SUNDAY: A SECOND APPLICATION OF A SIMULTANEOUS PREFERENCE REPORTING METHODOLOGY

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SWITCH ON THE SUN

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ABSTRACT

This paper, the second of three publications reporting on a Simultaneous Preference Reporting Methodology (SPRM), describes the collection of data on SunDay in May 1978. Respondents were drawn from among public visitors to SunDay activities on the Boston Common. The authors find among this presumably sophisticated and knowledgeable respondent group that photovoltaic (PV) solar energy is an undifferentiated innovation, that is, PV is too new for a broad sample of the public to comprehend and thus to make distinctions about the technology or its application. However, as in a previous application, the Simultaneous Preference Reporting Methodology appears to be an effective technique for collecting data on public preferences.

This paper describes the second application of a Simultaneous Preference Reporting Methodology. The authors are attempting to develop a new technique for ascertaining citizen preference and for determining public ability to differentiate with regard to the expenditure of public monies on innovation. In this instance, the innovation is photovoltaic (PV) solar energy. This research on PV is part of a larger study that is being conducted by the Energy Laboratory (E-Lab) of the Massachusetts Institute of Technology. The E-Lab is investigating the economic, marketing, and institutional factors which will affect the adoption and use of photovoltaic energy systems in the United States. The data collection described in this paper is one portion of the institutional analysis.

In an institutional analysis, there are six major institutional entities; the entity under discussion here is large public groups labeled "collectivities." The Simultaneous Preference Reporting Methodology (SPRM) was developed during the summer of 1977 to obtain data on collectivities within the Nebraska Agricultural Community (AgCom). SPRM was designed to: (1) diagnose and (2) predict collectivity response to innovation. The goals of SPRM also serve an objective of the US Department of Energy: accelerating acceptance of PV through defined interventions into institutional arenas. DOE is concerned with facilitating supportive institutional responses and minimizing responses that are hindering in nature.

The survey instrument employed in this methodology asks respondents to allocate finite funds (a "budget dollar") among seven research and

development categories. The analysis of these data focuses on the relationship between: (1) responses (the budget dollar allocations) which presumably represent collectivity perceptions of the funding needed to advance a specific innovation; and (2) the collectivities as defined by age, sex, and occupation.

The second application of SPRM on SunDay in May 1978 was undertaken as a test of the methodology itself. Budget pie formats are considered difficult to administer, and it seemed important to establish the applicability of SPRM. That is, was the first successful application a fluke that could not be duplicated, or was SPRM a methodology that could be repeated with diverse population groups? A less important, though equally interesting reason for this second testing was to determine whether or not a sophisticated and knowledgeable urban (rather than rural) population would differentiate in their responses to innovation. When the 294 useable questionnaires were analyzed, it was clear that, with one exception, for the population attending SunDay activities on the Boston Common, PV is an undifferentiated innovation. The one exception occurred among responses of collectivities defined by age groupings. Using discriminant analysis, the oldest age collectivity (aged sixty and older) was distinct from the other six age collectivities, displaying specific opinions, as a collectivity, on the expenditure of the budget dollar. Thus, some differentiation was exhibited.

In Boston, as in Nebraska, the methodology was successfully applied. This success offers further support for continuing the development of SPRM as a diagnostic and predictive tool.

This paper describes the collection of data on SunDay; analyzes these data; and briefly compares these results with the data obtained in Nebraska.

THE INSTITUTIONAL ANALYSIS OF INFORMATION

Photovoltaics is a unique kind of solar energy; it is electricity generated by solar cells from the light of the sun. At present, the most common solar cell material is single-crystal silicon. A two-inch diameter cell can generate about one-quarter watt of electricity in bright sunlight. Cells are connected in a weatherproof group called an array, which can be any size. The size of a particular array will depend on what equipment is to be powered. Until 1977, there had been no large-scale tests of PV; buoys, cathodic protection devices, communications equipment, and wristwatches represented typical PV applications. In July 1977, Lincoln Laboratory of MIT inaugurated the first large-scale application of the technology, an agricultural field test in Nebraska. The solar energy system in this demonstration irrigates an eighty-acre field of corn; the 12,000 bushels of corn harvested from these eighty acres were dried in storage bins utilizing PV-powered air-circulation equipment. In early 1979, a radar installation at Mount Laguna, California, will begin to receive supplemental power from a PV system, developed by MERADCOM. In the summer of 1979, Lincoln Laboratory will install arrays to power a daytime radio station by PV. In late summer 1979, the National Park Service development at Natural Bridges National Monument in Utah will be completed; all buildings and other equipment at the site will be powered by a PV system, again developed by Lincoln Laboratory. Though PV research is progressing, solar

photovoltaic energy systems are clearly technological innovations.

The collection of data on any innovation poses some unique problems. An innovation, by definition, is something new; therefore, potential respondents lack information on the subject. It is generally agreed in the literature that information is the "currency of innovation." (See Landers and Nutt-Powell, 1978; Lilien, 1978; and Nutt-Powell et al., 1978.) Thus, provision of information on a specific innovation becomes a part of the collection of data on responses to innovation. This information provision can be compared with exposure to a new product in marketing research. Data were collected in Nebraska because the field test and its accompanying educational exhibits and brochures provided information on the innovation of PV to potential respondents. Lincoln Laboratory's display at SunDay provided another opportunity to collect data at a site where information on PV was provided.

Institutional analysis is the study of how and in what forms social meaning is created, transmitted, maintained, and/or changed. An "institution" is a discernible entity that carries or is the repository for social meaning. Six types of institutional entities have been identified: formal and informal organizations; members; persons; collectivities; and social orders. Institutions are characterized by function, activity, and role. The institutional arena is the network of social exchanges between/among institutions. These exchanges, which occur over time, combine to yield a resource configuration. (For a detailed discussion of the approach to institutional analysis employed in this project,

see Nutt-Powell et al., 1978.)

Innovation is considered to be a deliberate and substantive alteration in the institutional arena. Information -- the currency of innovation -- is of two types: (1) Technical -- What do you trust?; and (2) Personal -- Whom do you trust? Institutions are risk averse; innovation creates the condition for risk by disrupting established patterns and definitions of social meaning. Thus, institutions will be more likely to accept an innovation (i.e., routinize it) if their information about that innovation is personal, since such exchanges are more likely to link to routine, stable meaning (Nutt-Powell, et al., 1978).

Further, in the institutional analysis theories in this research effort, it is hypothesized that there are at least three progressive stages of innovation acceptance. During the first stage, only the introducers of the innovation are able to differentiate ideas about or actions involving the innovation (Nutt-Powell, et al., 1978).

The data obtained from collectivities on SunDay are not as central to the institutional analysis being conducted by the MIT Energy Laboratory, as were the Nebraska data. Rather, this piece of research was undertaken to provide some further evidence that the Simultaneous Preference Reporting Methodology is a useful research tool. In other words, given the difficulties of successfully employing budget dollar formats, it is necessary to apply the methodology to different populations to determine whether or not the success in Nebraska could be repeated. SunDay offered the opportunity for such a test. Also, the population to be tested is a critical group with regard to the acceptance of new

technologies. That is, these potential urban respondents are young, well-educated, and upwardly mobile; these persons, in their institutional collectivities, set trends and styles and can help or hinder the acceptance of an innovation such as PV.

Collectivity is a social science research term originally coined by Talcott Parsons. As used here, collectivities are large, somewhat amorphous public groupings -- for example, the Environmental Movement or the media. A collectivity can be known or unknown to its members. It exists because it conveys some institutional meaning. At any point in time, a collectivity will have a certain institutional form, although the form can and does change over time. This research concentrates on collectivity reaction to and perception of innovation. It is an attempt to develop a theory on the behavior of collectivities when their members encounter innovation. The simple question to be answered is: at a particular point in time, is a specific innovation (e.g., PV) comprehensible to certain defined collectivities?

As implied earlier in this paper, the introduction of an innovation into an institutional arena demands that institutions change. As of now, institutional analysts do not know the specific costs of change for any collectivities. However, collectivity perception of these costs undoubtedly influences members' responses to innovation and is reflected in collectivity readiness to accept change (innovation) as well as in collectivity comprehension of (differentiation about) innovation.

RESEARCH DESIGN

Data were collected on SunDay to test the following propositions regarding the responses to innovation of various institutional collectivities attending SunDay:

1. Collectivities will distinguish among types of activities in support of PV research and development to the extent that the information encountered is personal. Conversely, collectivities will be unable to differentiate to the extent that the information is technical.
2. There will be differences among collectivities regarding stages of innovation differentiation.

It could be said that the null hypothesis is that collectivities will not differentiate about an innovation no matter what type of information is provided. This notion has particular application in the institutional analysis employed here with its theory of stages of innovation acceptance.

Two further propositions of this second application of SPRM are:

3. The Simultaneous Preference Reporting Methodology, though developed for use within the institutional arena of Nebraska agriculture, can be successfully applied in other institutional arenas.
4. Since the population from which potential respondents were to be drawn was expected to be a well-educated, technologically sophisticated, young urban population, respondents would evidence a greater degree of differentiation in their budget dollar allocations than was found within the Nebraska AgCom.

The potential respondent pool for SunDay represented a less well-defined institutional arena than the Nebraska agricultural arena tested in 1977. However, the population from which respondents were to be drawn could legitimately be described as representative of a particular segment of the urban population of large northeastern cities. It was further assumed that while a large number of people would "visit" the SunDay activities (on their lunch hours, for instance), it was thought that many respondents would be persons already supportive of solar energy systems. The basis for this assumption is, of course, the large amount of publicity alternative energy systems have received in the Boston area as well as the highly visible protests against nuclear energy that have also occurred in and around Boston, most notably in Seabrook, New Hampshire. At the very least, SunDay attendees were expected to be concerned with environmental issues and aware of declining oil resources.

It also seemed possible that, given the number of colleges, universities, and research institutions within the Boston SMSA, there might be a significant proportion of highly trained scientists and engineers among respondents. Although, given the current state of the art of institutional analysis, it is difficult, if not impossible, to predict which collectivities will differentiate; it was thought that these persons would be more likely to differentiate about an innovation either because they had a high level of prior information or because they would grasp more quickly the implications of research and development funding for an innovation.

As in the Nebraska research, collectivities were defined on SunDay by reference to sex, age, and occupation. As already noted, it was hypothesized

that engineers and scientists,as collectivities,would be more likely to differentiate about research spending for a technological innovation. It was also assumed that the range of collectivities among respondents would be representative of collectivities in other large, northeastern cities and that differences identified among collectivity responses would be diagnostic of innovation differentiation and predictive of responses of similar collectivities in similar urban centers.

Potential respondents on SunDay were presumed to be more likely to consider the proffered information about PV to be personal because of: (1) their interest in solar energy and their commitment to environmental interests as evidenced by their attendance at SunDay and their participation in this research; (2) their recognition that SunDay was legitimated (by presidential proclamation) as a national observance of the potential of solar systems as a viable energy source; and (3) their sources of information: Lincoln Laboratory and the Massachusetts Institute of Technology, both highly respected scientific institutions, both funded by the US Department of Energy, a new federal department, headed by a respected and respectable presidential appointment. It should be noted that while MIT and its research laboratories are not universally liked -- they have been the targets of numerous protests against defense oriented research--the laboratories and their personnel are respected for the high calibre of their work. People do expect to learn of new technologies from such institutions.

As in Nebraska, it was assumed that responses on the survey instrument would reflect the ways in which information is valued. Differentiation would indicate comprehension (acceptance) of the innovation. The absence of differentiation would indicate zero comprehension.

Since there was limited differentiation in the Nebraska data (Nutt-Powell and Sorrell, 1978) between the pricing categories considered to be hardware ("Operating Costs," for example) and those labeled software (e.g., "Institutional and Financial Aids"), with hardware receiving slightly higher allocations, it was thought that the SunDay data might also reflect this slight difference. This hypothesis had originally been formulated since it is simpler to visualize a product (hardware) innovation than it is to formulate a process (software) innovation.

A possible difference between SunDay data and the Nebraska research was thought to be that SunDay respondents, who might well be opponents of nuclear energy, would utilize the pricing category labeled "Other," as a means to communicate their opposition to nuclear energy research and nuclear plant construction. This item was semi-open-ended. (See the survey instrument in Appendix 1.)

Description of Data Collection Site

As already noted, SunDay was observed in cities and towns throughout the US. Patterned on the Earth Day celebrations of the 1960's, most SunDay festivities were held outside and included educational displays and information on solar energy. In most locales, elected and appointed officials attended some activities. SunDay was held on 3 May, a Wednesday, which was a lovely warm spring day in Boston.

The focus of Boston's SunDay activities was the Boston Common, where dozens of groups set up various displays, models, and exhibits on solar energy. The five-sided Common is a large, well-traveled

downtown park, with a Frog Pond (for children to wade and "swim"), benches, trees, and a history as the focal point of public activity across the political and social spectrums. It is located directly in front of the Massachusetts State House. Closeby are the financial and retail centers of Boston as well as the complex of local, state, and federal office buildings known as Government Center. The Tufts-New England Medical Center and the sprawling teaching, healthcare, research complex of Massachusetts General Hospital are also located within walking distance of the Common. The Common is bordered by the Public Garden with its famous Swan Boats. Beyond the Public Garden is the Back Bay section of Boston, populated by students, young professionals, and upper income slightly older professionals. Back Bay, in short, houses a large politically liberal, environmentally conscious, upwardly mobile middle and upper income population. To the west, Beacon Hill provides housing for these same population groups.

The Common and Public Garden are well-served by public transit, both bus and subway. Thus, students from Cambridge (across the Charles River) and inner ring suburbanites were expected to join the thousands attending SunDay.

Lincoln Laboratory's well-executed display was located at the heart of the SunDay exhibition. Research staff noted that it outdrew other displays by a factor of two. Figure 1 is a line diagram of the display site. The Nebraska portion of the display was the portable exhibit, describing PV and the Nebraska field test, which was first used at the Nebraska State Fair. The fifteen-panel exhibit presents a simple explanation of PV technology and includes three working models which allow

visitors to switch on or off the sun. Large color photographs illustrate the brief text on the PV field test in Nebraska. The silk screened metal panels are in eye-catching "sun" colors -- bright orange and yellow.

Engineers at Lincoln Laboratory had constructed a working model of the PV field test at Mead, Nebraska, to accompany the exhibit at SunDay. The model included a working gated pipe irrigation system and operative drying bins for corn.

At the center of the display site was a model of a PV-powered wheelbarrow-like irrigation system for less-developed countries. Beyond that portion of the display was a model of PV technology in the residential sector. A single-family house, heated, cooled, and so on, by a PV system was the focus of this part of the exhibit. Both of these components had exhibit panels of the same type as the agricultural exhibit.

The fourth component of the display was the data collection area. A grouping of tables and chairs were provided for respondents. Questionnaires were stacked on the tables. Boxes of brightly colored pencils, with the "Switch on the Sun" logo, were distributed for use in filling out questionnaires. Pencils were, of course, take-home items. Staff at Lincoln Laboratory had prepared some printed materials; however, these handouts were not specifically keyed to the displays. Rather, they presented general information about PV.

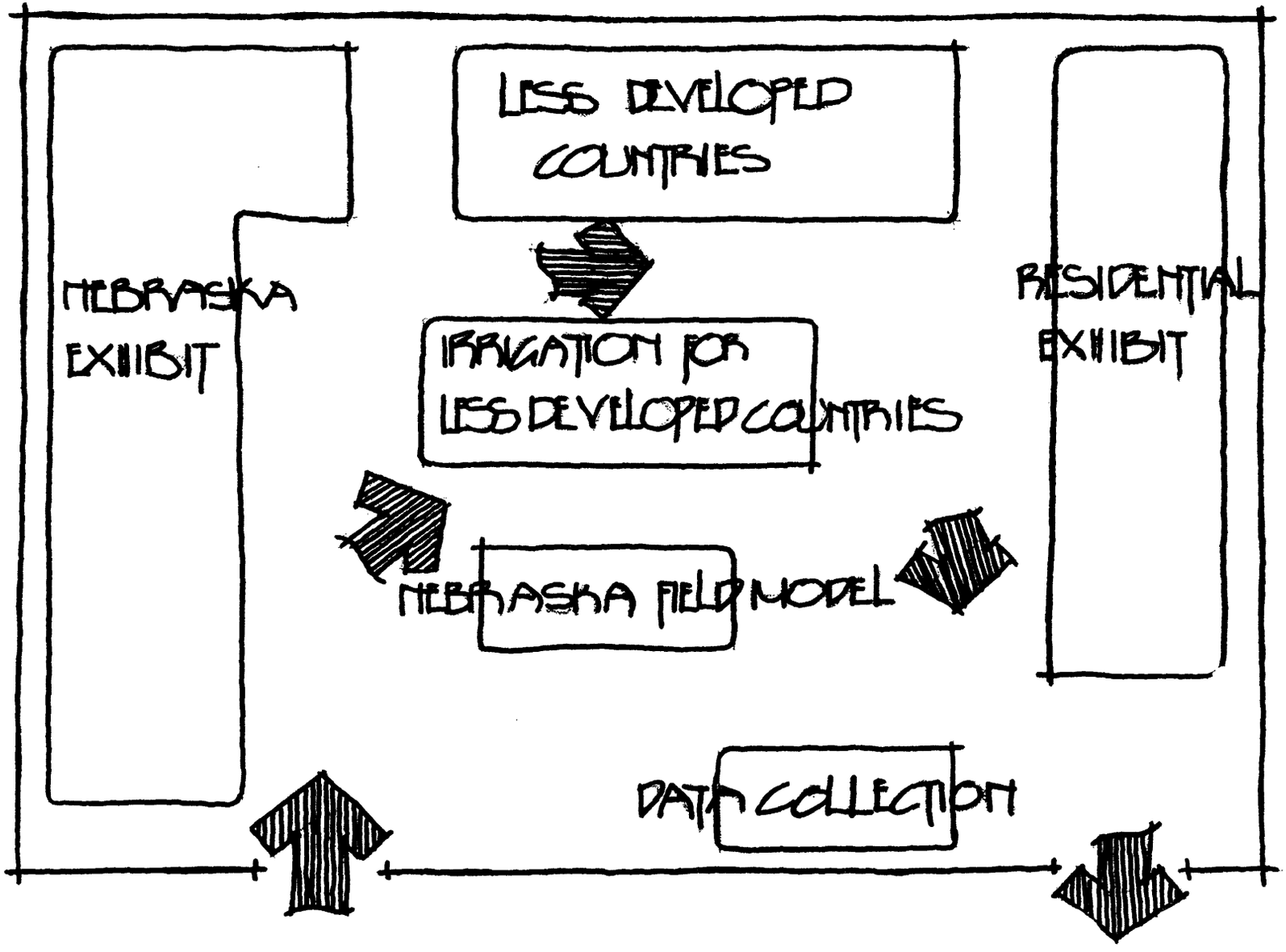

FIG 1. SITE PLAN: LINCOLN LAB P.V. EXHIBIT- 'SUNDAY' - BOSTON COMMON

Methodology

Originally, the research on collectivities within the Nebraska AgCom was to be composed of two one-shot case studies. (The terminology is that of Campbell and Stanley, 1963.) However, because of difficulties in developing the methodology and with data collection at one of the sites, only one study was successfully completed. The data collection on SunDay meant that research staff would now have the opportunity to carry out a second study. Although, as noted earlier, the population to be surveyed in Boston is quite different from the population of agricultural Nebraska, the data from the two surveys would at least provide material for contrasts; the surveys would generate information about differences. Most importantly, SunDay offered the chance for a second test of the Simultaneous Preference Reporting Methodology. While the focus of the research remained on collectivity response to innovation, it was equally important to prove or disprove the worth of SPRM.

The limitations of one-shot case studies are obvious, particularly threats to the internal validity (the reliability) of the research. The most serious weakness is that there may be rival plausible hypotheses that better explain the responses and that would invalidate researchers' conclusions.

What is important to note here is that several features of this research mitigate some of the concerns about the reliability of one-shot studies. As pointed out by Nutt-Powell and Sorrell (1978):

> First, the categorization of collectivities on the survey instrument (age, sex, occupation, and so on) would allow for an identification of bias as indicated in the assumptions discussed earlier. Second, while these assumptions had to be made explicit in the overall research design to maintain a level of quality in the research, this explicitness also defined the preconceptions that research staff believed would stimulate respondent interest in solar energy. For instance, it was assumed respondents under thirty years of age would express more positive reactions to PV than would over thirty respondents. Third, despite the research tradition of measuring a population prior to introducing the experimental X, research staff in this undertaking were not concerned with measuring knowledge about photovoltaics prior to the stimulus. Given the fact that PV technology is only now being developed and thus relatively little information has been published, it seemed reasonable to assume that very few potential respondents would have knowledge of PV prior to seeing the exhibit or the field test. The innovation had to be introduced into public consciousness before data could be collected on reactions and responses to PV. Thus, the usual concerns about the effects of testing on those being tested took on a different character. It was intended that the test (the exhibits, the brochures, and the survey instruments) have <u>some</u> effect on potential respondents (p. 17).

In institutional analysis, if SunDay respondents did possess a higher, prior level of information about PV, this information would not invalidate their responses. Rather, more information should allow for greater degrees of differentiation in assigning funds to the research and development categories.

The approach used, in Nebraska and again on SunDay, was one that is more reflective of a marketing (vendor) strategy than a traditional research design. The utilization of sophisticated displays with working models; the use of bright "sun" colors; the "handouts," especially items like pencils, all combined to create this strategy. While much effort had been directed toward explaining PV technology in simple terms, innovative technologies, including photovoltaics, are usually complex. In order to attract the attention of potential respondents to such complexity, marketing techniques were employed.

Given the population to be tested, it was impossible to obtain a random sample; thus, the weaknesses associated with respondent self-selection had to be recognized. The vendor strategy also affects willingness to participate. It is thought that vendor techniques increase the potential applicant pool by capturing the attention of more persons. In Nebraska and on SunDay, it was assumed that respondents would include larger numbers of people opposed to and supportive of solar energy. The assumption for SunDay was that most respondents would be supportive of solar energy systems prior to their attendance at SunDay. It was also expected that SunDay respondents would be younger (given the potential respondent pool described earlier) and better informed about solar energy than were their Nebraska counterparts. It is, of course, necessary to exercise caution in projecting SunDay responses onto a larger population.

The design and development of the Simultaneous Preference Reporting Methodology will not be discussed in detail in this paper. Readers interested in a more complete discussion are referred to the paper reporting the Nebraska survey. (See Nutt-Powell and Sorrell, 1978.) The decision to obtain simultaneous preference data (rather than simple binary choices) was based on two facts: (1) the resources under consideration are federal (tax) monies,and they are limited (finite); and (2) federal agencies allocating funds for research and development are faced with a range of choices which require simultaneous allocations of limited funds. It was decided that introduction of these "realities" to the collection of public preference data would greatly enhance the validity and usefulness of the opinions/preferences obtained. It is important to emphasize here that the word simultaneous in Simultaneous Preference Reporting Methodology refers to the simultaneity of dollar choices respondents are asked to make; it does not

refer to simultaneous forms of measurement or analysis.

The budget pie format though not widely used has certainly been well-tested. In the literature, it is considered a complex format and a difficult one to apply. (Again, for a review of such materials, see Nutt-Powell and Sorrell, 1978.) The budget pie format in the Nebraska and SunDay surveys was modified with a pricing technique. (See Appendix 1.) The assumption was that certain collectivities would assign monies to specific pricing categories while allocating no funds to other categories. These assignments would be interpreted as preferences and would presumably represent collectivity perception of the costs of change. If certain collectivities exhibited, through their budget dollar allocations, certain spending patterns, then, it would be assumed that for these specific collectivities, the innovation (PV) is comprehended and comprehensible. PV would for these groups have moved beyond the initial stage of innovation acceptance, where only the introducers of the innovation comprehend its usefulness. Thus, identifiable collectivity spending patterns would indicate that <u>these</u> collectivities are able to differentiate -- in this case, to make choices on the allocation of funds for PV research and development.

A difficulty in analyzing data from both surveys was the lack of a random sample. Thus, as pointed out in the earlier paper, no claims for construct or convergent validity can now be made for this research. Future tests will include attempts to confirm the validity of previously obtained data with other, independent measures.

The important objectives of the SunDay survey should be reiterated here: (1) a second testing of the Simultaneous Preference Methodology to ascertain whether or not it could be successfully applied to a

different population; and (2) a survey of a presumably more knowledgeable population to determine whether or not these respondents would differentiate with regard to an innovation.

The Survey Instrument

The questionnaire used on SunDay was the second of two survey instruments developed for use in the Nebraska AgCom. It is purposefully simple. All items appear on a single, legal-sized sheet. Most of the items on the survey instrument are close-ended. (Appendix 1 contains a copy of the survey instrument, which has been photographically reduced to fit on an 8 1/2 by 11 inch piece of paper.) Four of the twelve items might best be termed semi-open-ended in that they provide limited space within defined parameters for responses. These items deal with occupation; organizational affiliation; sources of more information on PV; and the final budget dollar item, "Other," with space to list personal choices for expenditure of funds.

The items on sex, age, occupation, and organizational affiliation were directed toward the identification of collectivities. The space for secondary occupation was relevant to the Nebraska survey -- a number of farmers and ranchers work at alternative employment during the winter months; this item was not considered important for SunDay respondents, although a surprisingly high percentage (32 percent) listed a second job. It would have been helpful in the SunDay survey to have included an item on education, especially since one of the working hypotheses was that this population would tend to be either in college or university or to be college graduates. However, time and budget constraints did

not allow for reprinting of questionnaires, so the Nebraska forms were used on SunDay. Utilization of the same form did permit a real test of whether or not the methodology could be transferred.

The budget dollar pricing technique asked respondents to pencil in amounts (from $.00 to $1.00) of the budget dollar for seven research and development activities. The seventh category, "Other," allowed respondents to make a binary choice if they desired, especially the chance to assign no money to PV research. However, in Nebraska and on SunDay, this choice proved to be too subtle; few respondents assigned any money to this category and no respondents assigned the entire $1.00 to this category with or without notation as to how the money should be spent.

The final item on the survey instrument -- asking where respondents would turn for more information on PV -- had been included as one means of ascertaining how the US Department of Energy could reach institutional collectivities to determine their responses to PV and to provide them with information they would use. It was hoped that SunDay responses, as representative of an "informed" urban population, would offer guidance to DOE in reaching collectivities within northeastern urban centers.

Possible criticism of this methodology and its survey instrument must be discussed here. Although it is the theory of this research that an absence of differentiation in collectivity responses represents a lack of comprehension (acceptance) of innovation by collectivities, a persistent critic might contend that such an absence really represents an inability on the part of the researcher to obtain information. In short, it could be said that the questions and techniques employed here cannot possibly determine innovation acceptance. It

must be admitted that at this point in the Energy Laboratory's institutional analysis, as with any new methodology, researchers are vulnerable to such criticism. Clearly, in the near future, other methodological approaches should be applied to test the validity and reliability of SPRM, to determine whether or not other methods will uncover comprehension and differentiation. Also, it is necessary to periodically retest previously surveyed collectivities (such as those in the Nebraska AgCom) to determine the accuracy of the theory that innovation is accepted in stages. Identifying transition points between stages of acceptance would add much credence to this theory.

DATA COLLECTION

The data collection on SunDay yielded 324 questionnaires. Thirty surveys had to be discarded. Sixteen were discarded because respondents failed to follow directions. Since only 5 percent of the completed questionnaires showed this flaw, it appears that SPRM with its budget dollar technique is a useable format and is not too complex for most respondents to complete. (This idea is further reinforced by the observation that very few persons asked for help in filling out questionnaires. They simply completed them.) Seven surveys were rejected because allocations summed to more than $1.00; three were rejected because allocations summed to less than $1.00. (This mathematical inability might be of interest to educators since three of the seven respondents who miscalculated gave "student" as their occupation.) Four surveys were discarded because they had been used only to express opinions (negative ones) about nuclear energy, without a concurrent allocation of funds.

As in the Nebraska survey, the item on organizational affiliation was largely ignored. Again, the working hypothesis is that respondents could see no connection between their semi-social activities and the survey and thus chose to ignore the question. It is also possible that fewer people are now organizationally active. Whatever the correct explanation may be for the lack of answers, these data were dropped from the analysis.

In the Nebraska survey, respondents almost totally disregarded the item on sources of more information on PV. The disregard for this question on

SunDay was high though not so overwhelming as in Nebraska. Almost 11 percent (thirty-two persons) of the 294 respondents indicated a definite source of additional information on PV. Of those responding to this item, 11 percent (four persons) suggested the Northeast Solar Energy Center as an information source; 10 percent (three persons) listed Mobil/Tyco; the remainder (twenty-five repondents) noted various universities, government agencies, individual researchers, libraries, and the like. References to MIT and DOE were discarded because these two institutions sponsored the exhibit and their names were prominently displayed. The response to this item was disappointing for this population who were presumed to be adept at acquiring information. These data were also dropped from the analysis.

The remaining items on the survey forms (sex, age, occupation, and budget pie allocations) were coded and keypunched. A standard statistical package (Nie, et al.,1976) was employed for the computer analysis. Results are described in the next section of this paper.

DATA ANALYSIS AND RESULTS

Of the 294 completed survey instruments, 185 were filled out by male respondents and 106 by females. (See Table 1.) As in Nebraska, male respondents outnumbered females; however, the split amongst SunDay respondents is almost sixty/forty, while in Nebraska males represented almost 80 percent of the respondents, an unusually high proportion. The male/female split on SunDay must also be considered unusual, although it is difficult to know what significance to attach to this breakdown. It may well be that, at this time, in this culture, men are more likely to be interested in technology than are females. Given the male/female representation of the potential respondent pool, it would be more "normal" to have obtained a fifty/fifty split or to have obtained more female responses.

As in Nebraska, the largest proportion of respondents fell within the twenty-to-twenty-nine-year-old age cohort. (See Table 2.) This group accounted for 56.2 percent of all SunDay respondents. Such a high proportion, as noted earlier, was expected given the population of Boston and its inner ring suburbs, as well as the nature of the SunDay activities; thus, at least one initial hypothesis proved correct. The second largest age cohort was the thirty-to-thirty-nine-year-old group, accounting for 18.5 percent of the respondents. Again, this result reflects the Nebraska findings. However, in Nebraska the twenty-to-twenty-nine group represented 41.7 percent of all respondents, while the thirty-to-thirty-nine-year-olds accounted for 21.4 percent. On SunDay, the respondents in their twenties outrepresented respondents in their thirties by a ratio of three to one.

TABLE 1 Respondent Breakdown by Sex

Category label		Absolute frequency	Adjusted frequency (percent)
Male		185	63.6
Female		106	36.4
No answer		3	Missing
	TOTAL	294	100.0

Valid cases 291 Missing Cases 3

TABLE 2 Respondent Breakdown by Age

Age cohort		Absolute frequency	Adjusted frequency (percent)
10-19		42	14.4
20-29		164	56.2
30-39		54	18.5
40-49		14	4.8
50-59		9	3.1
60 and over		9	3.1
No answer		2	Missing
	TOTAL	294	100.0

Valid cases 292 Missing cases 2

The occupational collectivity that occurred most frequently is that of student -- 74 of 294 respondents, or 25 percent. As noted earlier, this result was predicted given the sheer numbers of colleges and universities in the Boston area and the population (young, environmentally conscious, etc.) expected to attend SunDay. A variety of professional collectivities followed: twenty-three teachers (other than college or university) for 7.8 percent; twenty-one writers, artists, and entertainers, 7.1 percent; twenty engineers, 6.8 percent; seventeen nurses and physical therapists, 5.8 percent; and fifteen social scientists, 5.1 percent. It seems reasonable to assume that respondent self-selection would result in the more technically oriented and the research collectivities (engineers, social scientists) noticing the PV exhibit and being interested enough in the future of the technology to fill out a questionnaire.

The supposition on the frequency of teachers as respondents is based on the observation that a number of elementary and high school teachers brought their classes to SunDay on field trips; staffers noted that teachers seemed to choose questionnaire completion as a means for demonstrating citizen responsibility and participation. Also, teachers are used to giving and taking tests!

The representation of writers, artists, and entertainers was not unexpected in a city impressed with culture, as Boston is. This grouping most clearly represents the initial hypotheses about potential SunDay attendees among an urban population, i.e., young, upwardly mobile, politically liberal, environmentally conscious.

The relatively high proportion of health care respondents is most probably a function of the proximity of workplace.

Four other collectivities should be noted: public administrators, eleven respondents for 3.7 percent; homemakers, ten respondents for 3.4 percent; secretarial and clerical workers, ten for 3.4 percent; and nine construction workers for 3.1 percent. Most likely, proximity of workplace accounts for the presence of all but homemakers at SunDay. Appendix 2 displays a complete listing of primary occupations of SunDay respondents. In Nebraska, farmers (20.1 percent) and homemakers (16 percent) were the largest occupational collectivities. Such results were, of course, expected, and they were not expected to be repeated in Boston.

It was somewhat surprising that public administrators did not account for a larger proportion of the respondent total. Thousands of men and women work for local, state, and federal bureaucracies with offices adjacent to or within two blocks of the Common. It is likely that some respondents from other collectivities (e.g., engineers, social scientists, secretarial/clerical workers, and construction workers) are employed in one of the bureaucracies, but this governmental affiliation would not appear as their primary occupational collectivity. It may also be true that a large proportion of bureaucrats represent an older, less affluent collectivity, less interested in environmental issues and less likely to attend SunDay activities. As of now, these explanations are only conjecture. What can be reported is that only a few employees of the bureaucracy identified themselves as members of that collectivity and completed survey instruments.

A larger than expected percentage of respondents listed secondary occupations. Ninety-three (31.6 percent) of the 294 respondents listed primary and secondary occupations. Again, the occupation listed most

frequently was that of student -- 18/93 or 19.4 percent. Writers, artists, and entertainers formed the second largest group -- 14/93 or 15.1 percent. In retrospect, it seems obvious that these particular occupational collectivities should have appeared as "secondary" occupations in an urban population, where many young people work at temporary jobs while pursuing training for preferred occupations or attempt to become established in more esoteric fields. Appendix 3 contains a complete listing of secondary occupations.

As noted earlier, organizational affiliation data have been eliminated from this analysis.

Simultaneous preference allocations obtained through use of the budget dollar survey instrument are summarized in Tables 3, 4, and 5. Appendix 4 contains the printouts of all frequencies for respondents' budget dollar allocations. Table 3 displays from highest to lowest the means and median allocations to each pricing category. (Modes and standard deviations are also included.) Table 5 shows the ranges of allocations for each category. Table 6 indicates the number and percentage of respondents assigning some and no monies to each activity.

As noted earlier, "Other," the semi-open-ended seventh item of the pricing categories, should most probably be considered a flaw in the design of the survey instrument. SunDay respondents, like their Nebraska counterparts, did not utilize this category. It received fewer allocations, lower allocations, and has the narrowest range.

It appears from Table 3 that some minimum differentiation is evidenced in allocations. The activities in this table are ordered from highest to

lowest median and mean. This order is not the one in which items appeared on the survey form, thus, at least this differentiation occurred. It appears that some differentiation exists between hardware (Technology, Design, Purchase Price, and Operating Costs) and software (Technical Assistance and Institutional and Financial Aids) items. (Further analysis on this differentiation appears in the next section of this paper.) The four hardware items show means ranging from 22.8 cents to 16.9 cents. The two software items have means of 12.5 and 10.4 cents. The application of traditional statistical tests of significance was not successful since the sample is not a random one. However, it can be said that SunDay respondents did assign larger amounts of money to hardware than to software. This same differentiation occurred in Nebraska.

The ranges of money assignments in Table 4 display a slightly different ordering of pricing categories than is displayed in Table 3. Of the six defined activities, only the category labeled Technical Assistance, evidences a range of money assignments that is less than 0 cents to 99 cents. (The range for "Other" is 0 to 40 cents.) It is interesting to note that Nebraska respondents assigned monies in the broadest possible range (0 to 99 cents) to only three categories, Purchase Price, Technical Assistance and Other, although the ranges for the remaining four categories did not drop as low as the two lowest ranges for the SunDay data. Institutions within the agricultural

TABLE 3 Distribution, Mean, Median, Mode, and Standard Deviation of Simultaneous Preference Allocations/Budget Pie Format

Research and development activity	Mean ¢	Median ¢	Mode ¢	Standard deviation ¢
Technology [a]	22.8	20.1	20.0	14.301
Design	18.6	16.0	10.0	12.99
Purchase price	17.0	10.4	10.0	15.591
Operating costs	16.9	15.1	10.0	12.27
Institutional and financial aids	12.5	10.1	10.0	11.96
Technical assistance	10.4	9.9	10.0	7.40
Other	01.7	0.09	0.0	4.961

[a] Definitions of these categories as provided to respondents can be found on the survey instrument in Appendix 1.

TABLE 4 Range of Simultaneous Preference Allocations/Budget Pie Format

Research and development activity	Range (in ¢)[a]
Technology	0 to 99
Design	0 to 99
Purchase price	0 to 99
Operating costs	0 to 99
Institutional and financial aids	0 to 99
Other	0 to 40
Technical assistance	0 to 35

[a] The broadest possible range is from 0¢ to $1.00.

TABLE 5 Numbers/Percentages of Respondents Assigning Some or No Funds by Individual Research and Development Activity

Research and development activity	Respondents assigning some funds		Respondents assigning no funds	
	Number	Percent	Number	Percent
Technology	280	95.2	14	4.8
Design	272	92.5	22	7.5
Operating costs	266	90.5	28	9.5
Purchase price	255	86.7	39	13.3
Technical assistance	250	85.0	44	15.0
Institutional and financial aids	245	83.3	49	16.7
Other	45	15.3	249	84.7

N=294

arena view "assistance," especially from the extension service, and in the form of price supports, as an everyday occurrence. It may be that SunDay respondents, i.e., urban collectivities, simply lack frames of reference for this category.

Table 5 indicates that 83.3 percent of all SunDay respondents assigned some monies to every category except Other. The evenness of these allocations provides no support to the hypothesis suggested earlier that differentiation did occur between money assignment to hardware (technological categories) and software (non-technological categories). This same evenness of money assignment appeared in the Nebraska data.

The activity labeled Technology evidences the highest mean and median, the broadest possible range, and the highest numbers of respondents assigning funds. It is thought that since the information presented to potential respondents emphasizes the fact that PV is an "early-stage" technology, respondents are influenced by this information and assign monies accordingly. At some future time, it would be useful to place a new label on this category while retaining the same definition to see whether or not it would still show the highest mean assignment of money and the largest number of responses.

Answers to the question on where to look for further information on photovoltaics have been discussed in an earlier section of this paper. They were not utilized in the analysis.

Factor Analysis

In order to determine whether or not any allocational patterns did exist, a factor analysis was undertaken. If the hypothesis proffered earlier was correct -- that allocations could be categorized into two sets (hardware versus software) -- then, the factor analysis should result in two factors comprised

of the appropriate pricing categories. This particular utilization of factor analysis had two objectives: (1) exploring and detecting patterns of allocations; and (2) confirming the hypothesis that the pricing categories would be divided into two groups (technological and non-technological) by respondents' allocational decisions.[2]

Table 6 shows the seven pricing categories divided into technological (hardware) and non-technological (software) sets. The table also displays the abbreviations of the pricing categories that appear in the remaining tables on factor analysis.

There are some dangers in using correlations to analyze data obtained with a budget-dollar survey instrument. Because the format is close-ended, money allocated to one pricing category is necessarily taken away from the other categories. The result, then, is that two correlations may be set up where only one exists. If these double correlations exist, then the analysis is invalid. These confusions may be the price that is paid for introducing the realistic concepts of finite resources and simultaneity of funding decisions into survey research. However, with these reservations in mind, it is possible to utilize factor analysis to further explore allocational decision patterns.

The thirty-two occupational categories (See Appendix 2.) were recoded into seven general occupational collectivities to perform a factor analysis. These recodes are summarized in Table 7; Table 8 displays the numbers and percents of respondents falling into each recoded occupational collectivity.

TABLE 6 Abbreviations Appearing in Factor and Discriminant Analysis

Abbreviation	Category as it appears on survey form [a]
Hardware	
Price	Purchase price
Opcost	Operating costs
Design	Design
Technol	Technology
Software	
Assist	Technical assistance
Instfin	Institutional and financial aids
Other	Other. Please list here.

[a] For complete definitions of pricing categories, see the survey instrument in Appendix 1.

TABLE 7 Recodes for Occupational Categories (Primary Occupation Only)

Recode number	Included occupations
1	Professional, managerial, technical
2	Sales, secretarial, and service workers
3	Blue-collar workers
4	Farmers and ranchers
5	Students
6	Homemakers
7	Miscellaneous (including military and retired)

TABLE 8 Distribution of Primary Occupations, Recoded

Recode Number	Occupation	Absolute frequency	Relative frequency (percent)	Adjusted frequency (percent)	Cumulative frequency (percent)
1	Professional, managerial, technical	149	50.7	54.0	54.0
2	Sales, secretarial, and service workers	23	7.8	8.3	62.3
3	Blue-collar workers	16	5.4	5.8	68.1
4	Farmers and ranchers	2	0.7	0.7	68.8
5	Students	74	25.1	26.8	95.7
6	Homemakers	10	3.4	3.6	99.3
7	Miscellaneous	2	0.7	0.7	100.0
	No answer	18	6.1	Missing	100.0
		294	100.0	100.0	

Valid cases 276 Missing cases 18

The factor analysis employed here is "Principal Factoring With Iteration," described in the SPSS Manual (Nie, et al., 1975). Both varimax and quartimax rotations were utilized to approach simple structure. Tables 9 through 13 summarize the results of the factor analysis.

Four factors with eigenvalues greater than 1.0 were generated. (See Table 9.) Table 10 displays the factor matrix before rotation for the four generated factors. In this table, Factor 1 may demonstrate a caution raised earlier, that is, the problem of double correlations. Technol and Design show fairly heavy positive loadings while Price shows a fairly heavy negative result. This type of tradeoff (not evident in Factor 2 but noticeable in Factors 3 and 4) may be the result of respondents "taking away" funds from one category to assign to another. This pattern almost completely disappears after rotation. In Table 11, it can be seen that four variables -- Price, Opcost, Design, and Technology -- have high communalities,[3] ranging from .992 for Price, which has an extraordinarily high communality, to .929 for Opcost. These four pricing categories are considered to be the technological ones. The remaining three categories (the non-technological allocational activities) have much lower communalities. Instfin shows a modest level at .5487, however, Assist at .044 and Other at .026 are very low. It appears, then, that the generated factors explain the variation in technological variables but offer little information on the non-technological categories.

It is worth noting here that the factor analysis of the Nebraska data generated three factors and only one variable (Technology) possessed a high communality (.9986). Only two other variables displayed modest communalities -- Price at .654 and Design at .5588. Factor analysis

TABLE 9 Factor Analysis Display [a] -- Estimated [a]

Variable	Estimated Communality	Factor	Eigenvalue	Percent of variance	Cumulative percent
Price [b]	0.98228	1	1.68907	24.1	24.1
Opcost	0.97131	2	1.28055	18.3	42.4
Design	0.97414	3	1.10666	15.8	58.2
Technol	0.97858	4	1.08534	15.5	73.7
Assist	0.92368	5	0.98017	14.0	87.7
Instfin	0.97004	6	0.85372	12.2	99.9
Other	0.84939	7	0.00446	0.1	100.0

[a] After six iterations, communality of one or more variables exceeded 1.0. PA2 factoring terminated at Iterations.

[b] Variables appear in the same order that they are presented on the survey instrument.

TABLE 10 Factor Matrix [a] (Before Rotation)

Variable	Factor 1	Factor 2	Factor 3	Factor 4
Price	-0.78692	-0.32062	-0.00589	0.51964
Opcost	-0.31762	0.87260	0.24342	-0.08929
Design	0.58059	-0.25624	0.72644	0.07990
Technol	0.69510	0.19773	-0.52501	0.37991
Assist	0.11593	-0.04105	-0.08584	-0.14778
Instfin	-0.12388	-0.29117	-0.25399	-0.61977
Other	-0.12325	-0.03956	0.04595	-0.08471

[a] Using principal factor with iterations

TABLE 11 Communality of Variables

Variable	Communality	Factor	Eigenvalue	Percent of variance	Cumulative percent
Price	0.99210	1	1.58437	35.8	35.8
Opcost	0.92954	2	1.05701	23.9	59.8
Design	0.93685	3	0.93664	21.2	81.0
Technol	0.94223	4	0.84184	19.0	100.0
Assist	0.04433				
Instfin	0.54875				
Other	0.02604				

on the Nebraska data provided less information than was obtained when this technique was applied to SunDay data.

Both varimax and quartimax rotations were employed to approach simple structure; however, the results of the two rotations differed only in the second and third decimal places. Tables 12 and 13 display these rotations. An examination of these matrices shows that for the first factor, Technology (.945) loads heavily with modest contributions from Price and Instfin. For Factor 2 Design loads heavily (.95) with what must again be termed modest contributions from Price and Instfin. Opcost (.94) loads heavily on Factor 3, and again Price and Instfin load much less heavily. In Factor 4, Price (.84) loads fairly heavily -- though not as heavily as do the heavy loading variables for Factors 1,2, and 3. Instfin, however, loads more heavily here (.52) than for any other factor, while Assist makes an extremely modest contribution (.20). The three non-technological variables do not load heavily onto any of the four factors. Although Price and Instfin load fairly heavily onto Factor 4, their consistent more moderate loadings across Factors 1,2, and 3 discredit their use in this analysis. The point to remember is that only the technological variables load at all heavily, and each of the four predominantly loads onto a different factor.

The factor analysis does not support the hypothesis that collectivities will allocate funds to pricing categories by choosing between two sets (technological versus non-technological) of variables. These two hypothesized factors were not found in the analysis. Rather, as noted above, it appears that allocational decisions are made by choosing one of the four technological variables over all other categories of expenditures. It seems possible that choosing funding allocations in this manner is the first differentiation to

TABLE 12 Varimax Rotation

Variable	Factor 1	Factor 2	Factor 3	Factor 4
Price	-0.33430	-0.33818	-0.26174	0.83515
Opcost	-0.09629	-0.11950	0.94472	0.11616
Design	0.05102	0.95828	-0.12169	-0.03377
Technol	0.94544	-0.06893	-0.11301	-0.17567
Assist	0.01964	-0.01190	-0.05989	-0.20055
Instfin	-0.40263	-0.26912	-0.24739	-0.50300
Other	-0.15894	-0.02711	0.00449	0.00510

TABLE 13 Quartimax Rotation

Variable	Factor 1	Factor 2	Factor 3	Factor 4
Price	-0.35826	-0.34253	-0.30162	0.80960
Opcost	-0.09796	-0.12025	0.93813	0.15935
Design	0.07945	0.95699	-0.11944	-0.02130
Technol	0.94518	-0.09381	-0.10858	-0.16815
Assist	0.02220	-0.00878	-0.04994	-0.20315
Instfin	-0.40342	-0.24745	-0.22037	-0.52555
Other	-0.15972	-0.02244	0.00495	0.00244

appear in this analysis. However, the results are much too tentative to assert that collectivity differentiation has occurred.

Discriminant Analysis

To examine the level of differentiation exhibited by collectivities in their allocational decisions, discriminant analyses were performed. The discriminating variables were the budget-dollar items listed (with their abbreviations) in Table 6. The discriminatory criterion was the Rao's V. This method adds variables to the analysis until the point is reached where the addition of another variable results in less rather than more discriminatory power as expressed in "distance between groups" (Klecka, 1975). Discriminatory analyses were undertaken as groups: occupational collectivities; sex; and age cohorts.

Occupational Collectivities The discriminant analysis using occupational collectivities as the groups among which discrimination would occur was based on the recoded occupational collectivities displayed in Tables 7 and 8. The Rao's V process generated three variables for analysis: Technical Assistance, Technology, and Operating Costs. The analysis derived three functions. The results of the analysis on occupational collectivities as the designated groups of cases appear in Tables 14 and 15.

Two criteria -- associated canonical correlations and Wilks' Lambda -- are examined to judge the importance of the three functions. (See Table 15.) The canonical correlation squared is the proportion of variance in the discriminant function that is explained by the occupational groups. The Wilks' Lambda is an inverse measure of the discriminating power that has not been accounted for by earlier functions, beginning with zero functions. Thus, the larger the lambda, the less information remaining.

TABLE 14 Variables Generated Via Rao's V/Occupational Groups

Variable	Rao's V	Change in Rao's V	Significance of Change[a]
Assist	7.40133	7.40133	0.285
Technol	16.14650	8.74517	0.188
Opcost	22.84956	6.70306	0.349

[a] Chi-square significance of change for large numbers of cases

TABLE 15 Canonical Correlations and Wilks' Lambda/Occupational Groups

Discriminant Function	Eigen-value	Relative percentage	Canonical Correlation	Functions Derived	Wilks' Lambda
1	0.04332	50.80	0.204	0	0.9196
2	0.02796	32.79	0.165	1	0.9594
3	0.01399	16.40	0.177	2	0.9862

An examination of these two statistics indicates that a very low proportion of the variance is accounted for by occupational collectivities and that there is little discriminatory power obtained from grouping cases according to occupation. Because of these extremely negative results, the analysis was discontinued at this point. As in the Nebraska analysis, the SunDay data lead to the conclusion that occupational groupings are poor indicators of allocational preferences.

Sex The second discriminant analysis placed respondents into two groups: male and female. The Rao's V process generated four variables for analysis: Technology, Technical Assistance, Institutional and Financial Aids, and Other. (See Table 16.) The analysis derived one function.

Table 17 displays the standardized discriminant function coefficients. Each coefficient represents the relative contribution of the associated variable to a function. In this analysis, Technology is twice as important as Other; Technology is one-and one-half times as important as Institutional and Financial Aids. There is less difference between Technology and Technical Assistance, but Technology is clearly making a larger contribution.

Table 18 indicates the canonical correlation and the Wilks' Lambda for the one function derived. The canonical correlation is quite low, and the Wilks' Lambda must be described as borderline, especially when the significance is considered.

TABLE 16 Variables Generated Via Rao's V/Sex

Variable	Rao's V	Change in Rao's V	Significance of Change
Technol	3.73717	3.73717	0.053
Assist	6.44600	2.70883	0.100
Instfin	0.34216	1.89616	0.169
Other	9.44427	1.10211	0.294

TABLE 17 Standardized Discriminant Function Coefficients/Sex

Variable	Function
Technol	-0.66230
Assist	0.51099
Instfin	-0.42376
Other	0.34781

TABLE 18 Canonical Correlation and Wilks' Lambda/Sex

Discriminant Function	Eigen-value	Relative percentage	Canonical correlation	Functions Derived	Wilks' Lambda	Signifi-cance
1	0.03268	100.00	0.178	0	0.9684	0.056

TABLE 19 Prediction Results/Sex

Actual group	Number of cases	Predicted group membership Group 1	Group 2
Group 1	185	96	89
Male		51.9%	48.1%
Group 2	106	39	67
Female		36.8%	63.2%
Ungrouped cases	3	1	2
		33.3%	66.7%

Percent of "grouped" cases correctly classified: 56.01%

Before this effort at discriminant analysis was ended, the discriminant function's ability to classify (or regroup) cases was examined. As can be seen from Table 19, the discriminatory power exhibited is best described as minimal. The percent of cases correctly grouped is 56.01 -- hardly a significant proportion since there are only two groups in which to classify the cases. Clearly, then, sex is not a useful indicator (or predictor) of allocational preferences with regard to funds for research on an innovation.

Age Cohorts The final discriminant analysis employed age cohorts as the classified groups. The Rao's V process generated four variables for analysis: Operating Costs; Technical Assistance; Other; and Technology. (See Table 20.) The analysis derived four functions. (See Table 21.) When the canonical correlations and the Wilks' Lambdas are reviewed, it appears that the first function is significant, accounting for close to 10 percent of the variance in the discriminant function explained by the age groupings. The remaining three functions are of questionable value. Associated significance tests are reported in Table 22. Because this research lacks a random sample, these results must be viewed with caution. They are included with this analysis because Function 1 seems to be of value.

To further determine the value of this particular discriminant analysis. it is necessary to examine the classification prediction results, which are displayed in Table 23. The low percentage of correctly classified cases (28.77 percent) unfortunately cast serious doubt on the future use

TABLE 20 Variables Generated Via Rao's V/Age

Variable	Rao's V	Change in Rao's V	Significance of Change
Opcost	27.28384	27.28384	0.000
Assist	34.96228	7.67844	0.175
Other	44.04086	9.07858	0.106
Technol	51.03296	6.99210	0.221

TABLE 21 Canonical Correlations and Wilks' Lambda/Age

Discriminant Function	Eigen-value	Relative Percentage	Canonical Correlation	Functions Derived	Wilks' Lambda
				0	0.8418
1	0.10457	58.60	0.308	1	0.9298
2	0.04012	22.48	0.196	2	0.9672
3	0.02533	14.20	0.157	3	0.9917
4	0.00842	4.72	0.091		

TABLE 22 Associated Statistics for Wilks' Lambda/Age

Chi-square	Degrees of freedom	Significance
49.246	20	0.000
20.802	12	0.053
9.552	6	0.145
2.397	2	0.302

TABLE 23 Prediction Results/Age

Actual Group	Number of cases	Predicted group membership: Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
Group 2 10-19	42.	1. 2.4%	10. 23.8%	8. 19.0%	11. 26.2%	7. 16.7%	5. 11.9%
Group 3 20-29	164.	0. 0.0%	58. 35.4%	18. 11.0%	45. 27.4%	19. 11.6%	24. 14.6%
Group 4 30-39	54.	0. 0.0%	14. 25.9%	12. 22.2%	12. 22.2%	10. 18.5%	6. 11.1%
Group 5 40-49	14.	0. 0.0%	3. 21.4%	1. 7.1%	5. 35.7%	4. 28.6%	1. 7.1%
Group 6 50-59	9.	0. 0.0%	1. 11.1%	2. 22.2%	3. 33.3%	2. 22.2%	1. 11.1%
Group 7 60 and over	9.	0. 0.0%	0. 0.0%	0. 0.0%	1. 11.1%	2. 22.2%	6. 66.7%
Ungrouped cases	2.	0. 0.0%	1. 50.0%	0. 0.0%	0. 0.0%	1. 50.0%	0. 0.0%

Percent of "grouped" cases correctly classified: 28.77 percent

of this analysis. However, it is important to note that Group 7 seems to fare much better than do the other six groups.

Given this distinction, it is appropriate to review the group centroids for the one useable function obtained. The centroids summarize the age cohorts (or collectivities) in the reduced space defined by the discriminant functions. Table 24 shows that Group 7 is clearly distinguished from the other six groups.

An analysis of the discriminant function coefficients shows that the pricing category labeled Operating Costs is the major contributor to this function. (See Table 25.) It appears, then, that for the oldest (aged sixty years and older) respondents, operating costs are a major concern.

Thus, some differentiation can be identified in the SunDay data. It is, of course, extremely limited, but the results described above are the first substantial (i.e., statistically significant) indicators of differentiation among respondents. There is some limited substantiation for age as an indicator/predictor in cross-tabulations prepared on the Nebraska data and on the SunDay survey results.

Cross-Tabulations

A series of cross-tabulations were prepared as a final attempt at ascertaining dependency between various collectivities and allocation preferences. The seven recoded occupational groups, sex, and age cohorts identified the columns of the contingency tables, while the research and development pricing categories with their ranges of possible money allocations formed the rows of the matrix.

TABLE 24 Centroids of Groups in Reduced Space/Age

	Function 1
Group 2 10-19	-0.21808
Group 3 20-29	0.06564
Group 4 30-39	-0.17006
Group 5 40-49	-0.28507
Group 6 50-59	-0.26127
Group 7 60 and over	1.54671

TABLE 25 Standardized Discriminant Function Coefficients

Variable	Function 1
Opcost	0.8744
Technol	-0.1948
Assist	-0.0803
Other	-0.3150

Since the respondent population does not constitute a random sample, the use of contingency tables must be viewed as an exploration of the data, and not an attempt to attain a statistically significant result. It had been helpful to review the Nebraska data in these matrices, so the surveys from SunDay were prepared in this same manner.

There are two items which deserve comment. As in the cross-tabs prepared with the Nebraska data, the SunDay age cohorts (collectivities) demonstrated the most significant chi-squares (at least twice the size of the degrees of freedom). It does appear that collectivities based on age may be more useful as predictive and/or diagnostic indicators for innovation differentiation than had been thought when this research was begun. Age cohorts deserve further serious consideration in these public preference surveys.

The second item worthy of note is a much more negative one. When the pricing category Other (which is generally ignored by respondents) is eliminated, the matrices of the remaining variables display an almost breathtaking uniformity of allocational assignment. That is, for the groups with the largest number of respondents (e.g., the occupational collectivities of professionals and students; the age cohorts of 10-19 and 20-29), it is quite clear from a cursory persual of the tables that in each case, 50 percent (or more) of the respondents assigned either ten or twenty cents of the budget dollar to each pricing category. It is disappointing to see the lack of differentiation so clearly displayed.

CONCLUSIONS AND COMMENTS

The analysis of data collected in Boston on SunDay indicates that for SunDay respondents, photovoltaics is an undifferentiated innovation. No patterns for responses of specific collectivities emerged. It is probable that PV is so "new" that most respondents have little or no comprehension of its potential applications or of the costs of institutional adaptation to such a technology. This conclusion is identical to the one reached after analysis of the data collected at the Nebraska State Fair. Since the SunDay collectivities (defined by sex, age, and occupation) did not differentiate about PV, it seems clear that these respondents did not perceive of the proffered information as personal and thus accept it sufficiently to distinguish among budget dollar allocations -- for these respondents the information was of limited value.

It had been hypothesized that the SunDay population would be younger, better educated, and more knowledgeable about and more interested in solar energy than AgCom respondents in Nebraska and thus more likely to perceive of the information as personal and to differentiate about PV. Attendance at SunDay was presumed to indicate an interest in solar energy. Analysis of biographical data showed that a larger percentage of SunDay respondents were under thirty years of age (70 percent as opposed to 50 percent of Nebraska respondents), that more SunDay respondents were currently in school (25 percent versus 9 percent of Nebraska respondetns), and that a larger percentage of the SunDay population was classified as being employed in "professional" jobs (51 percent as compared with 25 percent in Nebraska). Employment within a "profession" generally implies completion of an educational program beyond high school. Thus, a portion of the

original hypotheses proved correct; however, these observed characteristics did not lead to respondent differentiation. The lack of differentiation exhibited in respondents' simultaneous preferences also seems to indicate that SunDay collectivities were not more knowledgeable about solar energy, in general, or photovoltaics, in particular. In short, the respondent collectivities surveyed on SunDay did not evidence differentiation about PV (the innovation), even though they possessed characteristics that were thought to increase the probability that differentiation would occur.

Further, the discriminant analysis indicated that occupational groupings have little diagnostic or predictive value with regard to simultaneous preference differentiation among collectivities. Again, these results duplicated the findings in Nebraska. A second analysis grouping respondents by sex exhibited minimal discriminatory power. The third discriminant analysis, with respondents grouped by age, was more successful in that one group (the oldest respondents -- sixty years and over) was significantly distinct from the other six groups. The distinction focused on the variable (pricing category) labeled Operating Costs. It appears, then, from this result as well as from the results of cross-tabulations prepared from both SunDay and Nebraska data that collectivities defined by age cohorts may prove to be more useful as research entities than collectivities based on occupation or sex. This possibility will be tested again with a second survey in Nebraska. As of now, what can be said is that despite the limited success achieved by identifying one statistically significant response, none of the identified collectivities can serve as an intervention point (for DOE) into an institutional arena.

A factor analysis of SunDay data, like the factor analysis performed on data from the Nebraska AgCom, offered no support to the theory that

there would be a differentiation between respondent allocations to technological (hardware) and non-technological (software) items. Although for both data sets, the mean and median allocations appear to support the assumption that this differentiation does exist, the factor analysis did not exhibit the two hypothesized factors. Rather, the analysis indicated that respondents chose one of the four technological categories over all other categories.

Despite the inability to accumulate analytic support for the technological/non-technological breakdown of allocations, the frequencies appearing in the raw data do seem to indicate that such a split exists. This discrepancy needs further study, and efforts are being directed toward developing a more appropriate means for proving or disproving the hypothesis.

The survey instrument was administered with little difficulty. It is clear, however, that the item on organizational affiliation is useless as it is now written. It may be possible to obtain such data only if a close-ended question can be constructed however, providing a list of organizations would greatly limit the use of the survey instrument. This criticism also applies to the item on other sources for PV information. It may also be helpful in future surveys to add an item on education. Such a question would have been useful in the SunDay survey but not so useful at the Nebraska State Fair. Problems with the semi-open-ended pricing category, "Other," continued. This item has been generally ignored in both surveys. Consideration is now being given to eliminating this category from the survey instrument.

The Simultaneous Preference Reporting Methodology proved useful in its application to respondents from a new and different population pool. The results of this second application are encouraging and provide some reassurance that the successful use of SPRM in Nebraska was not a fluke. However, tests of convergent and construct validity must be undertaken. It will be possible in a third application of SPRM (again, in Nebraska) to conduct a first test of convergent validity through application of a second and different survey instrument. Although the present working hypothesis is that SPRM is an appropriate research method and that PV is an undifferentiated innovation, data collection utilizing different techniques might not support this hypothesis. It is possible that the budget dollar approach is not a viable means for ascertaining citizen preference and identifying differentiation. It is important to find out whether or not the same data will be obtained through application of other independent measures.

The testing of construct validity is a more complex undertaking since it would involve not only the validation of budget pie measurement techniques but also the validation of some of the theories of institutional analysis, such as stages of innovation acceptance and information, which underlie these citizen preference surveys. Hopefully, other portions of the institutional analysis -- case studies and indepth interviews with representatives of other institutional entities -- will provide further elucidation, information, and, most preferably, confirmation.

NOTES

1. It is worth noting that rigorous efforts were made to standardize assignment of jobs to various professional collectivities. The same researchers made such judgments and coded data for both the Nebraska and SunDay surveys.

2. Jae-On Kim (1975) adds a third "common application" of factor analysis: use as a measuring device to construct "indices to be used as new variables in later analysis " (p. 469).

3. Communality is the variance in each of the variables (pricing categories) that is explained (or accounted for) by the factors the analysis derives.

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APPENDIX 1

APPENDIX 1 Survey Instrument Used to Collect Data on Sun Day, May 1978

RECORD YOUR REACTIONS...

Sex

Please check the appropriate category:

_____ Male _____ Female

Occupation

If you have more than one job, list your primary and secondary jobs. Examples of jobs are: farmer; rancher; homemaker; salesperson; student; banker; teacher county agent; legislator; insurance agent; state or local government official; etc.

Primary _____

Secondary _____

Age

Please check the appropriate age category:

_____ 0-9 _____ 10-19 _____ 20-29

_____ 30-39 _____ 40-49 _____ 50-59

_____ 60 and over

Organizational Affiliation

In what organizations are you most active?

1. _____

2. _____

3. _____

IMAGINE you are in charge of the US Energy Research and Development Administration's (ERDA) program to make photovoltaic (PV) solar energy generally available. Divide up this BUDGET DOLLAR in the ways YOU would spend ERDA's funds. Stamp an amount--from 0 to $1.00--for each use. REMEMBER---Don't spend more than your dollar!

PURCHASE PRICE	Money spent in this category would lower the selling price of PV equipment.	◯ ¢
OPERATING COSTS	Money spent would refine the technology to lower everyday costs and/or provide subsidies to owners for daily expenses.	◯ ¢
DESIGN	Money spent would increase the usefulness by reducing size, increasing mobility, and ensuring ease of installation for a variety of uses.	◯ ¢
TECHNOLOGY	Money spent here would improve the durability, reliability, and quality of PV systems.	◯ ¢
TECHNICAL ASSISTANCE	Money spent would provide expert assistance in and information on the use and maintenance of PV systems.	◯ ¢
INSTITUTIONAL and FINANCIAL AIDS	Money spent would guarantee favorable financing, ensure attractive tax treatment, and create strong support systems (such as insurance).	◯ ¢
OTHER	Please list here. _____ _____ _____	◯ ¢

Total $1.00

Where or to whom would you go for more information on photovoltaic solar energy?

_____

_____

Thank you!

APPENDIX 2

APPENDIX 2 Primary Occupation

Occupation	Absolute frequency	Relative frequency (percent)	Adjusted frequency (percent)	Cumulative frequency (percent
Accountant	2	0.7	0.7	0.7
Architect	4	1.4	1.4	2.2
Computer specialist	6	2.0	2.2	4.3
Engineer	20	6.8	7.2	11.6
Banker	2	0.7	0.7	12.3
Librarian	4	1.4	1.4	13.8
Life, physical science	6	2.0	2.2	15.9
RN, dietitian, therapist	17	5.8	6.2	22.1
Social science	15	5.1	5.4	27.5
Teacher- college	1	0.3	0.4	27.9
Teacher- other	23	7.8	8.3	36.2
Technician- Engineering, Science	8	2.7	2.9	39.1
Technician - other	1	0.3	0.4	39.5
Writer,artist, entertainer	21	7.1	7.6	47.1
Other professional	2	0.7	0.7	47.8
Public administrator-Federal	5	1.7	1.8	49.6
Public administrator-State	2	0.7	0.7	50.4
Public administrator-Local	4	1.4	1.4	51.8
Manager-private	6	2.0	2.2	54.0
Real estate	1	0.3	0.4	54.3
Sales- retail	6	2.0	2.2	56.5
Secretary, clerk	10	3.4	3.6	60.1
Construction crafts	9	3.1	3.3	63.4
Foreman	3	1.0	1.1	64.5
Mechanic, repairman	3	1.0	1.1	65.6
Laborer -miscellaneous	1	0.3	0.4	65.9
Farmer	2	0.7	0.7	66.7
Food service	5	1.7	1.8	68.5

APPENDIX 2 Primary Occupation (continued)

Other service	1	0.3	0.4	68.8
Student	74	25.1	26.8	95.7
Homemaker	10	3.4	3.6	99.3
Retired	2	0.7	0.7	100.0
No answer	18	6.1	Missing	100.0
TOTAL	294	100.0	100.0	

APPENDIX 3

APPENDIX 3 Secondary Occupation

Occupation	Absolute frequency	Relative frequency (percent)	Adjusted frequency (percent	Cumulative frequency (percent)
Engineer	2	0.7	2.2	2.2
Life, physical science	3	1.0	3.2	5.4
RN, dietitian, therapist	1	0.3	1.1	6.5
Health technician	1	0.3	1.1	7.5
Social science	3	1.0	3.2	10.8
Teacher-college	2	0.7	2.2	12.9
Teacher-other	9	3.1	9.7	22.6
Technician- Engineering, science	3	1.0	3.2	25.8
Writer, artist, entertainer	14	4.8	15.1	40.9
Other professional	2	0.7	2.2	43.0
Buyer, agent, salesperson	1	0.3	1.1	44.1
Public administrator-Local	3	1.0	3.2	47.3
Manager-private	2	0.7	2.2	49.5
Real estate	1	0.3	1.1	50.5
Secretary, clerk	4	1.4	4.3	54.8
Cabinetmaker	1	0.3	1.1	55.9
Construction crafts	6	2.0	6.5	62.4
Laborer- miscellaneous	3	1.0	3.2	65.6
Food service	3	1.0	3.2	68.8
Other service	1	0.3	1.1	69.9
Student	18	6.1	19.4	89.2
Homemaker	4	1.4	4.3	93.5
Other transportation	3	1.0	3.2	96.8
Military	1	0.3	1.1	97.8
Miscellaneous	2	0.7	2.2	100.0
No answer	201	68.4	Missing	100.0
TOTAL	294	100.0	100.0	

APPENDIX 4

Appendix 4 displays the complete printouts of respondent assignment of monies to the seven pricing categories on the survey instrument.

The column labeled "CODE" indicates the amount of money (from $.00 to $.99) assigned.

APPENDIX 4

TECHNOLOGY

Money spent here would improve the durability, reliability, and quality of PV systems.

CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
0.	14	4.8	4.8	4.8
2.	1	0.3	0.3	5.1
5.	8	2.7	2.7	7.8
8.	2	0.7	0.7	8.5
10.	49	16.7	16.7	25.2
15.	23	7.8	7.8	33.0
16.	1	0.3	0.3	33.3
17.	1	0.3	0.3	33.7
20.	78	26.5	26.5	60.2
24.	1	0.3	0.3	60.5
25.	25	8.5	8.5	69.0
30.	46	15.6	15.6	84.7
35.	2	0.7	0.7	85.4
40.	15	5.1	5.1	90.5
50.	22	7.5	7.5	98.0
55.	1	0.3	0.3	98.3
60.	2	0.7	0.7	99.0
75.	1	0.3	0.3	99.3
80.	1	0.3	0.3	99.7
99.	1	0.3	0.3	100.0
TOTAL	294	100.0	100.0	

MEAN	22.837	STD ERR	0.834	MEDIAN	20.115
MODE	20.000	STD DEV	14.301	VARIANCE	204.533
KURTOSIS	3.330	SKEWNESS	1.291	RANGE	99.000
MINIMUM	0.0	MAXIMUM	99.000		
VALID CASES	294	MISSING CASES	0		

DESIGN Money spent would increase the usefulness by reducing size, increasing mobility, and ensuring ease of installation for a variety of uses.

CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
0.	22	7.5	7.5	7.5
1.	1	0.3	0.3	7.8
2.	1	0.3	0.3	8.2
5.	8	2.7	2.7	10.9
8.	1	0.3	0.3	11.2
10.	84	28.6	28.6	39.8
13.	1	0.3	0.3	40.1
15.	28	9.5	9.5	49.7
16.	2	0.7	0.7	50.3
20.	71	24.1	24.1	74.5
25.	15	5.1	5.1	79.6
30.	28	9.5	9.5	89.1
35.	2	0.7	0.7	89.8
40.	16	5.4	5.4	95.2
50.	11	3.7	3.7	99.0
60.	2	0.7	0.7	99.7
99.	1	0.3	0.3	100.0
TOTAL	294	100.0	100.0	

MEAN	18.605	STD ERR	0.757	MEDIAN	16.000
MODE	10.000	STD DEV	12.985	VARIANCE	168.615
KURTOSIS	5.042	SKEWNESS	1.546	RANGE	99.000
MINIMUM	0.0	MAXIMUM	99.000		
VALID CASES	294	MISSING CASES	0		

PURCHASE PRICE Money spent in this category would lower the selling price of PV equipment.

CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
0.	39	13.3	13.3	13.3
2.	2	0.7	0.7	13.9
3.	2	0.7	0.7	14.6
5.	22	7.5	7.5	22.1
8.	2	0.7	0.7	22.8
10.	86	29.3	29.3	52.0
14.	1	0.3	0.3	52.4
15.	18	6.1	6.1	58.5
16.	1	0.3	0.3	58.8
20.	53	18.0	18.0	76.9
25.	10	3.4	3.4	80.3
30.	30	10.2	10.2	90.5
31.	1	0.3	0.3	90.8
40.	5	1.7	1.7	92.5
45.	1	0.3	0.3	92.9
50.	16	5.4	5.4	98.3
70.	1	0.3	0.3	98.6
75.	1	0.3	0.3	99.0
85.	1	0.3	0.3	99.3
99.	2	0.7	0.7	100.0
TOTAL	294	100.0	100.0	

MEAN	17.041	STD ERR	0.909	MEDIAN	10.430
MODE	10.000	STD DEV	15.591	VARIANCE	243.070
KURTOSIS	6.208	SKEWNESS	2.006	RANGE	99.000
MINIMUM	0.0	MAXIMUM	99.000		
VALID CASES	294	MISSING CASES	0		

OPERATING COSTS — Money spent would refine the technology to lower everyday costs and/or provide subsidies to owners for daily expenses.

CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
0.	28	9.5	9.5	9.5
2.	1	0.3	0.3	9.9
4.	1	0.3	0.3	10.2
5.	13	4.4	4.4	14.6
8.	2	0.7	0.7	15.3
10.	85	28.9	28.9	44.2
12.	1	0.3	0.3	44.6
14.	1	0.3	0.3	44.9
15.	25	8.5	8.5	53.4
16.	1	0.3	0.3	53.7
17.	1	0.3	0.3	54.1
20.	74	25.2	25.2	79.3
25.	16	5.4	5.4	84.7
30.	27	9.2	9.2	93.9
40.	8	2.7	2.7	96.6
50.	6	2.0	2.0	98.6
60.	3	1.0	1.0	99.7
99.	1	0.3	0.3	100.0
TOTAL	294	100.0	100.0	

MEAN	16.871	STD ERR	0.716	MEDIAN	15.100
MODE	10.000	STD DEV	12.269	VARIANCE	150.529
KURTOSIS	7.589	SKEWNESS	1.847	RANGE	99.000
MINIMUM	0.0	MAXIMUM	99.000		
VALID CASES	294	MISSING CASES	0		

INSTITUTIONAL AND FINANCIAL AIDS

Money spent would guarantee favorable financing, ensure attractive tax treatment, and create strong support systems (such as insurance).

CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
0.	49	16.7	16.7	16.7
2.	2	0.7	0.7	17.3
3.	1	0.3	0.3	17.7
5.	34	11.6	11.6	29.3
8.	2	0.7	0.7	29.9
10.	103	35.0	35.0	65.0
12.	1	0.3	0.3	65.3
15.	28	9.5	9.5	74.8
16.	1	0.3	0.3	75.2
20.	43	14.6	14.6	89.8
23.	1	0.3	0.3	90.1
25.	7	2.4	2.4	92.5
30.	10	3.4	3.4	95.9
35.	2	0.7	0.7	96.6
40.	2	0.7	0.7	97.3
50.	6	2.0	2.0	99.3
90.	1	0.3	0.3	99.7
99.	1	0.3	0.3	100.0
TOTAL	294	100.0	100.0	

MEAN	12.476	STD ERR	0.697	MEDIAN	10.073
MODE	10.000	STD DEV	11.957	VARIANCE	142.960
KURTOSIS	15.432	SKEWNESS	2.952	RANGE	99.000
MINIMUM	0.0	MAXIMUM	99.000		
VALID CASES	294	MISSING CASES	0		

TECHNICAL ASSISTANCE

Money spent would provide expert assistance in and information on the use and maintenance of PV systems.

CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
0.	44	15.0	15.0	15.0
1.	1	0.3	0.3	15.3
2.	2	0.7	0.7	16.0
3.	1	0.3	0.3	16.3
4.	1	0.3	0.3	16.7
5.	43	14.6	14.6	31.3
8.	3	1.0	1.0	32.3
10.	120	40.8	40.8	73.1
14.	1	0.3	0.3	73.5
15.	22	7.5	7.5	81.0
16.	1	0.3	0.3	81.3
20.	37	12.6	12.6	93.9
25.	8	2.7	2.7	96.6
30.	9	3.1	3.1	99.7
35.	1	0.3	0.3	100.0
TOTAL	294	100.0	100.0	

MEAN	10.395	STD ERR	0.432	MEDIAN	9.933
MODE	10.000	STD DEV	7.404	VARIANCE	54.820
KURTOSIS	0.399	SKEWNESS	0.710	RANGE	35.000
MINIMUM	0.0	MAXIMUM	35.000		
VALID CASES	294	MISSING CASES	0		

OTHER

CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
0.	249	84.7	84.7	84.7
2.	1	0.3	0.3	85.0
4.	2	0.7	0.7	85.7
5.	13	4.4	4.4	90.1
8.	2	0.7	0.7	90.8
10.	19	6.5	6.5	97.3
20.	4	1.4	1.4	98.6
25.	1	0.3	0.3	99.0
30.	2	0.7	0.7	99.7
40.	1	0.3	0.3	100.0
TOTAL	294	100.0	100.0	

MEAN	1.653	STD ERR	0.289	MEDIAN	0.090
MODE	0.0	STD DEV	4.961	VARIANCE	24.610
KURTOSIS	21.720	SKEWNESS	4.231	RANGE	40.000
MINIMUM	0.0	MAXIMUM	40.000		
VALID CASES	294	MISSING CASES	0		