth.

Even this brief review of the four institutional arenas most involved in the HUD SHAC residential demonstration program reveals clear mismatches in the currencies of exchange, routines, and atmospheres. Concluding that institutional entities from these four arenas could readily mesh activities to accelerate the acceptance of solar technologies is as difficult as imagining that a business manager of a Teamster's local, a debutante, a medical technician, and a neighborhood gossip could form easy and pleasant company for each other at a dinner party given by the head of the Latvian Communist party.

FACTORS IN THE ACCEPTANCE OF SOLAR ENERGY IN HOUSING

In the course of analysis, three general types of factors prompting builder/developers to integrate solar thermal technologies into housing emerged. These are useful in understanding housing institutional arena routines and especially important for designing programs that can connect innovation to routine in order to facilitate innovation acceptance.

The three factor types are developer motivation, information exchanges, and comprehensibility..

A series of case studies illuminated the character of the three factors:

> Friends Community: a 160-unit, semi-detached housing development in North Easton, Mass., developed by a nonprofit corporation established by the New England Yearly Meeting;
>
> Reservoir Hill Solar Houses: a 15-unit, single-family, attached, market-rate development in the Reservoir Hill urban renewal area of Baltimore, Md.;
>
> Project Solar for Indiana: single-family houses, identical in terms of design, size, and solar units, each constructed by one of seven builders in different parts of the state with the coordinating sponsorship of the Homebuilders Association of Indiana;
>
> Santa Clara, California: a city-owned utility installing solar units in a new single-family development on the same basis as electric service;
>
> San Diego County, California: a mandatory solar hot water ordinance adopted by a county for new housing development;
>
> PNM/AMREP: the collaboration of a major utility (Public Services of New Mexico) and a major developer (AMREP) in the development of 25 solar homes in New Mexico, 23 of which are in AMREP's Rio Rancho Development in the Albuquerque housing market.

The prevailing notion had been that money stimulates builder/developer behavior. The case studies revealed the existence of other influences. Each of these was a necessary impetus for even contemplating the purchase of a solar thermal system.

Developer Motivations

In Friends Community, selecting a solar system was a logical consequence of the ideals on which the development was based and was pursued

despite the persistent arguments of infeasibility offered by many of the project's advisors. Normatively motivated developers commonly base decisions on their ideals. In Indiana team spirit motivated each of the seven developers involved in the Solar for Indiana project. None of them had responded to HUD's early proposal solicitations. However, each was very active in HBAI, and became involved in Cycle 3 as a consequence. The developer of Reservoir Hills in Maryland used solar as the lever to make his new development corporation viable. The solar grant provided the organizational foundation for his venture. AMREP was interested in solar as a potential vehicle for corporate expansion long before the HUD program. AMREP's idea that anything with a "sunny" character, fitting the New Mexico climate, could potentially enhance the corporation's image and consequent market share, not through any actual technical performance, but precisely because of its "sunny-ness."

Information Exchanges

The type, source, density,and continuity of information exchange influenced builder/developers' acceptance of solar technologies in housing. The critical information for the Reservoir Hills builder was not that solar would work but that it would make the development financially feasible in the eyes of the financial backer. The types of information (financial) and the source (a savings and loan association) were very important factors. Information of another type (aesthetic appeal, for example) or from another source (e.g., information of financial feasibility from the city's design review committee) would not have been as

compelling to that developer.

The compelling factor for the builders in Indiana was that the project information came from a highly trusted source, the Homebuilders Association of Indiana. The same information had been made available in preceding years through HUD's solicitation process with additional prompting from the state's Energy Office; but it had not been viewed positively, notably because each of those sources was outside the routine of Indiana builders.

The density of information was an important variable for AMREP. The company had been considering a solar initiative for its Rio Rancho development for over a year. AMREP decided to act after its Director of Construction had participated in a two-day MITRE Corporation conference devoted entirely to solar energy. The density of information provided by this conference was the impetus for AMREP to commit its resources to designing a prototype solar unit and testing it at Rio Rancho before the SHAC program had even been approved by Congress.

In Santa Clara, California, a Science Advisor, funded by NSF as part of its initial grant to use solar energy in a new municipal recreation facility, provided the continuity of interest in solar. The Science Advisor became a continuing source of information. He was ultimately responsible for furnishing new ideas on possible solar applications, including the installation by the municipally owned utility of solar home heating and hot water units in new homes as part of the HUD program.

Comprehensibility

The more comprehensible an innovation, the more readily it will be accepted. In the context of this study comprehensibility means that the actors can understand an innovation because it is part of and/or relates to the routines that exist. Information provided by the supporting institutional network enhances this comprehensibility. In the housing arena, this process becomes part of the basic routine as one of the interdependencies created to mitigate market risk for any of the institutional entities in the arena.

In the Indiana program, a legitimator, the Homebuilders Association of Indiana enhanced comprehensibility. In the AMREP/PNM program, a translator, the vice-president of the solar system supplier, enhanced comprehensibility. This person was able to interpret the needs and interests of the two parties for each other and, in turn, to create an acceptable solution in solar terms, solar being a new "language" for both AMREP and PNM. AMREP's early interest in solar energy was generated by the presence of a linking pin. An environmental consultant, who also consulted with MITRE and General Electric in developing their solar energy interests, linked AMREP to these two companies and provided the critical first step in AMREP's acceptance of the solar innovation as part of its corporate routine.

The New England Yearly Meeting, which developed Friends Community in Massachusetts, is a classic example of a different sort of actor -- the plunger, an institutional entity that accepts an innovation mostly as an article of belief, and plunges ahead with its implementation against

all odds and logic. For the Friends, technical infeasibility could not outweigh the routine feasibility of their beliefs.

Finally, San Diego County's role as a regulator, requiring by county ordinance solar in new development, was simply a continuing manifestation of the county's routine activities in relation to builder/developers. The county did not need to expend funds on direct financial incentives; rather it constrained the options of builders and gave them no choice but to accept solar.

MESHING INNOVATION WITH ROUTINE

The SHAC program is a legislative hybrid of technology development and housing objectives limited by its hybrid origin to, at best, partial achievement of its goals. As suggested in the comparison of the four institutional arenas, their currencies of exchange and routines do not mesh. When the routines of any given arena are met, those of one or more of the other routines are thrown into confusion.

In housing, financial incentives and technical data are not sufficient to lead to the acceptance of a solar innovation. The former represent the currency of the federal policy arena, the latter the currency of the technology development arena. Neither contribute to the currency of the housing arena, marketability, which is passed by word of mouth. Marketability is influenced by developer motivation, information exchange (type, source, density, continuity), and the comprehensibility provided by matching the routines of the particular arena, especially

through such mediating institutional forces as a legitimator, translator, linking pin, plunger, and/or regulator.

Innovation acceptance in the housing arena requires mediation through routine at the local market level. The nature of mediation, which aids comprehensibility, can be analyzed in a general sense (as above) but cannot be planned for in the aggregate. An analysis of each housing arena is necessary to understand the nature of the mediating routines and entities that it contains.

Recipients of SHAC subsidies were motivated by other than conventional market objectives. The motivations that prompted developer involvement in the SHAC residential demonstration program were varied but cannot be characterized as market oriented. The motivations included realization of ideals (Friends), team spirit (Indiana), organizational foundation (Reservoir Hills), and corporate expansion (AMREP).

Acceptance of the subsidy does not necessarily mean acceptance of the innovation. No developer refused the subsidy (although AMREP's first prototype was done entirely with corporate funds); however, accepting the subsidy was not a sign that a developer had accepted the innovation. The subsidy more typically allowed the realization of other objectives. Because the realization of the solar energy innovation accompanied the realization of other objectives, solar may find general acceptance comes easier later on. Being cloaked in the mantle of the success of other objectives contributes to furthering innovation acceptance. However, such simultaneity of events could just as likely be an example of spurious correlation as it is evidence of genuine acceptance.

The probability of acceptance of an innovation increases when information comes through routine exchanges. Especially in an arena such as housing, which exists in an atmosphere of market risk, the extent to which routine mediates the entry of an innovation is a measure of the probability of its acceptance. HBAI acting as a legitimator, the solar supplier acting as a translator, the environmental consultant as a linking pin, and the county as a regulator are all examples of routines in housing arenas which mitigate market risk by fostering particular institutional interdependencies.

Information must pertain to the innovation, not to the subsidy. Institutional entities typically assume that federal programs only provide funds. In this case they saw the SHAC residential demonstration program as a means to obtain funds and, as a consequence, established no new routines. The developers who continue to maintain a commitment to solar energy (Friends, Santa Clara, AMREP) were already committed to solar energy before they participated in SHAC; HUD funds simply made it easier for them to realize other motivations that were linked with, but not dependent upon, solar. Developers who have not continued to use solar energy (Reservoir Hills, Indiana) would again accept federal grants, for solar or any other activity that served their own objectives.

LESSONS

There are at least three very basic lessons to be learned from the SHAC residential demonstration program relative to designing a program to facilitate rapid acceptance of photovoltaics in the residential sector.

Research and demonstration are separate activities. Research and related development activities tend to fall into the technology development arena. Demonstration tends to fall into the federal program administration arena. The currencies of exchange and routines of each do not mesh. In constructing the SHAC legislation Congress mixed the two, creating a hybrid program doomed to frustrate the hopes of persons interested in achieving either set of objectives. Program design, implementation, and evaluation for the two are different. To be successful, each objective must be provided for separately.

The design and administration of innovation acceptance programs for the housing arena should take place outside Washington, D.C. The federal policy and program administration institutional arenas are among the few that exhibit a unity of conceptual and geopolitical space. The density of information exchanges this occasions, the legitimacy this density creates, and the consequent primacy of routines from these two institutional arenas create a strong climate of confidence in the routines. Because innovation acceptance in housing is facilitated by programming to match existing and definitionally local housing arena routines, design and administration of such a program must be allowed to escape capture by routines that counter chances of achieving success in the housing arena.

An effective program to facilitate innovation acceptance must mesh with the routines of the accepting institutional arena. Because in housing the routine is word of mouth, with exchanges among and between multiple actors with multiple motivations and maximum interdependencies,

the key to an effective program is a strategy that allows the dissemination of information in each local housing market.

APPENDIX I

SHAC CHRONOLOGY

Sources

1951-72	Diverse bills filed; none passed
1952	Paley Report on materials policy need for solar energy research
1971-72	Task Force on Energy, House Committee on Science & Astronautics (S & A)
Dec., 1972	NSF/NASA Solar Energy Panel Report
1972	S & A Committee Staff Report.

Design

June 7, 12, 1973	Hearings on solar energy technologies S & A Subcommittee on Energy supported expanded federal solar programs
June-Oct. 1973	HR 10952 drafted NSF, NBS, NASA, HUD, DOD introduced 10116 by McCormick
Nov. 2, 1973	S.2650 introduced by Cranston (Banking, Housing and Urban Affairs)
Nov. 5, 1973	S.2658 (H11864 companion) introduced by Moss & Weicker
Nov. 13-15 1973	Hearings on HR 10952 Energy Subcommittee
Dec. 10, 1973	HR11864 (amended version of 10952) to full committee
Jan.28, 1974	Reported to House
Feb. 13, 1974	Passed, with amendments by House
Feb. 19, 1974	HR 11864 - referred to Senate Committee on Aeronautical & Space Sciences

Feb. 25, 1974	Senate hearings on HR 11864, S.2658
March 11, 1974	Senate Committee (A.S.S.) reports HR 11864 substituting S.2658 language
March 13, 1974	HR 11864/S.2658 referred to 4 Senate Committees Commerce Banking, Housing, & Urban Affairs Labor & Public Welfare Interim & Insular Affairs
March 20-21, 1974	Hearings on S.2650 & HR 11864 - BHUA Subcommittee on H & VA
March 27, 1974	Hearings on S.2650 and HR 11864 L & PW Subcommittee on NSF
March 29, 1974 & April 5, 1974	Hearings on S.2650 and HR 11864 - Subcommittee on Science and Technology
May 21, 1974	HR 11864 passes Senate, with amendments
Aug. 12, 1974	Conference Report Senate agrees
Aug. 21, 1974	House agrees
Sept. 3, 1974	President Ford signs PL 93-409

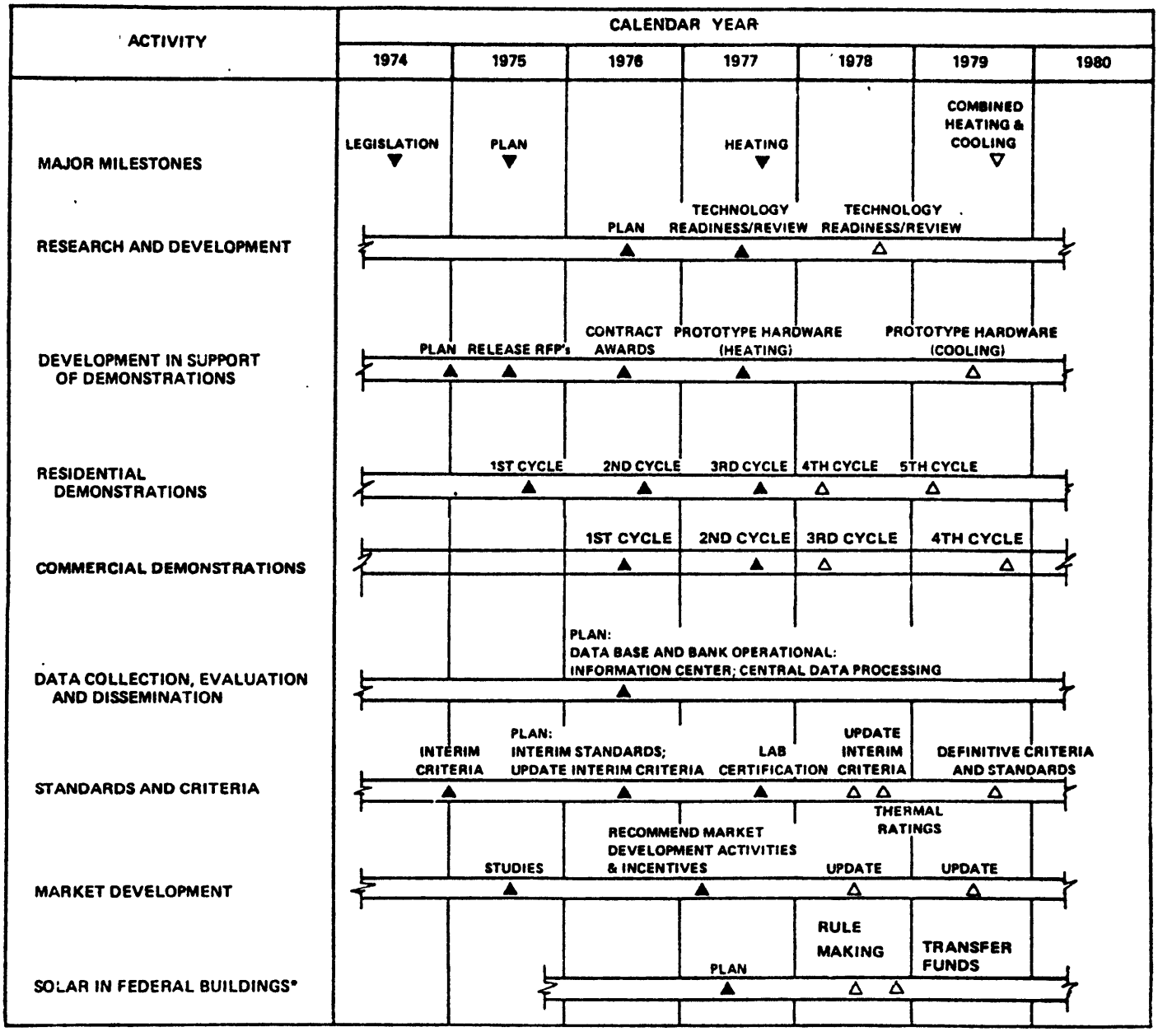
Implementation

Sept.-Dec. 1974	NASA/HUD with NBS, DOD, NSF prepare program plan submitted to Congress 12/30/74
Sept.-Dec. 1974	HUD prepares interim performance criteria for systems and dwellings to White House/Congress 1/1/75
Jan. 19, 1975	ERDA established - PL 93-438

March 1975	ERDA 23 - National plan
Oct 1975	1st National Conference on Solar Standards
Sept. 13-15, 1975	2nd National Conference on Solar Standards
Jan. 19, 1976	HUD Cycle 1
Nov. 1976	ERDA 23A - (76-6) updated national plan
Jan. 1, 1977	HUD Cycle 2
May 30, 1977	HUD Cycle 3
Oct. 1977	DOE established
Mar. 29, 1978	HUD Cycle 4
July 1978	DOE/CS-0007 national plan
Sept. 28, 1978	HUD Cycle 4a - passive

APPENDIX II

SOLAR HEATING AND COOLING PROGRAM



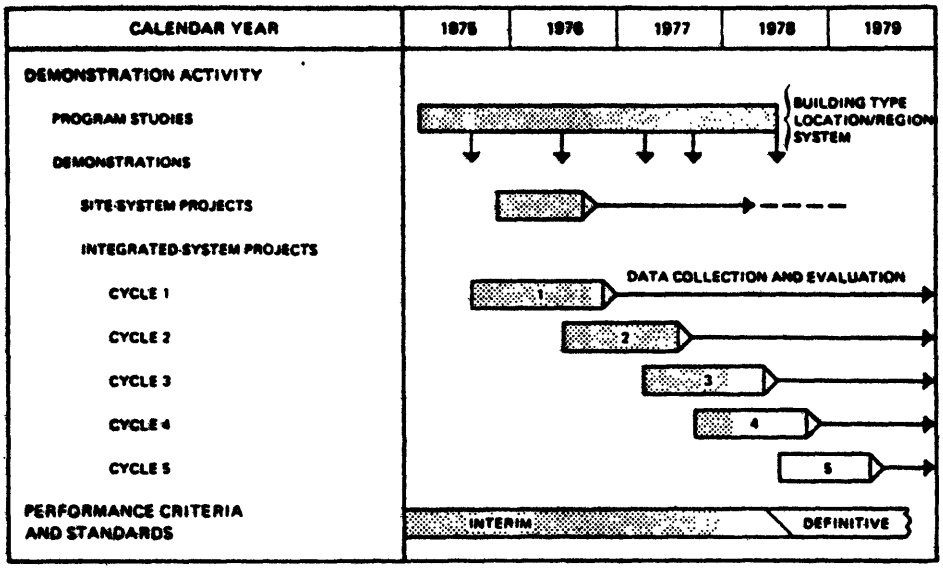
*A NEW THREE YEAR PROGRAM TO BE DEVELOPED IN ACCORDANCE WITH THE NEP.

▲ ACCOMPLISHED ACTIVITIES

△ SCHEDULED ACTIVITIES

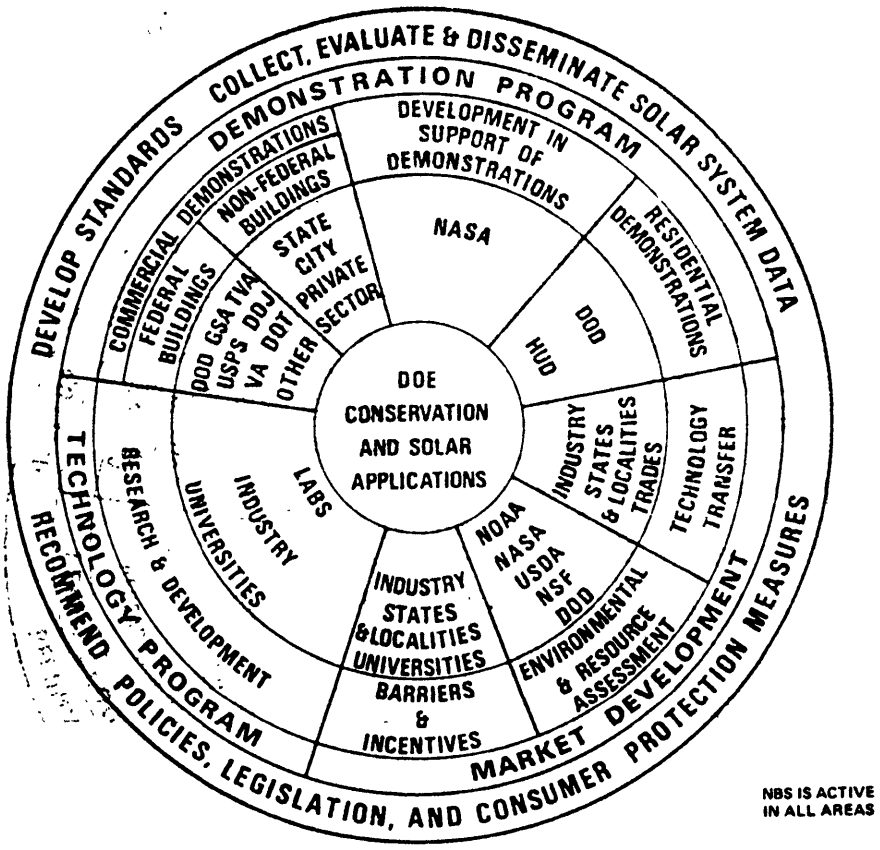
SOURCE: DOE, 1978c.

HUD RESIDENTIAL DEMONSTRATION PROGRAM

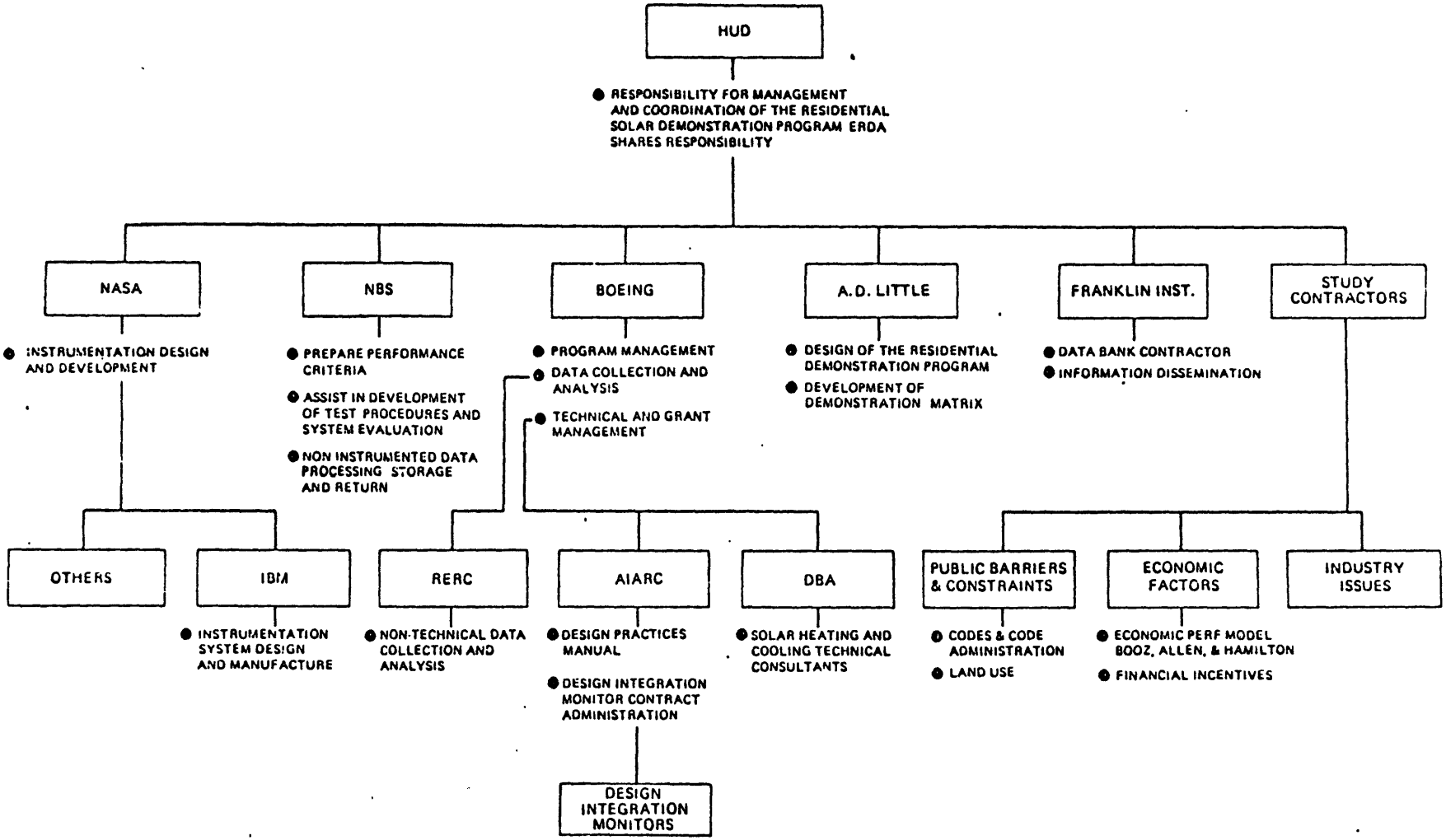


SOURCE: DOE, 1978c.

PROGRAM PARTICIPATION
NATIONAL HEATING AND COOLING OF BUILDINGS



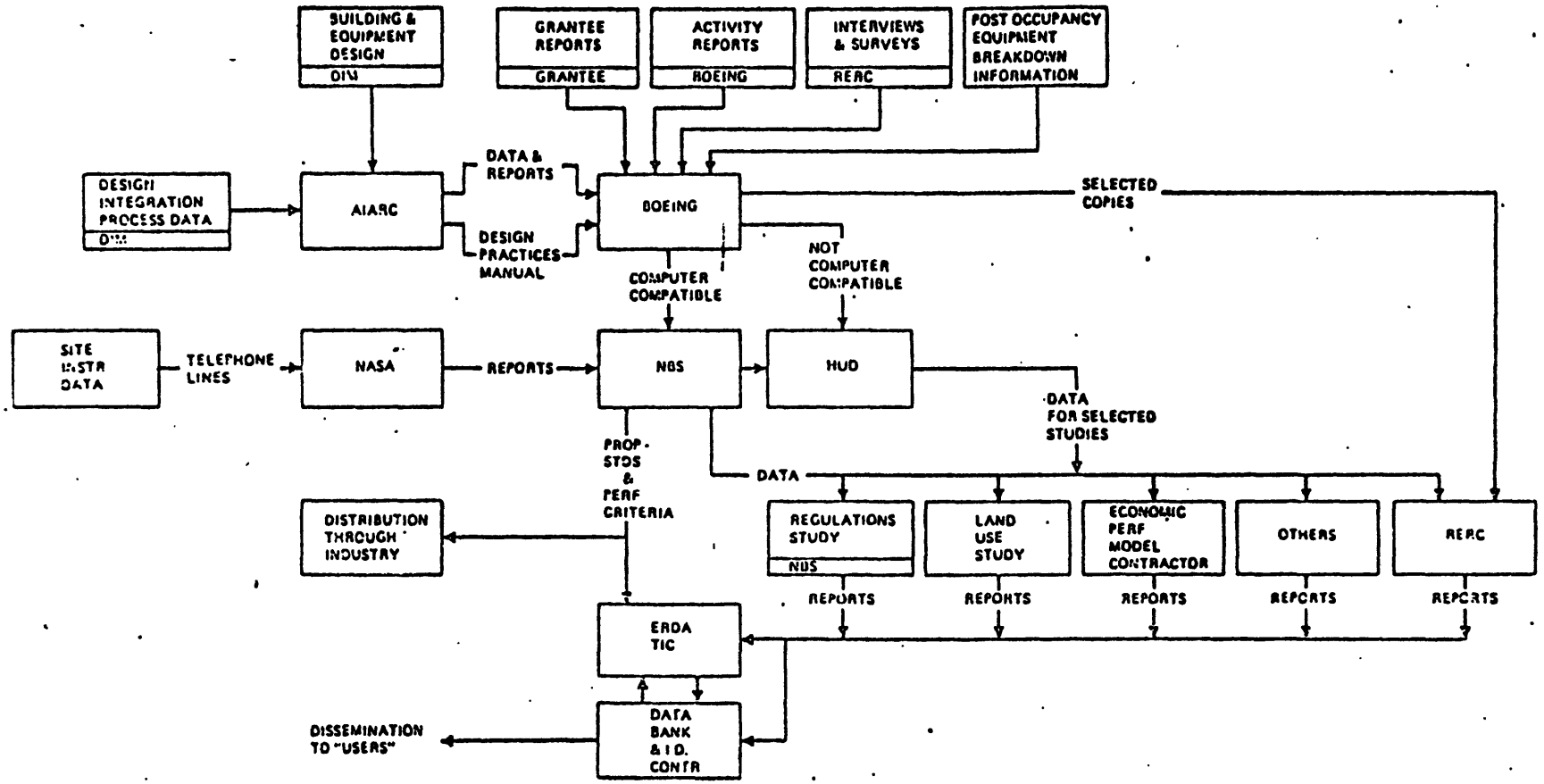
SOURCE: DOE, 1978c.



HUD Solar Energy Demonstration Program Organization Chart

RESIDENTIAL DEMONSTRATION PROGRAM

DATA FLOW CHART



REFERENCES

DOE (1978a) SOLAR HEATING AND COOLING DEMONSTRATION PROJECT SUMMARIES
Washington: DOE/CS-0009.

DOE (1978b) SOLAR HEATING AND COOLING RESEARCH AND DEVELOPMENT PROJECT SUMMARIES
Washington: DOE/CS-0010

DOE (1978c) NATIONAL PROGRAM FOR SOLAR HEATING AND COOLING OF BUILDINGS: ANNUAL REPORT
Washington: DOE/CS-0007.

ERDA (1976) NATIONAL PROGRAM FOR SOLAR HEATING AND COOLING OF BUILDINGS, PROJECT DATA SUMMARIES, VOLUME 1, COMMERCIAL AND RESIDENTIAL DEMONSTRATIONS
Washington: Division of Solar Energy.

Furlong, Michael and Nutt-Powell, Thomas E. (1979) INSTITUTIONAL ANALYSIS OF RESEARCH AND SOCIALIZATION IN HOUSING: A PRELIMINARY EXPLORATION
Cambridge: MIT Energy Laboratory.

HUD (1976) SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM: A DESCRIPTIVE SUMMARY OF HUD CYCLE SOLAR RESIDENTIAL PROJECTS
Washington: HUD-PDR-230.

HUD (1977) SOLAR HEATING AND COOLING DEMONSTRATION PROJECTS: A DESCRIPTIVE SUMMARY OF HUD CYCLE 3 SOLAR RESIDENTIAL PROJECTS
Washington: HUD-PDR-230-1.

HUD (1978) RESIDENTIAL ENERGY FROM THE SUN: A BRIEF DESCRIPTION OF HUD's RESIDENTIAL SOLAR DEMONSTRATION PROGRAM
Washington: HUD-PDR-351.

Library of Congress, Congressional Research Service, Science Policy Research Division, ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION, STATUTES AND LEGISLATIVE HISTORIES: Volume I, Solar Heating and Cooling Demonstration Act of 1974, prepared for the Subcommittee on Advanced Energy Technologies and Energy Conservation Research, Development and Demonstration of the Committee on Science and Technology, U.S. House of Representatives (Washington, Government Printing Office, April 1978).

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., Furlong, Michael, McDaniel, Patricia, Parker, Barbara and Reamer, Andrew (1979) SOLAR HEATING AND COOLING OF HOUSING: FIVE INSTITUTIONAL ANALYSIS CASE STUDIES
Cambridge: MIT Energy Laboratory.

Parker, Barbara and Nutt-Powell, Thomas E. (1979) INSTITUTIONAL ANALYSIS OF STANDARD 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 ANALYSIS
Cambridge: MIT Energy Laboratory.

Swetky, Carole and Nutt-Powell, Thomas E. (1979) INSTITUTIONAL ANALYSIS OF HOUSING PRODUCTION: A PRELIMINARY EXPLORATION
Cambridge: MIT Energy Laboratory.

Work reported in this document was sponsored by the Department of Energy under contract No. EX-76-A-01-2295. This report was prepared as an account of work sponsored by the United States Government.