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Jan Buhrmann is a professional research assistant in the Department of Sociology, University of Colorado, Boulder. Writer Dawn Griffin assisted in project management and conducted some of the focused interviews and prepared field notes. Karen Brown, Ph.D., helped in the development of the qualitative codebook. Aiding considerably in the coding of the qualitative data were Elisabeth Sheff and Dorian Wilson, doctoral candidates in the Department of Sociology, University of Colorado, Boulder. Rochelle Watters provided support in a variety of ways, including preparation of the manuscript. Jim Miller, Kay Vernon, and David Crawford provided graphics, word processing, and editorial support.

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Executive Summary

This project began when the Colorado Governor's Office of Energy Conservation (OEC) and utility companies considered making residential grid-tied photovoltaic (PV) systems available in Colorado. The idea was to find 50 homes owned by people willing to pay the costs of grid-tied PV (GPV) systems without batteries—$8,000 or $12,000 for a 2- or 3-kilowatt (kW) system, respectively. These costs represented two-thirds of the actual installed cost of $6 per watt. The other third would be subsidized.

The National Renewable Energy Laboratory (NREL) and OEC partnered to conduct a market assessment to identify residential customers willing to pay these amounts for a GPV system and to explore their reasons for wanting to participate, their preferred product attributes, and their attitudes toward utility involvement in GPV. This paper reports on the results from the qualitative phase of the research, based in the diffusion-of-innovation research tradition, which serves as the foundation for a subsequent homeowner survey.

A purposive sample of 120 Colorado households was developed, and lengthy face-to-face open-ended focused interviews were completed. Focused open-ended interviewing yields rich volunteered information. Nearly 9,500 responses were coded from the interviews. After interviewing was concluded, the names of interested households were given to the candidates' respective utility companies for follow-up contacts.

This report contains the results of the qualitative study. Interviews lasted from 1.25 to 3 hours; interviewers prepared field notes on them. The resulting 450 pages of field notes were coded, resulting in volunteered data on motivations to adopt PV tied to the utility grid, barriers and concerns, preferred product attributes, attitudes toward utilities, information needs and sources, and preferred public policies on GPV.

The study's results cannot be generalized to any population; the sample was undoubtedly atypical of Colorado electricity customers. Instead, respondents spoke from the standpoint of innovators and early adopters of PV technology. They tended to be men or married couples ranging in age from their early thirties to their mid-eighties; professionals, managers, or small business owners; people relatively financially secure, with extensive experience in energy efficiency and renewable energy. Many worked directly in the energy field or in related occupations such as architecture.

Motivations are more complex than is often realized. As would be expected, environmental concern and cost considerations were mentioned often. More surprising was the emphasis given to benefits to the community (such as the opportunity to help create and expand the PV market), the desire to send utility companies a strong signal about preferences for renewable energy, the significance of having a choice in electricity production, the opportunity to express deeply held personal values through a PV purchase, a desire to participate driven by interest in technology and how it works, the sense of "having a hand in shaping the future" through such participation, and even the sense of getting a bargain because of the subsidized cost. Many were specifically interested in a grid-tied system because of the utility involvement, which meant utility risk-sharing with customers, a reputable energy organization standing behind the PV systems, and the ability to use the grid as "storage" for excess power.

The sample had obviously given energy a good deal of thought. Many respondents mentioned advantages and disadvantages of other forms of energy, particularly coal (from which 96% of Colorado's electricity is produced) nuclear energy, and wind energy, in addition to PV. Many said that they believed, on balance, that PV was the best option available for producing electricity today, in terms of its expected impacts on the environment and the economy.

Respondents tended to believe that PV technology was feasible for residential applications. Respondents from this sample indicated that the state of the technology has advanced to the point where PV should be offered and available to consumers, and that from a technological standpoint, PV offers a number of advantages as compared with conventional electricity. Responses pointing to the feasibility of system performance indicate respondents' beliefs that the systems are reliable and produce high quality power.

Product attributes favored most were net metering, warranties and guarantees for the PV system, financing arrangements, quality installation of a durable system, sufficient system efficiencies in producing electricity to be worthwhile, a maintenance option, a feedback mechanism (such as utility billing, metering, or tie-in to personal computers), battery options, and an aesthetically pleasing system flush-mounted on a home's roof rather than on the ground. Almost 40% of the sample wanted to break even on the system cost over a 20-year period (most frequently mentioned as the expected lifespan of a PV system); 26% said they were unconcerned about breaking even or expected never to break even, and that it was not their reason for wanting to invest in a GPV system. The rest of the sample did not raise this point.

Most of the sample needed information on the manner in which their utility company would offer them the system, such as whether financing would be provided, whether a site assessment would be done, whether a maintenance program would be offered, and whether they would have the option to own or lease the system. Some respondents also suggested several information sources for eventual PV system users, including a local or 800 number for technical support, a single point of contact for help and information, a training class for system users, newsletters or bill stuffers, an instruction book or plaque, and a PV system users group or website.

The respondents expressed more negative than positive comments about utility companies. A good deal of skepticism existed among the sample regarding the utility's motives for offering a PV product, although many described in detail benefits the utility company could receive from offering residential GPV systems. However, many positive comments reflected an interest and willingness to work with utility companies on GPV, to help utilities "climb the PV learning curve," and to report their experiences with PV to the utility companies.

GPV was seen as a more advantageous way to produce electricity than conventional energy technologies. It was also seen as compatible with mainstream societal norms and values. Adopting GPV was viewed as a fairly complex process; those seeking to offer GPV systems should strive to simplify the purchase as much as possible. Potential adopters will want credible feedback on GPV system production of electricity in order to observe how well their systems are performing. Adopters wanted to reduce their financial risk as much as possible by having warranties, guarantees, maintenance programs, and leasing options.

Some respondents suggested the following policies for PV: special financial consideration for early adopters of PV technology (such as fixed electric rates for a number of years); tax credits or incentives; net metering (preferably at retail cost, but at least at an amount between retail and avoided cost); export of PV technology to developing countries to expand U.S. manufacturing capability; and government investments in renewables research and development.

Among the potential early adopters in this sample, perceptions were favorable to PV adoption in the immediate future if Colorado utilities offer a GPV product that is perceived as satisfying customers' reasons for purchasing PV systems.

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Introduction

Background

A consortium of Colorado utility companies, the Governor's Office of Energy Conservation (OEC) and other organizations successfully competed for a federal grant to subsidize the cost of installing 50 grid-tied photovoltaic (PV) systems in the state. Utilities faced the problem of finding 50 buildings whose owners were willing to pay $8,000 or $12,000 for a 2- or 3-kW system, respectively—the costs of grid-tied PV (GPV) systems without batteries. This reflected an installed system cost of $6 per watt with a $2 per watt federal/utility subsidy. Customers were asked to consider paying two-thirds of actual installed system cost ($4 per watt).

The National Renewable Energy Laboratory (NREL) and OEC teamed to examine customer interest in residential GPV as a utility service option. NREL had reason to believe that at least a small market for residential GPV existed (Farhar-Pilgrim and Unseld 1982; Farhar 1993, 1994a, 1994b, 1996; Farhar and Houston 1996). The project's purpose was to identify residential customers willing to pay these amounts for GPV and to explore their reasons for wanting to participate. This paper reports partial results from the qualitative phase of the research, based in the diffusion-of-innovation research tradition, which serves as the foundation for a subsequent survey of a probability sample of Colorado homeowners. The GPV system cost far exceeded the usual amounts previously discussed in the literature on willingness to pay for renewable electricity (e.g., less than $5.00 per month). Therefore, this was an unprecedented green-pricing approach.

A residential GPV system consists of solar panels, mounted on a customer's roof and connected to the customer's conventional electric system, that convert sunlight to electricity. During the day, the solar panels provide electricity for use in the home. Excess electricity is sold back to the utility. At night, or when additional power is needed, the utility provides conventional electricity to the home.

Residential photovoltaics tied to utility grids (GPV) is an area of critical focus for increasing the use of renewable energy. Relatively little information exists in the published literature about the market for GPV (Farhar and Houston 1996).

The study was designed in two phases:

(1) *Qualitative pilot work*, involving focused, open-ended interviewing of a purposive sample of interested candidates for the PV systems

(2) *Survey of a probability sample of residential electricity customers*. Based on the pilot research, a survey was developed to assess the interest in renewables among residential electricity customers and to estimate the potential size of the market for GPV systems in Colorado.

The qualitative phase of the study, covered in this report, is intended as a starting point to answer questions about the GPV market by identifying potential customers and exploring their motivations and preferences. It addresses such questions as:

- Who these customers might be
- Why they would choose to pay considerably more for electricity from residential PV systems tied to their utility grid
- How much they are willing to pay for PV systems on their properties
- Whether customers would prefer to own PV systems or lease them from utilities and why

- Information needs that customers might have about owning such systems
- Policy preferences.

The study was intended to help the Colorado OEC better understand electricity customer views of residential GPV systems from a policy standpoint. The OEC has an important role to play in developing governmental policy in Colorado relative to renewable energy. The market assessment also was intended to help the Colorado utilities involved to determine the role they would play in offering PV systems and in designing PV products that would best meet the needs of their customers.

Results from the survey of a probability sample of Colorado homeowners will be addressed in a later report.

Getting the Most from Qualitative Data

Open-ended research with a self-selected sample is useful even if the results cannot be generalized to a universe of electricity customers. Those who adopt an innovation considerably sooner than others are the earlier adopters of that innovation, leading the way in the diffusion-of-innovation process (Rogers 1995). These earlier adopters are the market niche for any renewable electricity offering in its initial stages. When introducing an innovation, it is especially useful to have information on the motivations and perceived barriers of these kinds of electricity customers.

The second reason this information is useful is its open-ended nature. Much market research, including focus groups, is conducted in a stimulus-response mode, when ideas formulated within companies are tested against customer response. The open-ended data collection technique, in contrast, yields information that is customer-defined. This is appropriate for demand-driven programs. When customers volunteer information on their motives for being interested and the concerns they have, the results are more grounded and more market-driven than those from any other research approach. The results provide a rich foundation for focus-group and survey research. In addition, the results give information that allows early programs and products to provide the added value for which customers want to pay. Even when customers are not well informed, the kind of information they need becomes more clear from this type of research, so that programs and marketing campaigns can be responsive.

The data collected in this study were rich and detailed. They can be approached in two ways. First, the data can show in broad terms the range of motivations, concerns, information needs, and product preferences that earlier adopters have about GPV. By frequency of mention, the data also show the weight given to these concerns. Second, because data were volunteered, the mention of any single response has some import. A great deal of detail can be gleaned from studying the data tables (which were constructed to include, virtually verbatim, all responses coded as “other”). This type of detail helps ensure that the entire ground is covered in reporting why customers are interested in GPV—and there are myriad unique reasons as well as common themes—as well as their preferences for these systems. Even a single mention of some point can help PV manufacturers improve their products, utility companies improve their product offerings to make them more satisfactory to customers, and policy makers consider and refine various potential policy options.

Overview of the Report

The report describes the market assessment’s guiding ideas and its approach to the research. It then briefly describes respondents in the sample and also their homes as potential sites for GPV. Next, findings are presented on respondents’ motivations for purchasing GPV, whether they believed that PV is technically feasible, cautions and concerns they expressed, PV product attributes they preferred, and their knowledge levels and their need for information. Respondent attitudes toward utility companies and their suggestions for policies to promote PV are presented. Finally, conclusions are presented and recommendations made.

Guiding Ideas of the Study

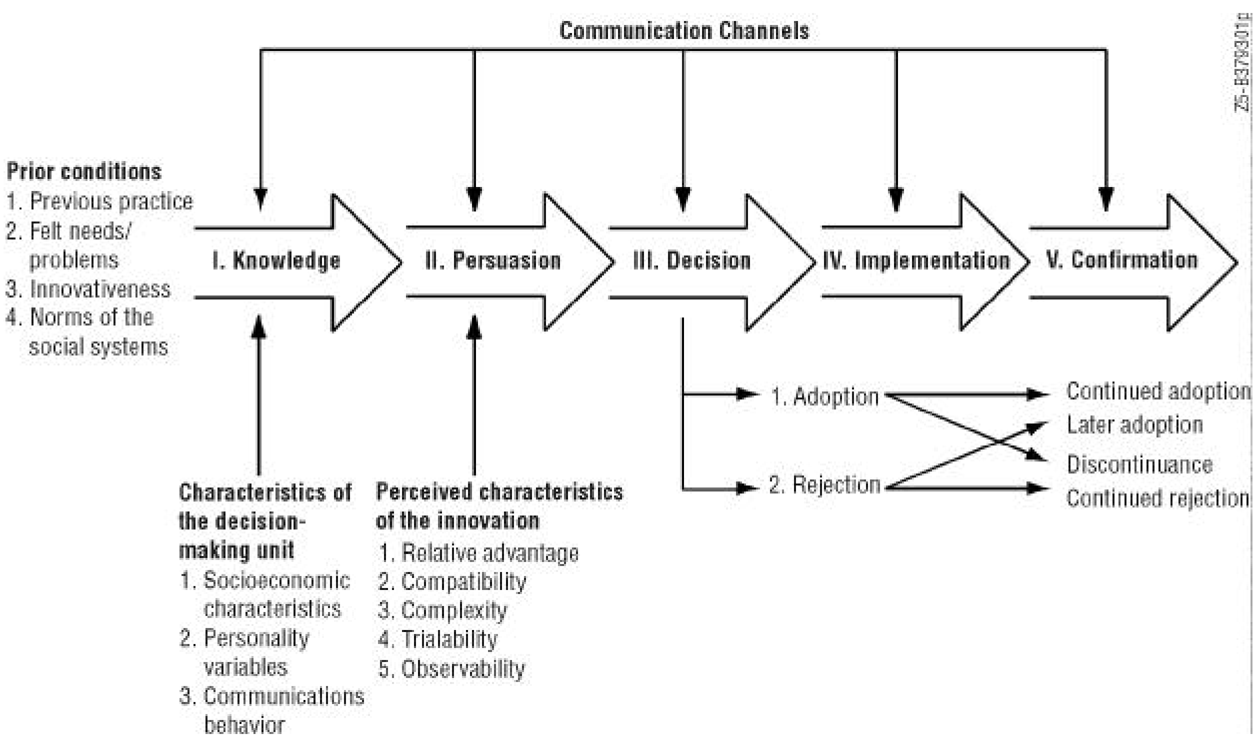
Literature Review

NREL had reason to believe customers would be interested in GPV (Farhar 1993; Farhar 1994a, 1994b; Farhar and Houston 1996). National poll data show that, since 1979, majorities of the U.S. public have exhibited a marked preference for renewable energy and energy efficiency when cost is not mentioned, and majorities indicate a hypothetical willingness to pay more for environmental improvement and protection, including use of renewable electricity (Farhar 1996).

Stages in the Adoption of Innovations

Producing electricity for households using a PV system installed at a residence and tied to the utility grid is an innovation. The diffusion of innovations literature has been extensively reviewed by Rogers (1995). An extensive literature explains how and why innovations are adopted. A long-established research tradition views the adoption of innovations as a process occurring over time. Much research has focused on the perceived characteristics of innovations that affect their rate of adoption and on the characteristics of innovation adopters.

To explain the potential market for renewable electricity in Colorado, it is useful to understand the innovation-adoption decision process. Figure 1 shows the accepted model of the decision process that has informed this research (Rogers 1995).



Source: Rogers 1995

Figure 1. Model of the Innovation-Adoption Decision Process

1. The *awareness stage* refers to individuals and organizations (called market "actors") having heard about the innovation. They might be interested because of prior experience, professional interest, business interest, interest in technology, social pressure, and social values. At the end of this stage, an actor may be eager to know more, be disinterested, or be somewhere between.

2. The *persuasion stage* refers to the aware actor's efforts to learn more about the innovation, how it works, how much it costs, who is using it and with what results, who is for and who is against it, and how it might "fit" in the individual's own situation. By the end of this stage, an actor has formed a favorable or unfavorable attitude—a position—toward the innovation, both in terms of its general use and its specific relevance to the actor. Actors could be generally favorable to the new idea but not favorable to their own involvement with it.

3. If an individual or organization is favorable to becoming involved, this "propels" them to the next stage of the process: the *decision stage*. During this stage, the actor decides to become involved with the innovation and makes plans to adopt it within the foreseeable future. The actor's "behavioral intention" is to adopt the innovation—in the case of renewable electricity, to participate in the program. If no major obstacles intervene, the likelihood is high that the actor will pass to the next stage.

4. In the *implementation stage*, the actor purchases or otherwise implements the innovation. This stage is not yet termed "adoption," because the actor's experience with the innovation may cause them to reject it. Once the implementation stage has been reached, the last stage inevitably follows.

5. In the *confirmation stage*, the individual or organization lives with the positive and negative consequences of adoption. After a time, they decide whether they made a good choice and are satisfied. If problems arise during this stage, actors try to resolve them.

The end result of the process will be continuance or discontinuance of the adoption decision.

Rate of Adoption

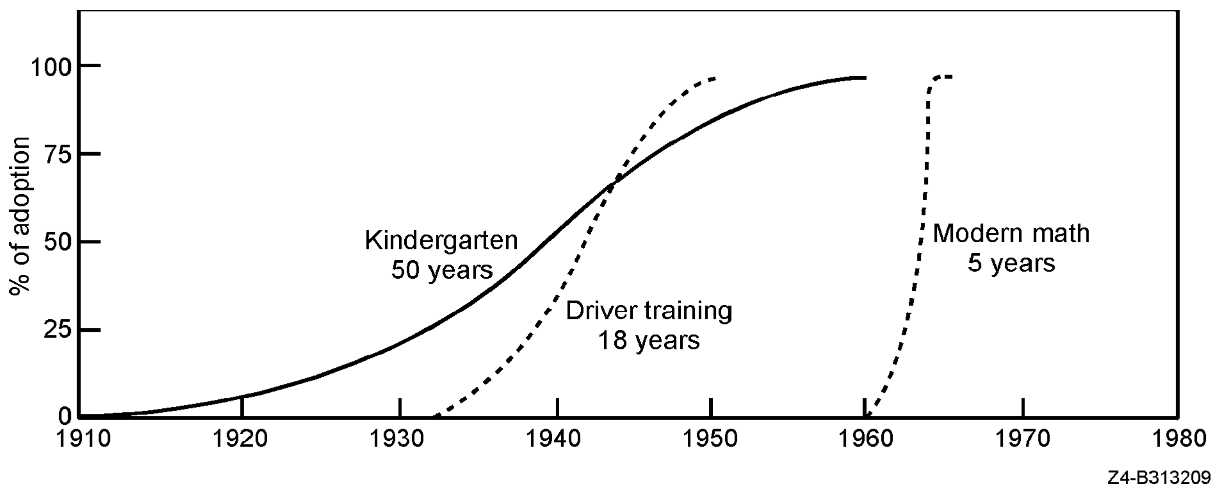
Innovations take varying lengths of time for adoption. Innovations that can be adopted by individuals, such as the birth control pill, can reach "saturation" within 5 years. Innovations requiring organizational and community change, such as kindergarten, can take as long as 50 years to reach saturation. Figure 2 shows rates of adoption of three different innovations over time.

Variables determining the rate of adoption of innovations—how quickly they will spread—include the perceived attributes of the innovation, the type of innovation-decision, communication channels used, the nature of the social system in which the innovation is adopted, and the extent of the promotion efforts of change agents (Rogers 1995, p. 207).

From 49% to 87% of the variance in rate of adoption can be explained by five attributes: (1) relative advantage, (2) compatibility, (3) complexity, (4) trialability, and (5) observability.

- **Relative advantage**

The perceived relative advantage of an innovation is positively related to its rate of adoption. Relative advantage is "the degree to which an innovation is perceived as being better than the idea it supersedes" (Rogers 1995, p. 212). Often, the relative advantage of an innovation is expressed in terms of economic and prestige advantages. VCRs sold for more than $1,200 in 1980, but within a few years a similar model sold for only $200. When prices decrease in this fashion, a rapid rate of adoption is encouraged.



Source: Adapted from Rogers and Shoemaker 1971

Figure 2. Examples of Diffusion Curves

- **Compatibility**

The perceived compatibility of an innovation is positively related to its rate of adoption. Compatibility is "the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters" (Rogers 1995, p. 224). Innovations may be compatible or incompatible with sociocultural values and beliefs, with other ideas, and with the adopter's needs. For example, the miracle varieties of rice invented in the 1960s "green revolution" tripled crop yields. Bred for high yields and pest resistance, the grains' taste was ignored. In South India, farm people, not liking the taste of the new varieties, refused to eat them, although they grew them for sale to others.

- **Complexity**

The perceived complexity of an innovation is negatively related to its rate of adoption. Complexity is "the degree to which an innovation is perceived as relatively difficult to understand and use" (Rogers 1995, p. 242). The first adopters of home computers loved technological gadgets; many were engineers with extensive mainframe experience. But most people had difficulty using personal computers (PCs) and had to join computer clubs, take courses, obtain help from friends, or find other means to cope with the difficulties their computers posed. This slowed down the rate of adoption. Eventually, PCs became more user friendly and, by 1994, about 30% of households owned one.

- **Trialability**

The more the innovation can be tried out, the faster its rate of adoption. Trialability is "the degree to which an innovation may be experimented with on a limited basis" (Rogers 1995, p. 243). If new ideas can be tried out without too much risk, uncertainty can be dispelled. The perceived trialability of an innovation is positively related to its rate of adoption. Early adopters are more concerned with trialability than are later ones.

- **Observability**

The perceived observability of an innovation is positively related to its rate of adoption. Observability is "the degree to which the results of an innovation are visible to others" (Rogers 1995, p. 244). The effects of some ideas are readily observable; the effects of others are difficult to discern. The observability may include how visible adoption is to others, thereby conferring status on the adopter, or showing that the innovation indeed "works." Observability may also include the ability to actually see the effects of the innovation.

Assuming that an innovation may be perceived as having characteristics desirable for adoption, other factors come into play that can speed up or impede decisions to adopt an innovation. These include the following:

- The innovation has to be available through institutionalized channels.

- The adopter has to understand enough about the innovation to make a decision.

- The adoption decision has to have salience—it has to be important enough to be at or near the top of the person's action list.

- The adopter has to have a support system in place, preferably the organization from which the innovation was purchased, but also friends who understand the innovation.

- The adopter has to have the financial wherewithal to purchase the innovation, or financing arrangements have to be adequate to make purchase possible.

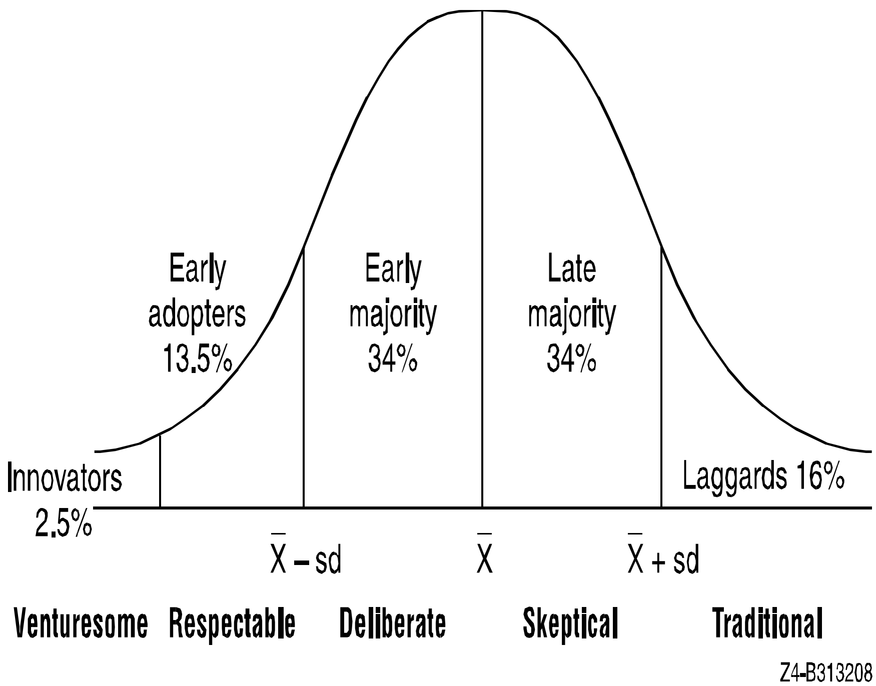
Characteristics of Innovation Adopters

Other empirical work has focused on characteristics of innovation adopters. People have been categorized into five types by how quickly they adopt innovations (Figure 3). A small proportion (the first 2.5% of the population to adopt) are "innovators," the leading edge of adopters. Next, a group of about 13.5% is defined as "early adopters," those who benefit from the experience of innovators, maximizing their advantages in adopting the innovation, while minimizing their risks. Early adopters, it turns out, are also frequently "opinion leaders," and thus serve as an important social catalyst to shift the innovation's penetration from the select few to the "early majority" (34%). Gradually, the "late majority" (34%) adopts the innovation, for not doing so would leave them in a worse position relative to everyone else. Finally, the "laggards" (16%) get around to adopting. When most people have adopted an innovation, the market is said to be "saturated" (Rogers 1995).

Innovators tend to be venturesome and members of social groups of like-minded individuals. They tend to control substantial resources, have complex technological knowledge, and tolerate uncertainty in outcomes.

Early adopters are well integrated into local communities and tend to be people to whom others look for advice before adopting an innovation. They tend to maintain respect by their judicious use of new ideas. They are opinion leaders. The early majority are more deliberate than the first two groups, taking longer to adopt new ideas. They comprise the most numerous adopter category.

The early majority adopts innovations just before the average person. The early majority interacts frequently with others and links the early adopters to the majority through their interpersonal contacts. They may deliberate for some time before adopting.



Source: Rogers 1995

Figure 3. Categories of Innovation Adopters

The late majority are skeptical of new ideas and cautious about adopting them. They tend not to adopt until others have done so. Laggards are the last in the social system to adopt an innovation; they are more local than cosmopolitan in orientation and may be less well integrated in social networks. Their resources are relatively limited, and their caution is often born of financial necessity (Rogers 1995, pp. 263-267).

Some demographic characteristics of earlier adopters as compared with later adopters are as follows (Rogers 1995, p. 269):

- Earlier adopters tend to have higher levels of formal education
- They tend to have higher socioeconomic status
- They have a great degree of upward social mobility
- They control larger units (such as companies)
- They are no different in age from others.

Innovativeness tends to be linked with wealth, yet wealth does not explain innovative behavior. Many wealthy people are not innovators.

Other distinctions between earlier and later adopters include personality differences. Earlier adopters, as compared with later adopters, tend to be less dogmatic, be more able to deal with abstractions, use greater rationality, have more favorable attitudes toward science, be less fatalistic, and have higher aspirations. They have more contact with change agents, seek more information about innovations, and have greater knowledge of innovations than later adopters (Rogers 1995, pp. 273-274).

Adoption of GPV actually represents two innovations in one—the idea of producing and owning electricity nd the use of PV technology at one's residence to accomplish this. Those volunteering for GPV system purchase are innovators and early adopters. They may have nominated themselves because they perceived GPV as having attributes that diffusion theory predicts would foster PV adoption. This possibility is discussed further in the Conclusions section of the report.

Research Approach

The qualitative pilot work was NREL's first step in the market assessment. Its intent was to identify Colorado electricity customers interested in purchasing, leasing, or otherwise obtaining a subsidized GPV system through their existing utility company. NREL located and interviewed these customers about the reasons for their interest and the features of these systems that they would find desirable, and forwarded the names of those interested to their respective utility companies. Potential candidates were told they must be willing to seriously consider paying $100/month or more to have a 2-kW or 3-kW system installed on their roofs, or purchasing a system outright in the cost range of $8,000 to $12,000.

Sampling

To develop the purposive sample of customers, the research team sent out global e-mail messages at NREL and Public Service Company of Colorado (PSCo).[1] The Colorado OEC sent notices to several newsletters with subscribers that might be interested in the GPV program. NREL issued a news release, and several newspapers around the state published short articles on it. PSCo sponsored a Parade of Homes in Evergreen, Colorado, that included a house with a GPV system. PSCo compiled inquiries it received about the house and shared these with NREL.

NREL and OEC developed a one-page form (Appendix A) to send, along with a cover letter, to people who nominated themselves or whose names were provided by other people. The form explained the costs that people would probably be asked to pay to participate in the program and stated that they would need to agree to an interview and possibly to meet with a utility official. They also were told that some utilities planned to offer a limited number of systems to their customers.

NREL received 515 inquiries from individuals to whom forms were sent; 260 people completed and returned the forms. The research team developed a purposive sample from this group, taking them somewhat in first-come, first-served order, but also making sure there was at least some representation from among the various interested utility companies around the state. Other potential respondents were placed on a wait list. Once interviewing was completed, NREL provided the names of 250 potential candidates for the GPV program to utilities around the state, including 141 names to Public Service Company of Colorado alone.

Those interviewed constituted a purposive sample of residential customers interested in obtaining a GPV system at today's costs. Therefore, the study's results cannot be generalized to any population; the sample was undoubtedly atypical of Colorado electricity customers. Instead, respondents spoke from the standpoint of innovators and early adopters of PV technology.

Qualitative Data Collection

The research team completed personal focused, unstructured, face-to-face interviews with 120 potential candidates (including candidate couples) for the program. These interviews lasted from 1.25 hours to 3 hours. Interviews were conducted at respondents' offices or other places of work, at public places (such as coffee shops), or at their homes, especially in cases where both the husband and wife wanted to be included in the interview. Data were collected between October 1996 and March 1997.

Interviews focused on the following topics: (1) reasons respondents wanted to pay $8,000 for a 2-kW system or $12,000 for a 3-kW system mounted at their property; (2) any preferences they mentioned for system features;

[1] The state's largest utility, located in Denver, has 886,987 residential customers.

and (3) information they needed (including any concerns they had) to make a purchase decision. No interview guide was used. These interviews resulted in volunteered responses, which interviewers probed for specificity (e.g., "What do you mean by . . .?") and completeness (e.g., "Any other reason?"). The interviews began with a statement about the topics to be covered, after which respondents started talking. Interviewers took notes. Interviewers did not probe for responses not mentioned by respondents. Because responses were volunteered and respondents developed their own statements rather than responding to questions, the data have particular value. This focused interviewing approach may tend to mute "social desirability" bias in responses by avoiding the subtle guidance of the interview with choices that respondents can judge as desired or expected (Merton et al., 1990).

Interviewers did not "educate" respondents about the type of product that they could expect from their utility company. When respondents raised questions, these were noted, and coded later as types of information needs. Similarly, interviewers did not correct misperceptions that respondents might have had about GPV systems or PV technology for two reasons: (1) interviewers were not knowledgeable enough to provide technically accurate information about PV systems, and (2) utility companies had not yet specified their PV product offerings at the time of the interviews; therefore, interviewers could not describe such offerings to respondents. In addition, because perception is critical to action, the research team thought it useful to document perceptions (and misperceptions) so that those offering GPV systems could foster accurate understanding of their products.

Interviewers told respondents that utility companies were responsible for offering their customers GPV systems. Interviewers also told respondents that they would give their names and addresses to their utility companies, with respondents' permission.

Otherwise, interviewers said that responses would be held in confidence and only reported in aggregation with others' information. Respondents were thanked for their participation in the interview and given a contact name and number should they want to contact someone from the research team at a later date.[2] Interviews were followed up with a mailing of additional information about the Solarex PV system that was to be provided through the program.

Coding

After each interview, field notes were prepared. A codebook was prepared, pretested, revised, and further tested until a final draft codebook was produced with approximately 475 code categories. Code categories were derived from the data (Glaser and Strauss 1967); some categories overlapped because of the difficulties inherent in coding text.

Three doctoral candidates in sociology coded each relevant sentence in the 450 pages of field notes, resulting in 9,407 coded responses, organized into such groupings as "motivations to adopt GPV," "preferred product attributes," and "attitudes toward utilities." Each set of field notes was coded by two independent coders and the results were tallied. All discrepancies in coding decisions were resolved in two-person coding meetings. Data were entered into an Excel database, checked for accuracy, and cleaned.

Analysis

An Excel program was developed to produce the number of mentions and the number of respondents mentioning each response. Respondents could think through the reasons for their own decisions, as well as information they

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[2]Many respondents subsequently called the principal investigator because they had not yet been contacted by their utility company. A follow-up study on the 120 households in the study 1 year later will be completed; its results will be presented in a later report.

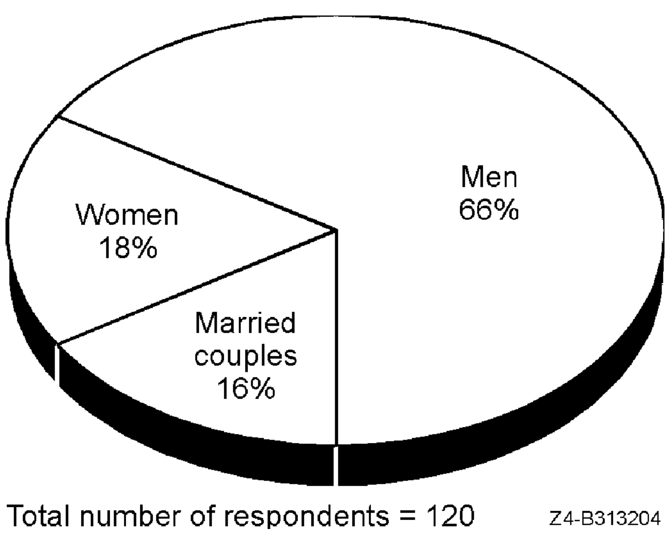
required to make a decision, at the time of the interview. Because interviewing was brought to a close only after responses had become repetitious (at 120 interviews), the set of responses represented in the body of data are the most complete of which we are aware on reasons why people would want to purchase GPV.

As mentioned earlier, the interviews yielded 9,431 discrete pieces of information. We distinguished between coded responses that described the respondents, their sites, and some other miscellaneous information (N = 2,287) and the responses that contained substantive information on motivation and other key study variables (N = 7,144). Table 1 shows the distribution of these types of responses, representing an overview of the findings. These findings show the relative emphasis respondents gave these topics.

Most responses (76%) dealt with substantive variables, such as motivation, perceived barriers to adoption, and information needs. Sixteen percent described the respondents themselves, and 7% described attributes of their properties relevant to GPV, such as solar access. Some miscellaneous information, such as the interviewer conducting the interview, also was coded.

Respondent Characteristics [3]

Demographic data came from volunteered responses or direct observation. The sample was dominated by men. As one respondent put it: "It's a guy thing." The data suggest that interest in GPV is more widespread among men than women among these innovators and early adopters. This could be, in part, a function of how the sample was generated (in part through professional networks). Two-thirds of respondents were male, 18% were female, and 16% were married couples whose responses were written up and coded jointly as one household's responses (as one respondent) (Figure 4 and Table 2). Thus, we interviewed 140 people representing 120 households.



Source: Constructed by the authors

Figure 4. Respondent Gender

[3] Tables 2-13 show the data describing the sample's respondents.

Adults aged 31-65 composed most of the sample, although 17% of the sample were retirees. The interested households were mostly married couples living alone or with children. All were homeowners whose electricity bills ranged from relatively low to relatively high, but the majority of electric bills, as estimated by respondents, were low to moderate. This suggests that, although high electricity bills might have been a reason for some to be interested in PV, most respondents did not appear to be in that position. Also, the electricity bills of this sample may have been lower than average because these respondents were likely to have already used renewable-energy technologies, to have invested in energy-efficiency improvements, or both. Six out of 10 resided in PSCo's service territory; the other 40% were distributed in other utility service territories, although not every Colorado utility company was represented in the purposive sample.

The sample was composed of those who had heard about the GPV systems through professional or activist networks, those who had read about them in the newspaper, or those who heard about them second-hand. Occupationally, respondents and their spouses disproportionately represented professionals, managers, and business owners. Many worked directly in the energy field and in related occupations, such as architecture and building. Thus, the respondents tended to be highly aware and knowledgeable about energy in general and renewable energy specifically. In fact, 63% of the respondents reported prior personal experience with renewable energy and an interest in having more such experience. Many also had invested in energy efficiency; others mentioned having practiced recycling and other environmentally friendly behaviors. The sample appeared to be weighted toward those interested in taking at least some actions to simplify their lifestyles and decrease their individual impact on the environment and those who described themselves as renewables activists, self-identified "techies," and environmental activists. Although the question was not asked directly, researchers gained the impression that many respondents tended to be moderately to very well-off financially. Most of the homes owned by the sample were large.

This profile would fit the pattern of earlier adopters of innovation (Rogers 1995), who tend not to differ in age from others, but tend to have other distinguishing characteristics. Generally, earlier adopters tend to have higher socioeconomic status than later adopters. They tend to have more years of formal education, a greater degree of knowledge of the innovation, and higher occupational aspirations. Other characteristics of adopters—such as a more favorable attitude toward science and toward change and greater exposure to interpersonal communication channels (Rogers 1995)—also seem to characterize the sample**.**

Because many respondents were knowledgeable about PV, they may have given prior thought to the characteristics of their homes when considering purchase of a PV system. Some mentioned that their sites were so conducive to the use of GPV that it was a motivation for them to purchase a system.[4] Most reported their solar access to be excellent or very good. The majority had shingle or composition roofs. Respondents also mentioned a variety of additional site attributes (Table 19) including roof pitch, passive solar design, sunspaces or greenhouses, and solar thermal systems. Referring to possible restrictions, a few respondents mentioned that they belonged to a homeowner's association.

Classification of Response Codes

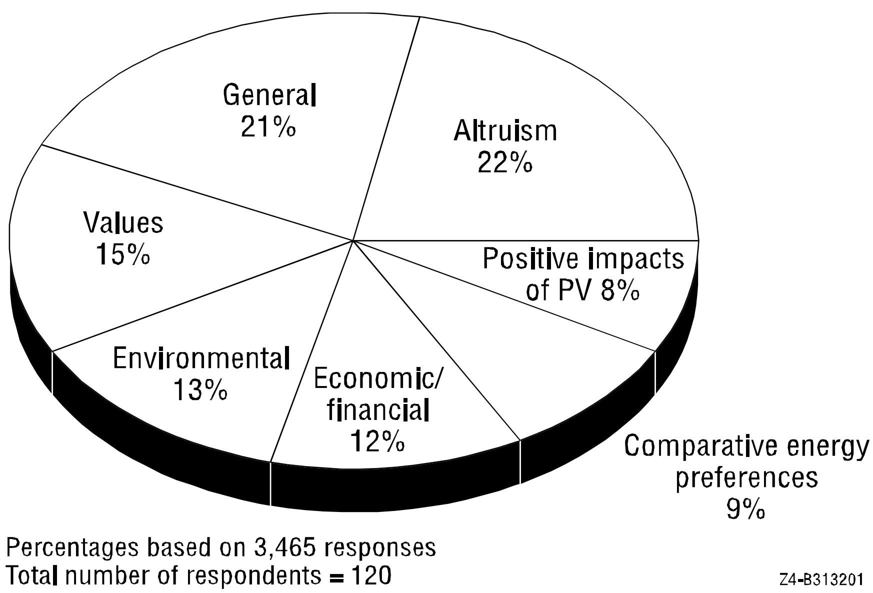
Seventy-six percent of responses (N = 3,465) dealt with reasons respondents gave for wanting to purchase a GPV system. Another 21% of responses described features that respondents wanted the PV system to include. Other responses dealt with perceived barriers to adoption (9%), information needs and preferred sources (9%), attitudes toward the utility company (7%), and preferred policy options (3%). Findings are described for each of these kinds of responses.

[4]Tables 14-19 show data describing the sample's homes.

Motivation to Adopt GPV

By examining the distribution of coded responses within a classification of response types (such as stated reasons for wanting to purchase a GPV system), we can gain insight into the relative emphasis on reasons given within the body of thought encompassed in the data set. Figure 5 presents an overview of the categories of motivations that respondents brought up during the interviews and the percentage of all responses mentioning motivations of each type. Per respondent, the mean number of comments on motivation was 29. This result occurred because of the interviewing process, which continued probing for reasons until the respondents said they had no further reasons to offer.

Of the 3,462 responses on motivation, motivations classified as altruistic occurred most frequently. A "general" category of motivations was mentioned next most frequently, including such responses as a desire for self-sufficiency or for acknowledgment and recognition. Next, the role of personal values in motivating respondent interest in PV, environmental advantages of GPV, and economic and financial reasons for interest were mentioned. A few responses focused on comparative energy preferences representing "total fuel cycle thinking"—these were discussions on the advantages and disadvantages of forms of energy other than PV (such as coal, oil, nuclear energy, and wind energy). Other responses focused on the perceived impacts of GPV as reasons for adopting it (Figure 5 and Table 21).



Source: Constructed by the authors

Figure 5. Motivation by Type of Response

Most respondents volunteered all of these types of reasons for adopting GPV. The percentages of respondents discussing each type are as follows: general, 99%; altruism, 94%; environmental, 94%; values, 93%; economic/financial, 90%; positive impacts of GPV, 78%; and preference for renewables over conventional electricity sources, 75% (Table 22).

Altruism

Altruism refers to the desire to help the community-at-large. Altruistic reasons for purchasing GPV were widely mentioned. Sixty-eight percent of respondents said that participating in the GPV program would help create and expand the PV market thereby helping the PV industry. Forty percent said they wanted to help educate others about renewable electricity and PV in particular; in fact, 28% of respondents said that they were willing for their homes to be PV demonstration sites. Thirty-four percent of respondents stated explicitly that there was no economic reason for them to participate; they commented that they would be adopting GPV for other, noneconomic, reasons (Table 23).

One-third of respondents said they believed adopting GPV was the right thing to do and that they wanted to be part of a larger societal effort. Also, 36% said that renewables are the way of the future. Approximately one-third of the sample mentioned the idea of taking individual responsibility ("If not me, whom? If not now, when?"). In addition, one in five were willing to collect data on their PV experiences and turn their data over to their utility company, much as volunteer weather watchers in decades past turned data over to the National Weather Service. Twenty percent said they wanted to have a hand in shaping the future. Sixteen percent said they wanted to "put their money where their mouths were" with respect to renewables, and this program gave them a chance to do that. A similar percentage said specifically that they were willing to be "guinea pigs" with this new technology. A few respondents mentioned several other reasons, including willingness to donate excess electricity to the community good.

General

Reasons classified as "general" included 21% of the responses on motivation (734 responses) (Table 24). A majority (55%) of respondents mentioned self sufficiency; 49% mentioned perceived benefits to utilities; and 45% said they were curious about PV, particularly in cases where they were building homes and wondered about including PV in construction. About a quarter mentioned a desire to monitor their electricity use more closely, leading to possible changes in their consumption behavior; and 38% perceived the utility grid as storage for the electricity they would produce. Approximately the same percentage mentioned a desire to "stay in synch" with friends, neighbors, and opinion leaders who value renewable electricity.

Some wanted recognition for their investment in PV. For example, 27% mentioned that they would like to receive some public attention, such as favorable media publicity for having a GPV system, although others preferred to remain anonymous. Those seeking attention seemed to be motivated more by a desire to educate the public that PV is practical and feasible rather than for more self-serving motives.

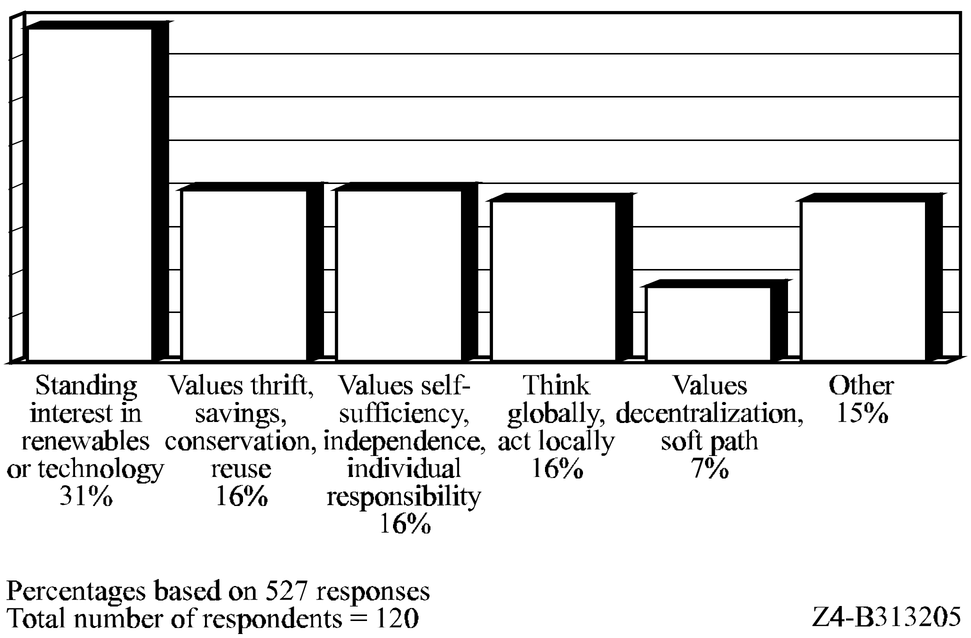
Some people just thought PV would be "fun"—a new technology to enjoy.

As mentioned previously, 16% of motivations coded as "general," mentioned by half of the sample, pointed toward perceived benefits to utility companies if customers purchased a system (Table 25). Among the benefits identified were cost advantages of not having to build more power plants (25% of respondents) and help in meeting peak loads (22%). A few respondents also mentioned increasing utility options in a milieu of utility restructuring, assisting the utility in "climbing the learning curve" with respect to PV, helping provide a public relations advantage to the utility company, and reducing utility risk by customers paying most of the costs of the PV systems.

Values

Values refer to deeply held cultural beliefs that generally are expressed in lifestyle choices (cf. Kempton et al. 1995). As noted previously, many of the respondents were involved in renewable energy: 63% had prior personal experience with renewable energy, 16% were renewable-energy or energy-efficiency professionals, and 29% reported that they were renewables activists. Therefore, it is not surprising that 75% of the sample mentioned a "standing interest in renewables or technology."

Half of the sample said they valued self-sufficiency, independence, and individual responsibility; 43% expressed the idea of thinking globally but acting locally—the GPV program was seen as an opportunity to take local action with global effect. Also mentioned frequently (by 42%) was having been brought up by their families with values of thrift, savings, frugality, conservation, and reuse. Twenty-three percent said they valued decentralization of electricity supply, or the "soft path." Thirteen percent said they valued being a pioneer; 13% said they had a strong love of nature. Figure 6 shows the relative emphasis of the values responses (Table 26).

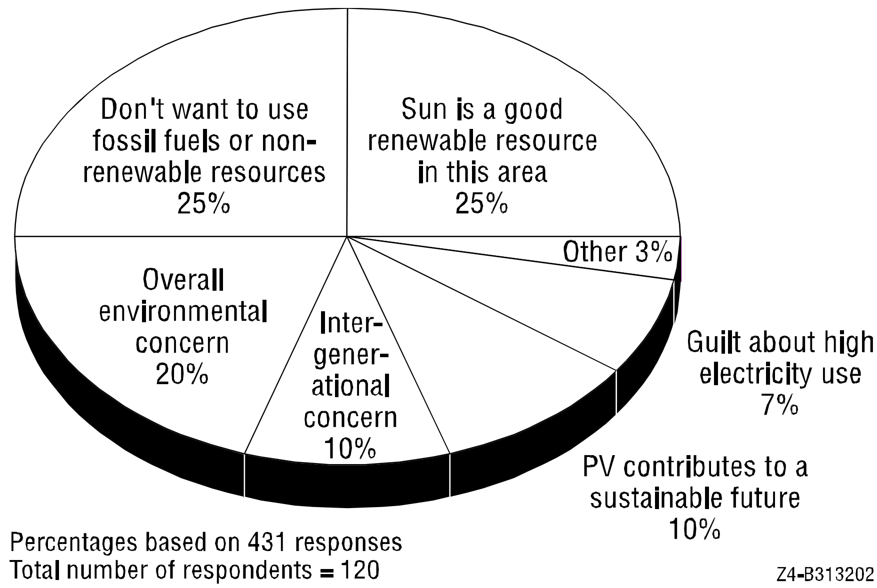


Source: Constructed by the authors

Figure 6. Values Mentioned Most Frequently

Environmental

It is generally thought that environmental reasons are the most important motivations for adopting renewables. Environmental reasons for adopting GPV were important to this sample (Table 27). Two-thirds of the sample said that they wanted to adopt GPV because they did not want fossil fuels and nonrenewable sources such as coal to be used for electricity production. A majority (58%) said the sun is a good renewable resource in Colorado. About half of the sample (53%) expressed general environmental concerns as a reason to adopt GPV. Twenty-eight percent of respondents underscored interest in GPV because of intergenerational concerns; 23% pointed to the perception of GPV as contributing to a sustainable future; and 18% referred to guilt about high electricity use that respondents did not want to give up, but preferred to power through GPV because it was seen as more environmentally benign than other electricity sources. Figure 7 shows the distribution of these types of environmental responses.



Source: Constructed by the authors

Figure 7. Environmental Motivations Mentioned Most Frequently

Economic/Financial

Respondents frequently mentioned business or financial reasons to consider GPV. Thirty-one percent of responses classified here were made by people whose careers, businesses, or professional aspirations related in some way to GPV (such as architects, engineers, builders, owners of energy service companies, and the like). Thirty-nine percent of respondents said they wanted to compare the costs of acquiring a GPV system with the benefits (Table 28). Thirty-eight percent expected reductions in utility bills; 27% mentioned anticipated cost increases of other energy sources; approximately one in five perceived the GPV system costs mentioned ($8,000 for a 2-kW system and $12,000 for a 3-kW system) as a “good deal”—these were people knowledgeable about standalone PV system cost. Eighteen percent believed a GPV system would add to the resale value of their homes; 13% defined GPV ownership as a good investment. Some mentioned that they had the financial ability to purchase the system.

Regarding the economics of GPV ownership, 38% said they expected to break even during the lifetime of the system, most commonly expected to be 20 years (Table 29). Twenty-six percent said that they expected not to break even; they would be purchasing a GPV system for reasons other than economics.

Comparative Energy Preferences

Most of Colorado’s electricity is generated by coal. Respondents frequently compared PV to other types of fuels for generating electricity. “Total fuel cycle thinking” was extensive in this sample, suggesting that these respondents were quite thoughtful about energy issues. When talking about electricity fuel sources other than PV, the most comments were made on coal and oil (54% of responses on this topic), followed by nuclear energy

(20%), wind power (18%), hydropower (5%), natural gas (2%), and geothermal (1%) (Table 30).

Of the sample's comments on coal and oil, 87% were negative and 13% positive. Among negative comments, 36% of respondents mentioned problems with combustion processes. Respondents also mentioned that continued fossil fuel use involves externalized costs, that the earth must be strip mined to extract coal, that fossil fuels are a nonrenewable resource, that train transport of coal incurs transportation costs, that the acid rain that coal-fired power plants produce is killing the Colorado mountain forests, and that mining causes health problems. Positive comments about coal and oil (such as their perceived availability and comparatively lower cost) were relatively rare (Table 31).

Of the 65 comments about nuclear energy, 78% were negative and 22% were positive. Thirteen percent of respondents mentioned radioactive waste disposal as an unresolved problem. Smaller percentages referred to the high cost of nuclear energy, dangers to health, and high levels of government subsidies. On the positive side, there were 14 comments mentioning that there had been no deaths from nuclear energy in the United States; that fear of nuclear energy was motivated by environmentalists; and that nuclear is a clean energy source if managed properly (Table 32).

When respondents mentioned wind energy, 66% of comments were positive and 34% were negative. Fourteen percent of respondents volunteered a positive remark about wind energy, 8% said wind is abundant, and 3% mentioned that it is a renewable resource. On the negative side, a few said that wind could be an intermittent resource in Colorado; that bird kill could be a side effect; or that they opposed having windmill structures or wind farms nearby (Table 33).

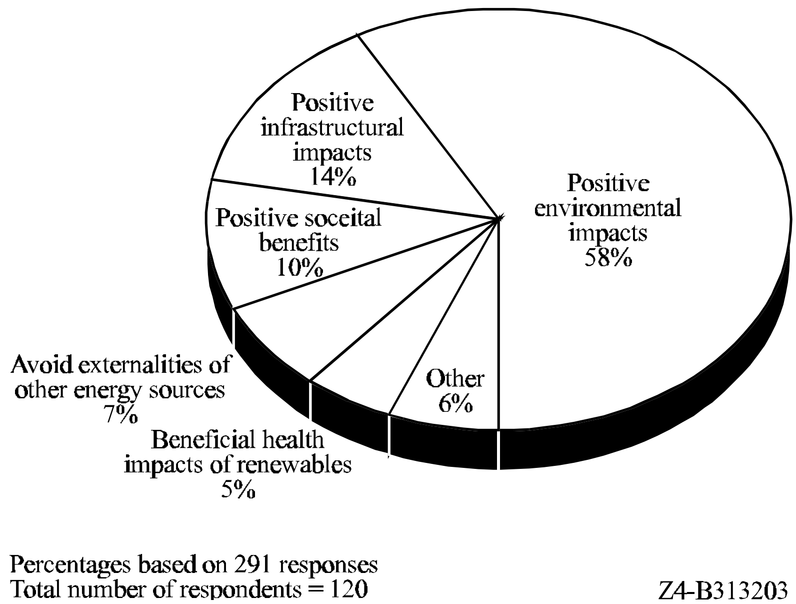
A few other comments made negative or positive mentions about natural gas and geothermal energy alternatives, by 3% or fewer of the sample (Table 34).

Impacts of Grid-Tied PV

Respondents described broad positive societal impacts as part of their preference for GPV. Two-thirds of the sample mentioned positive environmental impacts of PV as a reason for wanting to adopt it. Positive impacts on the infrastructure (such as fewer power plants) also were mentioned, as were societal benefits, avoiding externalities of other fuel sources, and protecting against negative health impacts. Fifty-five percent said specifically that use of PV protects against the negative impacts of other energy alternatives. Respondents also said that PV electricity is clean and would prevent air pollution (36%) and would protect against global warming (7%). About a quarter of the sample (27%) said PV would have positive infrastructure impacts by reducing the number of power plants and power lines. Thirteen percent mentioned specifically that use of PV avoids the externalities of other energy sources and a comparable percentage said that PV use would have positive societal benefits. Eight percent cited beneficial health impacts of renewables use. Compared with other types of electricity sources, 5% said PV was safer. Four percent cited positive economic impacts from PV use. Figure 8 and Tables 35 and 36 show the relative emphasis of the positive impacts responses.

A few respondents mentioned negative impacts of PV, including the amount of energy that goes into producing PV systems, battery disposal problems that they believed remain to be solved, and panel recycling at the end of PV system life (Table 37 and 38).

These thoughts seem interlinked and somewhat overlapping. Taken together, they paint a picture that potential adopters have of PV technology compared with other fuel sources for electricity. This expresses perceived relative advantage in its classical sense—that this way of producing electricity is superior to the way it has been done in the past.



Source: Constructed by the authors

Figure 8. Positive Impacts of GPV Mentioned Most Frequently

Perceived Feasibility of PV Technology

Perceived feasibility reflects respondents' ideas and perceptions about whether PV technology actually converts sunlight into electricity and whether it is technologically ready for application and use. Perceived feasibility includes two types: perceived feasibility of the PV technology itself and feasibility of the PV system's performance.

The sample tended to believe that PV technology itself is technologically ready for use on residential buildings. Respondents frequently described PV systems as long-lasting and trouble-free producers of high-quality electricity.

Twenty-four percent of respondents said PV is technologically and economically ready for the marketplace. Thirteen percent believed PV actually produces useable electricity; 16% said PV provides more reliable or higher-quality power than conventional electricity. This was mentioned particularly by respondents at the end of the utility lines in the mountains and by people who knew about the use of renewable electricity for emergency purposes when power outages occur (Table 39).

The perceived feasibility of PV system performance centered on the belief, mentioned by 18% of the sample, that the systems are durable, have good longevity, and have no moving parts. Eleven percent of respondents mentioned that PV systems produce enough electricity to make them worthwhile. An additional 5% mentioned other aspects of feasibility, including the ability to provide uninterrupted service for computers and other electronic equipment, for heat tapes to keep pipes from freezing, and for television and radio during emergencies (Table 40).

Summary of Motivations

In summary, the reasons volunteered most frequently by majorities or a large portion of the sample, along with the categories into which we classified them, were as follows:

• Had standing interest in renewables or technology (*values*)	75%
• Wanted to create/expand the PV market (*altruism*)	68%
• Perceived positive environmental impacts of PV use, relative to other energy sources (*positive impacts*)	68%
• Opposed using nonrenewable sources of energy, especially coal (*environmental*)	66%
• Believed sun is a good renewable resource in this area (*environmental*)	58%
• Desired self-sufficiency (*general*)	55%
• Expressed overall environmental concern (*environmental*)	53%
• Perceived benefits to the utility company (*general*)	49%
• Had curiosity, technological interest (*general*)	45%
• Perceived opportunity to act locally while thinking globally (*values*)	43%
• Valued thrift, savings, frugality, conservation, reuse (*values*)	42%
• Wanted to educate others about PV (*altruism*)	40%
• Expected financial breakeven over 20 years (*economic*)	38%

More than one-quarter of the respondents said explicitly that they would not be purchasing a GPV system for economic reasons and that they did not expect payback even after a 20-year period. Although they expected a decreased utility bill after installing GPV, they believed that the amount of their investment would not be made up in decreased utility costs over time. Their reasons for GPV investment were noneconomic in the sense of direct personal benefit.

Most people thought GPV systems would last at least 20 years or so. The respondents expecting breakeven over a 20-year period (38%) may have believed that they could sell enough of their excess electricity to the utility company and save enough on their electricity bills to eventually make up the costs of installing the system. People who responded in this way often did not mention the alternative uses of the money over the 20 years, but some were concerned about this, mentioning that they could invest the system costs in the stock market and come out ahead over the 20-year period.

In general, people who wanted to adopt GPV were thoughtful about where electricity comes from. They had informed themselves about the advantages and disadvantages of fuels that society can use to generate electricity, including PV. For them, the advantages (particularly the environmental impacts) of PV outweighed any disadvantages PV had. PV was considered far more desirable than any other option for producing electricity. This is the essence of perceived relative advantage in innovation adoption—that the new idea is relatively more advantageous than continuing with the established way of doing things.

The emphasis on personal values is theoretically relevant as well. The compatibility of an innovation with cultural values increases its rate of adoption. At least for these respondents, GPV was highly compatible with their personal values.

The respondents in this purposive sample were thoughtful and sophisticated. They obviously gave a good deal of weight to the environment in expressing their reasons for wanting to adopt GPV, but environmental concern was not the only significant motivating factor. Other important reasons for wanting to get personally involved included technological interest; economic and financial interests (particularly career interests); a moral interest, encompassed by taking action consistent with personal values and the belief that adopting GPV is the right thing to do; a sense of play—that adopting GPV would be fun; and a belief that the utility company would be offering them a choice that would empower them to play a part in their community's and in society's future.

Perceived Barriers to PV Adoption

Although the purposive sample was enthusiastic about PV, their enthusiasm was moderated by a degree of caution. Most respondents expressed some concern. Many knew little about the potential GPV offering. They had received no other information beyond what they had heard by word of mouth, a brief newspaper article, or a short e-mail note. Therefore, during the interviews, they wondered aloud about possible problems that might come up in connection with a GPV system. We classified these potential concerns as economic/financial risk (mentioned by 75% of the sample); the quality and performance of the specific PV product to be offered (57%); health and safety concerns (52%); legal and regulatory uncertainties (21%); aesthetic concerns (19%); environmental disadvantages (14%); and other concerns (35%) (Table 41).

Economic and financial concerns were mentioned an average of 2.36 times per respondent. About a third (31%) of respondents were concerned about high initial system cost. Approximately one in five expressed concern about whether there would be fair pricing for electricity purchased by the utility through net metering. Another fifth were concerned about whether their utility company would continue its involvement with grid-tied PV once they had purchased their system. These respondents were particularly concerned because a major reason for their willingness to pay for PV was to involve utility companies in its deployment. Concerns mentioned by 13% or fewer of the respondents included the high cost for batteries, personal financial constraints, concern about what would happen to the PV system if or when the homeowner moved, potential for decreased resale value of home, and concern about whether homeowner insurance costs would increase when a PV a system was installed (Table 42).

About a quarter of the sample (26%) mentioned that they were unsure about how vulnerable PV panels would be to weather extremes such as wind and hail. Smaller percentages mentioned other concerns, such as uncertainties about system longevity, system efficiency in converting sunlight to electricity, and the quality of PV power and whether it could run electronic equipment (Table 43).

Expressions of concern about health and safety averaged approximately one response per respondent, although some respondents were more concerned than others about this. Mentioned most frequently, by 20% of the sample, were concerns about roof damage in connection with system installation. Other concerns, mentioned by 15% or less of the sample, included overall safety, battery safety, grid surge effects on the system, danger to utility linemen, and the potential for vandalism (Table 44).

Legal and regulatory concerns were mentioned infrequently. The average number of responses in this category is approximately one comment for every four respondents. Most frequently mentioned, by 11% of the sample, was liability or liability insurance concerns (Table 45).

A few other concerns came up during the interviews. Thirteen percent of respondents mentioned possible environmental disadvantages of PV, such as the need for panel recycling at the end of PV system life, the amount of energy and materials used to produce panels, the need for battery disposal, and wondering whether PV panels produce electromagnetic fields (EMF). Thirteen percent of respondents raised the question of how much space a system would require on their roofs. This was an important question, because the 2 kW system would require at least 500 sq. ft. of roof space uninterrupted by pipes and chimneys and the 3 kW system would require even more space. A few respondents mentioned concerns about whether they had enough land or roof space to accommodate a system or wondered whether they had the right type of roof or adequate solar access. A few also were worried that their utility company might not offer a PV system. Respondents also mentioned concerns that neighbors might take a dim view of a GPV system (Table 46).[1]

Although a number of concerns came up during the interviews, and interviewers were careful to encourage their expression when they were raised, respondents expressed many more reasons to adopt PV than they did barriers. High system cost was the primary concern mentioned; however, most concerns seemed capable of resolution by better information on the actual PV product the utility company was offering. Some concerns, particularly those involving regulatory or policy matters, would probably require answers from a policy source, such as the Governor's Office of Energy Conservation, rather than from the customer's utility company.

In general, the number and kind of concerns expressed did not appear to be at such a significant level that they would impede adoption, with the exception of financial constraints or structural impediments, such as inadequate roof space.

[1]Interviewers sensed that some respondents had difficulty between solar thermal systems, which often are installed using brackets lifting the system away from the roof to increase solar gain, and PV systems, which are usually flush-mounted on the roof or, less frequently, mounted on the ground.

Preferred Product Attributes

Respondents expressed an interesting variety of features and attributes they would like to see the PV systems include (Table 47). The range and depth of responses revealed the sophistication of many respondents with regard to renewable energy and PV, and illustrated their creativity in describing possible product attributes that would make the PV product attractive to them. These preferences tended toward the following:

- A quality installation
- Durability and reliability of the system
- Equipment warranties
- Optional maintenance agreement
- A preference to own the PV system
- A preference to finance the system, with financing options offered
- A preference for the system to meet all or most of their electricity needs
- A preference that the system provides excess electricity, at least part of the time
- On-site or real-time feedback on system performance
- A do-it-yourself option
- Batteries for storage, for emergency backup, or to power other equipment, such as an electric car
- A larger (3-kW) system
- A preference for roof mounting
- A preference for the system to be aesthetically pleasing.

Most respondents mentioned the idea of selling electricity from their grid-tied PV system back to their utility company. They varied considerably in their understanding of this concept. Opinion varied on whether electricity should be sold back at retail cost or at avoided cost. Some 31% felt strongly that if the electricity at their meter was worth, for example, 8.5¢ going in, it was worth 8.5¢ going out. A few others said that if the utility company were going to maintain all of the lines and continue to make a profit, it could not be expected to credit them with retail cost, so they were willing to sell back at avoided cost. Still others took a position somewhere between retail and avoided cost. A few didn't care because selling electricity back was not the major reason they were interested in a system.

Many wanted to see the meter run forward and backward, and only applied the concept of retail and avoided cost to the "excess" electricity—either that consumed beyond what their PV system produced, or that produced beyond their consumption and provided to the grid. In fact, 25% said they would be satisfied with net metering to zero net consumption, and not necessarily being a net producer of electricity.

Some said that early adopters should reap the benefits of higher buyback rates. They thought that if many homeowners began producing excess electricity, that might mean utilities would pay lower buyback rates later on. Several respondents said they would like to see legislation requiring the utility companies to buy back excess power produced by customers. One said, "The utility company should be OK with writing checks back, given how long we have had to pay them."

In addition to net metering, some respondents desired financial consideration for being pioneers, such as a rate freeze or a favorable financing rate. Several respondents said they wanted to contribute their excess electricity so that low-income people could have access to renewable electricity, too.

Among product attributes, 38% preferred to own their system and 36% were unsure whether to own or lease. Seventeen percent preferred leasing. Reasons for owning were that systems were perceived as highly reliable and the best financial advantage would come from owning them, including increased resale value of the home.

Reasons for leasing commonly included the belief that the technology would advance and they would be left with older systems and that leasing would provide a way out. Because respondents seemed to be split fairly evenly on the advantages of leasing versus owning the PV systems, it may be beneficial if both of these options were offered to customers (Table 48).

Thirty percent mentioned a preference for a roof-mounted system (as opposed to a ground-mounted system), although there were many questions about safe installation, flush mounting, roof pitch, roof surface, and the portability of systems. Another concern was whether one would have to go on the roof to clean snow off of the system. Many did not mention which type of mounting they preferred.

Information Needs and Information Sources

During the focused interviews, respondents raised a variety of questions concerning the PV systems that utilities might offer their customers and how the PV product would be offered. When they raised questions, we probed respondents to capture data on their information needs and how they would like to receive information on the PV systems.

Information Needs

Respondents needed a great deal of information on these innovative systems and how they would be offered by their utility companies. In fact, virtually all respondents (92%) raised questions about the PV product that their utility company would be offering and how the utility would offer the PV product to their customers. A majority (68%) wanted technical information about the PV system, such as how it works, its efficiency in converting sunlight to electricity, how the PV system would be integrated with the home's electrical system and with the utility grid, how durable the PV system would be, and the expected performance of the 2-kW and 3-kW systems (Table 49).

A majority of respondents (67%) also had questions about system installation, system operation (including warranties), maintenance, repairs, or panel recycling at the end of the system life. A majority (58%) had questions about the financial aspects of system ownership or leasing, and included questions about system cost and payback, changes in utility bills, net-metering rates, impacts on homeowners insurance, and effects of the PV system on resale value of their homes.

A quarter of respondents needed information on the availability of GPV through their utility and what the utility's motives were in offering the PV product to its customers. Another point, mentioned by 23%, was information on the degree of homeowner control over the PV system (such as portability, ability to add on, upgrade, or customize the system). Some respondents (17%) were curious about the suitability of their sites, and 15% wondered about the amount of benefits to PV system users from electricity produced, feedback on performance, and whether their lights would stay on when power outages occur.

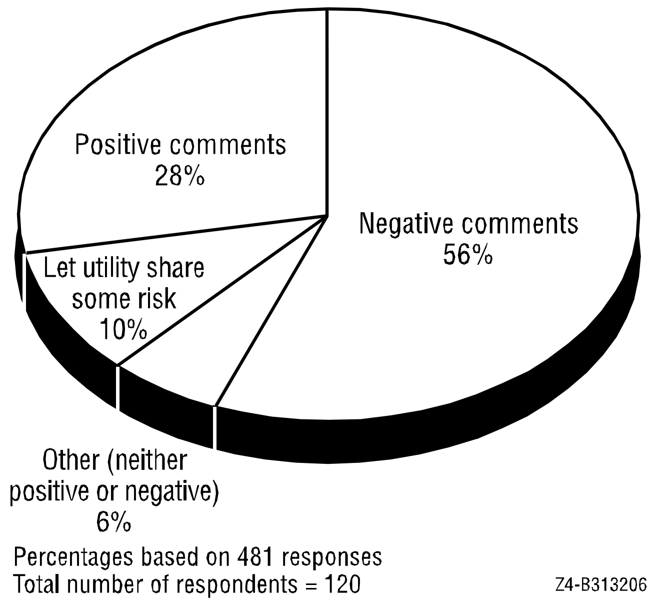
Other information needs identified included quality control issues, the safety of PV systems, the background of the company manufacturing the systems, legal/regulatory issues, policy aspects, questions about the GPV Market Assessment, amount of reflection of the sun from panels, and responsibility for follow-up on the success of the program.

Information Sources

Respondents talked about ways they would like to get information once they had the PV system (Table 50). Thirty percent of responses expressed a preference for a local or 800 number for technical support or for a single point of contact. A quarter of responses included a preference for a training class on the PV systems. Nine percent of responses involved a request for an instruction book or instruction plaque mounted on the system. Eight percent of responses included a request for a PV users group for the program, and 8% mentioned newsletters or bill stuffers as a source of information. Other suggestions were phone numbers and other information for use in emergencies, media coverage of program results, a user group website, a PV demonstration home, financial statements and references from the equipment manufacturers, the establishment of a coordinating agency for the program (such as NREL), and a PV user meeting with manufacturer representatives.

Attitudes toward Utility Involvement in PV

Respondents' attitudes toward utilities revealed sentiments that were both complimentary and critical, and illustrated the diversity of thoughts and ideas about utilities and their business approaches, as well as their participation in the PV program. Total responses were grouped into positive comments, negative comments, and comments about how the utility should run the PV program. More than half (56%) of the comments about utilities were negative, 28% were positive, and the remainder were neither positive nor negative (Figure 9).



Source: Constructed by the authors

Figure 9. Types of Attitudes toward Utility Company Mentioned Most Frequently

One-third of respondents were skeptical of the utility company's motives in offering a PV system (Table 51). Fourteen percent of respondents believed that utilities don't like independent power producers, and 12% were dissatisfied with the utility apart from the PV program. Nine percent said their utility company was inexperienced with offering PV; 9% also remarked that utilities will ultimately be forced to use renewable energy sources. A few respondents believed that utilities fear that customers would become too independent; expressed skepticism about the accuracy of utility billing systems in general and their ability to deal accurately with net metering; believed that utilities think renewables are too expensive; or expressed concern that utilities would engage in false advertising about PV.

Positive comments represented 28% of responses on attitudes toward utilities. Twenty-six percent of respondents said that they wanted to partner with the utility company to be a team player in the PV program. Some 18% were favorable toward utility involvement with the program, and the same percentage acknowledged the utilities' need for profit. Ten percent of respondents desired a mutually beneficial relationship with utilities in the PV program (a win-win situation). A few respondents reported being satisfied with the utility apart from the PV program, believed that the utilities have safety and technology concerns about PV, or reported being contented shareholders in the utility company.

Additional comments on attitudes toward the utility focused on how utilities should run the PV program. About a quarter of respondents (28%) said that the utility should take some of the risks in developing the PV program rather than letting customers take all the risks. One-third mentioned other points, such as a belief in greater potential for cogeneration; a belief that the utilities are responding to customer demands by providing cheap energy; the opinion that utilities have total control; a belief that utilities are male dominated; a belief that utility companies will have to adapt to the standards of PV technology; a belief that power providers in the metropolitan areas of Colorado will have to look seriously at wind power; and a belief that developing economies of scale would drop the price of PV dramatically. Additional comments included the belief that utilities should offer larger subsidies to PV users, the opinion that some utilities are beginning to move toward demand-side management, and the view that utilities should learn about and plan for long-term involvement with PV.

As noted, a number of negative responses centered on skepticism of the utilities' motives with regard to their involvement with the PV program. Twenty-two percent of respondents believed that utilities have no real commitment to renewables. Eighteen percent said that utilities are only driven by bottom line profitability. Twelve percent said that the utilities engage in double standards regarding pricing (referring to net metering and compensation for excess electricity produced), and 11% said that their utility company was not environmentally concerned. Eight percent said that the utilities are probably involved in the PV program for public relations reasons. A few respondents believed that utilities fear restructuring, saw the PV program only as a "do-good" program, believed that the utilities will charge whatever the market will bear, or saw the PV program as a financial write-off for utilities (Table 52).

Policy Options

Although policy was not a focus of the interviews, respondents volunteered some suggestions about policy, both corporate and governmental. Twenty-eight percent of respondents (21% of policy responses) included a preference for special financial considerations for early adopters of PV systems. Twenty-eight percent wanted tax incentives or tax credits for PV (representing 20% of all policy responses). Eighteen percent said that GPV continues to need subsidies, and a few indicated that PV should not be subsidized. Fourteen percent expressed a preference for a net-metering policy or required buyback of excess electricity produced, and the same percentage wanted government to invest in research and development on renewables.

A few respondents mentioned that "time-of-day" pricing should be available or mandated; that the United States should export PV technology to developing countries; that the utility companies should use conventional electricity more efficiently; that a balance between government regulation and incentives for environmental protection should be found; that a system of energy credits should be implemented with each person allotted a certain amount per year; and that the amount spent on subsidizing nuclear power should be shifted to renewable energy technologies (Table 53).

Conclusions and Recommendations

GPV has, or could have, attributes that would accelerate its use. As described in the second section of this report, the attributes of an innovation that would speed its adoption are perceived relative advantage, compatibility, complexity, trialability, and observability. With respect to *perceived relative advantage*, the sample believed that PV was a more advantageous way to produce electricity than conventional energy technologies. No one argued that the current system should be shut down. However, many wanted PV to be phased in because of its many perceived advantages: environmental benefits, flexibility, diversification of the fuel mix, increased self sufficiency and independence, the sense of participation for societal good, and benefits to future generations. However, the significantly higher cost of GPV compared with conventional electricity sources constitutes an important barrier to adoption. Nevertheless, even at a cost of $8,000 to $12,000, the noneconomic advantages of GPV were of significant interest to the sample.

Clearly, the sample saw PV as *compatible* with mainstream societal norms and values. The sample viewed PV adoption as fostering environmental protection and improvement; the development of the PV industry; the evolution of the utility industry; the involvement of the public in an open, democratic society; and the values of savings, thrift, and efficiency. Other mainstream American values mentioned in connection with PV were independence, self sufficiency, prudent investment, and wise use of resources.

The sample viewed the adoption of PV as relatively *complex*, at least in part because not enough was yet known about how utility companies would offer GPV systems to their customers. Skepticism about utility motives was fairly widespread, making it more difficult for utility companies to achieve credibility about their PV offerings, even among those eager to purchase PV systems. Once the PV product is more thoroughly explained and understood, it may seem less complex to potential purchasers. Some evidence for this was made available from respondents who already owned stand-alone off-the-grid PV systems on their mountain cabins—they said their systems were simple and trouble-free and performed flawlessly year after year.

Utility companies offering the PV product can, to some extent, control the perceived *trialability* of the PV product. Respondents themselves mentioned several ways in which a utility could offer the GPV product in such a way as to reduce their sense of risk, suggesting, for example, warranties, guarantees, maintenance programs, leasing options, and other "escape" mechanisms if the PV system does not work out for the customer.

Observability of PV performance is important to these potential adopters. As the findings showed, many mentioned that they wanted ways to see how their system was performing—how much electricity it was producing. This feedback could come on the meter, on utility bills, or via a hookup with their computers.

These volunteers comprise an opening niche market for GPV. Although not all of this sample will ultimately adopt GPV, the indications are that many more of them would adopt than in the general population. If utilities were to offer the product at the prices mentioned and if their sites were suitable, a number of these respondents would probably adopt GPV.

In summary, through their decisions, utilities, the Public Utility Commission, and the state legislature can affect the perceived relative advantage, trialability, and observability of GPV systems. The use of renewables is already compatible with widely held social values. Complexity is the most serious obstacle to PV dissemination; however, a large part of perceived complexity is because of inexperience with the necessary institutional arrangements, such as net metering.

Utilities should look seriously at including GPV among the electricity options they offer their customers. Respondents felt strongly that the utilities should do their share to stimulate the PV market and that Colorado utility companies should take a proactive stance toward PV. Because GPV offerings depend on customers for their success, they should be designed with customer preferences and opinions in mind. The motivations, preferred product attributes, and perceived barriers discussed in this report reveal important aspects of a GPV program that, when addressed ahead of time, could avoid potential problems. Utilities and PV manufacturers have the opportunity to build options into GPV that meet the diverse needs of customers. Utilities should offer a financing option, a choice to either own or lease a GPV system, a choice of roof or ground mounting, and a variety of system sizes. These options will make GPV attractive to more customers.

Utility companies can affect the perception of relative advantage by their PV pricing and net metering policies. If these are seen as fair, then customers will be more willing to adopt. Potential PV customers believe that by putting substantial sums "on the table" for PV purchases, they are helping the utility company to learn about PV and how to integrate it into the Colorado electricity supply.

Potential participants want to be well informed on all aspects of PV system performance and how the product will be offered by the manufacturer and the utility. Utility companies, PV manufacturers, and others should educate customers about GPV, communicating the benefits of widespread GPV ownership. Marketers should enthusiastically promote the GPV products and options available.

Policy Recommendations

A well-defined net-metering policy is critical to the success of the GPV products. The possibility of reimbursing customers at retail cost should be seriously considered to foster favorability and a sense of fairness among PV customers. The buyback rate should be made clear to customers. From the standpoint of those interested in GPV, the State of Colorado should take some action to foster GPV purchases, such as tax credits or rebates. From these customers' point of view, the PUC should consider special rates for PV adopters.

Research Recommendations

To better understand the potential market for GPV and the policy preferences surrounding it, more systematic research on perceptions and preferences of GPV is needed based on a probability sample of electricity customers. High-quality market research is still needed to undergird the design of successful GPV products, effective market delivery schemes, and sound public policy.

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Appendix A

Form for Potential Candidates

10/30/96 **Return to:** Dr. Barbara Farhar, National Renewable Energy Laboratory, 1617 Cole Blvd., Golden, CO 80401

Form for Potential Candidates
Colorado Residential Rooftop Photovoltaics (PV) Program

The National Renewable Energy Laboratory (NREL) and the Colorado Office of Energy Conservation (OEC) are working with several Colorado utilities to look into customer interest in grid-tied rooftop PV systems as a utility service option. A grid-tied rooftop PV system consists of solar panels that convert sunlight to electricity mounted on a customer's roof and connected to the customer's conventional electric system. During the day, the solar panels provide electricity for use in the home. Excess electricity is sold back to the utility. At night or when additional power is needed, the utility provides conventional electricity to the home.

This market assessment will help the Colorado utilities involved to determine the role they will play in offering rooftop PV systems and what PV products will best meet the needs of their customers. Some of the utilities participating in this market assessment also plan to offer a limited number of these systems to their customers in the spring of 1997. NREL will forward the names of customers participating in this market assessment to their electric utilities as potential candidate customers for these systems.[1] The market assessment will also help the Colorado Office of Energy Conservation better understand the public view of residential rooftop PV systems from a policy standpoint.

NREL's first step in the market assessment is to identify Colorado utility customers interested in purchasing, leasing, or otherwise obtaining a grid-tied, rooftop PV system through their electric utility company. NREL will interview these customers about the reasons for their interest and features of these systems that they would find desirable, and forward the names of those interested to their respective utility companies. Interviewees must be willing to:

- Be interviewed in person about why they are interested and to help define product attributes (such as leasing vs. purchase, net metering, maintenance options, and fixed electric rates)

- Seriously consider paying $100/month or more to have a 2kW or 3kW system installed on their roofs or purchase a system outright in the cost range of $8,000 to $12,000 (a 3kW PV system produces approximately the same amount of electricity as is used in the average Colorado single-family home)

- Possibly meet with a utility company official

- Follow-up with purchase or other agreement if the PV product offered by the utility is acceptable to the customer and the residential structure is suitable for installation.

If you are interested in being a candidate--or if you want to nominate someone you know--please complete the information below.

Name:
Address:
Home phone:
Work phone:
E-mail address (if known):
Fax:
Name of utility company (if known):

Any pertinent comments about the potential candidate's current situation (e.g., type of house, why you or the person you are nominating might be interested, etc.) *Use back of page for additional comments.*

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[1]Individual utilities will determine availability of PV systems. Not all utilities taking part in this market assessment have committed to offering PV systems to their customers.

Appendix B
List of Respondent Occupations

Colorado Residential Grid-tied PV
Respondent List of Occupations

ID#	Gender[2]	Occupation[3]
1	M	Electrical engineer
002	F	Graphic designer; program design assistant
003	M	Attorney; CPA
004	F	Grocery store clerk
005	F	High school teacher
006	M	Professional engineer in mechanical systems
007	MC	Aerospace technician; homemaker
009	M	Sells and designs solar systems
010	M	Works with the criminal justice system
012	M	Advisor on energy policy; teacher
013	MC	Retired; pediatrician
014	MC	Auto wholesale business; retired child care center director
015	M	Professional at medical out-patient facility
016	M	Beauty salon owner; hairdresser for the business
018	MC	Bicycle shop manager; technical assistant
019	M	PV scientist
020	MC	Retired mining engineer; weaver
021	M	Natural gas/electric vehicle researcher
022	M	Solar installer
023	M	Hydroelectric technician
026	M	President of an energy audit company
027	F	Physician
030	M	Oil and gas company executive
031	M	Real estate professional
033	MC	Publishing business owners
034	M	Retired computer specialist
036	M	Renewable energy engineer
037	M	Computer systems administrator; office administrator
039	M	Director of an animal shelter
040	F	Registered nurse
041	M	Electrician; mortgage loan processor
042	F	Title insurance business; mortgage underwriter
044	F	Government records clerk; attorney
045	M	Government administrator

[2] M=Male, F=Female, MC=Married couple.

[3] Some respondents mentioned both their own and their spouse's occupations.

ID#	Gender	Occupation
047	M	Investigator
048	M	Attorney
049	MC	Attorney; administrator for the practice
052	F	Pastor; accountant
053	M	PV researcher; recent graduate in architecture
055	F	Retired interviewer
056	MC	Retired electrical engineer; homemaker
057	M	Construction business
059	M	Auditor
061	M	Engineer
063	M	Programmer
065	M	Retired government administrator; teacher
066	MC	Computer scientist; builds bridges and highways
067	M	Retired real estate professional
068	M	Physical scientist
070	M	Semi-retired and does some property management
071	F	Energy engineer
073	MC	Laundromat chain owner; legal secretary
074	F	Landscape architect; urban planner
075	M	Consultant in renewable energy
078	F	Furniture business owner
079	M	Journalist
080	M	CPA
081	M	Solar energy company regional executive
083	M	Electrical engineer
084	M	Retired electrical engineer; teacher of solar energy
085	M	MD, developing businesses
086	F	Senior administrative assistant
087	M	Semi-retired physicist; retired
088	M	Finance/accounting staff; homemaker
090	M	Attorney
091	MC	Public affairs staffers for nonprofit organization
093	F	Designer/builder
094	MC	Energy engineer; marketing
095	M	Retired
096	M	Semi-retired geologist; teaching consultant
097	M	Electrical engineer; musician
100	M	Developing a farm in the mountains
101	M	Sales representative; student in environmental ethics
103	M	Court interpreter
104	M	Owner dental equipment repair business
105	M	Computer programmers
107	M	Tire store owner

ID#	Gender	Occupation
108	M	Mechanical engineer
109	M	Ski patrol member and structural engineer; civil engineer
111	F	Veterinarian
114	M	Office supervisor
115	M	Local governmental official
116	M	Psychologist
117	M	Real estate investor
118	MC	Computer consultant; government worker
119	M	Environmental compliance consultant
120	M	Physician in family practice
122	MC	Local government administrators
123	M	State government administrator
124	F	Home-based custom software business owners
125	MC	Artist and teacher; business manager
126	M	Architect
127	M	Electrical engineer and part owner of a technology company
128	MC	Local government official and teacher; homemaker
130	MC	Physician; Ph.D. in organizational communication
131	M	Executive director of a local office of a national nonprofit organization
132	M	Small business owner
133	F	Civil engineer and house inspecting business owner; secretary for the business
134	F	Construction business; works for a communications company
136	M	Bicycle shop owner
137	M	Engineer managing energy research
141	M	Solar cell products manufacturer
142	M	PV scientist
143	M	Director of a community office for resource efficiency
144	F	Recycling educator
145	M	Professor of physics
146	MC	Retired meteorologist; works for a controls wholesaler which sells heating and ventilation parts
147	M	Architect and engineer (both mechanical and civil) and owns commercial energy and facilities management business
148	M	PV technical monitor
149	MC	Communications management
150	M	Senior biochemistry scientist
151	M	Economics professor; science teacher
152	M	Mechanical engineer
153	F	High school mathematics teacher
156	MC	Electrical engineer; environmental engineer
157	M	Works for the deputy district attorney’s office
158	F	Farmer; would like to start a home-based secretarial business

ID#	Gender	Occupation
159	M	Investment business owner
160	M	Quarter horse rancher and real estate broker
161	M	Retired military

Appendix C

Selected Quotes from the Interviews

Selected Quotes from The Focused Interviews

Motivation

Altruism

I'm really bothered by the fact that the United States generates 25% of the greenhouse gasses in the world—for one country to be polluting that much is unconscionable. As Americans we think we have a birthright to cheap oil: we are screaming about gasoline price increases, where in Europe they pay $4 and $5 a gallon. The United States needs to wake up to what a mess this is on a global basis and take responsibility and do something. Getting a PV system is one of those things.

PV technology is what the future looks like.

My involvement would contribute to the evolution of the use of new, clean energy.

I would love to have it— I'd be proud of it. My house would be charging up other people's houses with electric power.

When I think about doing this PV system, I feel like I'm part of the future; the immediacy of it, I have it right here with me and my family—my kids.

I want to be part of getting the utility company's attention.

Having a hand in shaping the future is a big draw for us . . . it would also give us an empowerment feeling: the power company can sell you power and if I do a good job, I can sell power back to the power company.

So, for us, it's that we want to show the utility company that this CAN work and that they should be involved.

I find system aesthetically pleasing; it's a flag I can fly.

General

Solar is the back-up for the grid, not the other way around.

There would not be public good aspect. My guess is that people will say this when they run their cost/benefit analysis. When you run out of cost/benefit, then it's "psychic income"; e.g., in Colorado Springs, I get paid by the mountains.

If we buy a little now while it's expensive, our kids will have tons of PV.

I have never seen bumper stickers that say "Stop Solar Energy." If you eliminate the power struggle that goes with the distribution of resources, both globally and locally, you have a less contentious society . . . When we use the sun, then it makes all this moot.

The more independent you can be, the more control you can have over your consumption.

I have a personal commitment to be an innovator and collect data.

America is always leading the way and it is time we looked seriously at PV.

I don't think it will take long before people see that the benefits from PV and other renewable energy alternatives are phenomenal.

I'm convinced that this country and the world need a renewable energy option; geopolitical and environmental considerations force us in that direction.

Values

Only my generation knows the wisdom of "use it up, wear it out, make it do, or do without."

There are a lot of sustainable choices. Do we want to have more people and use less, or do we want to have less people and have more open space and habitats for other species?

Everyone's got a refrigerator; everyone benefits from this, not just stockholders. If I pay for this it will be purely out of idealism!

Know what you have and use it wisely.

I see things globally and act locally. Hell, I can help a little bit by doing something locally.

There is a religious motivation and a spiritual aspect. It's also just common sense . . . It's life encompassing.

I'm jumping in and want to try to take control of how my electricity is being produced. I want to be self sufficient.

It's an internal, irrational decision that you are trying to justify rationally, yet it is a leap of faith, putting your money where your heart is instead of where your brain is.

Environmental

There was an article recently in *Consumer Reports* that ranked the most environmentally impactful actions. The single most detrimental environmental action was having a child and the second most detrimental was having a car.

I believe that when you approach an issue from a defensive or fearful point of view, that creates fanaticism, which leads to the same kinds of problems one is reacting against.

If we can't stop the onslaught of people moving here than at least we need to have environmentally friendly options for energy production.

We're running through natural gas supplies and it's a great feedstock for other things—chemistry, chemical factories, plastics. They'll need these things more in the future than we need just to burn it. After all, there are 5+ billion people on the planet. If we are going to win the race against our demise, then we have to have systems that are sympathetic with natural systems.

It doesn't make sense to me that we can put a man on the moon, but we can't figure out how not to pollute our own air.

The use of PV can be like "karma dollars"— balancing by reducing the impact of the need for coal use and carbon dioxide emissions.

It has to almost be religious . . . This is a gift, something sacred and we shouldn't just use it all up.

I do like my luxuries, but I want to provide my own electricity.

It is a responsibility thing—when I think about it, we have a responsibility to succeeding generations . . .

Economic/Financial

People are going to be willing to pay more if they feel like their input is taken into consideration and that the financing is together.

I've noticed an interesting double-standard in people's thinking. The clients I work with in pollution prevention want to know if recycling is going to pay for itself. Yet, no one expects landfills to pay for themselves.

The market is designed to create and sell products and doesn't take into account the type of thinking that is being suggested by groups like the Rocky Mountain Institute. Anything that doesn't begin to take in all costs is doomed. In a true free market . . . we would have to pay for the "real costs" of products, including disposal and liability. We wouldn't have as many troops in the Middle East as we do, if it were not about oil.

My chicken coop needs a PV cell. The chickens lay well with 12 hours of light.

People are conservation-minded when they can afford to be.

It's astounding that people are thinking about payback. The way we think about payback—we don't ask when our suit will pay back. You've got to find your own payback.

If people would just look at building these systems into the cost of their homes, it really wouldn't be more than about 4% of the total cost of the home, which, when you think about it in terms of the larger picture, isn't a significant cost for the benefit . . . I recall a time when everyone had outhouses and there was a big fight against putting in the infrastructure for a sewer system because of the cost. Today, the thought of everyone having outhouses seems absurd.

Even though people are strongly in favor of alternative energy technologies and see them as essential to our future well-being, there is a hesitation to invest in them without a return on investment. Yet no one questions paying much more for a car that is not only guaranteed to have no return investment, but instead will continue to take more money through its lifetime and will ultimately degrade quality of life on a larger scale.

We have to try to demonstrate to people that there is an alternative way that is not more expensive and is more responsible.

I can see myself running a line to the neighbor's house to sell my excess electricity if I could get a better price for it from the neighbor than from the utility.

Comparative Energy Preferences

It's not costing us extra to use PV! Behind the back door are nuclear and coal that are really costing us, and not just our electric bill. They are costing people's lives, injuries, and disease. Downwind, animals have been deformed with birth defects and miscarriages.

Coal is better off holding up the ground, which is what it normally does.

Positive Impacts of PV

In natural light, labor productivity is high. When people are put into sealed boxes with artificial light, they become alienated. PV is not exactly the same as daylighting, but it's in the same league and works on the same principles.

Preferred Product Attributes

I certainly don't think PSCo should get that (PV) energy for free if we're the ones investing the money to produce the power.

The electricity going in there is worth eight cents before it comes to our house, so when it arrives from our house at the transformer where it can be used by our neighbors, it is still worth eight cents.

Perceived Barriers

Without a utility program, it's a big hassle. It's the difference between picking it up at the City Market and having to grow it.

Getting a PV system is the cutting edge, even the bleeding edge. Spending $8,000 on a system is a reach.

Attitudes toward Utility

Utilities are very male-dominated; they are very engineer-oriented. They are incredibly male. They have control of our energy system—it's scary to me.

Public Service staff needs to be educated about renewable energy technologies if they are going to be expected to sell them. You can't sell a perfume you hate.

Policy Options

Currently in Colorado Springs, a developer has to show a 100-year supply of water before getting a building permit. Suppose they had to have energy-neutral (self-sustaining) or 50% sustaining from an energy standpoint to get a permit. They could forestall the building of a new power plant forever.

Appendix D
Data Tables