Understanding Residential Grid-tied PV Customers and Their Willingness to Pay Today's Costs: A Qualitative Assessment

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ABSTRACT

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 systems without batteries—$8,000 or $12,000 for a 2- or 3-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 grid-tied PV and to explore their reasons for wanting to participate, their preferred product attributes, and their attitudes toward utility involvement in PV. 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.

The purposive sample of 120 Colorado households was developed and lengthy face-to-face focused interviews were completed. Focused open-ended interviewing yields rich volunteered information. Nearly 9,500 responses were coded from the interviews. This paper reports results on (a) who these respondents were sociodemographically and (b) what they said about their motivations and their attitudes toward utility company involvement in grid-tied PV. These innovators and early adopters are a niche market for grid-tied PV systems. The study's results provide a foundation for designing renewable electricity products and programs and for more systematic survey and market research.

Introduction and 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 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.

This paper reports results on respondent characteristics, respondent motivations for adopting GPV, and attitudes toward utility company involvement in GPV. The results provide a foundation for designing renewable electricity programs and for more systematic survey and other market research.

Methods

NREL's first step was to identify Colorado utility customers interested in purchasing or leasing a GPV system through their electric utility company. Through word-of-mouth, e-mail messages, and a press release, NREL developed a list of 250 potential candidates interested in obtaining a system. People were told that the study would help Colorado utilities to determine the role they would play in offering GPV systems and the type of GPV products that would best meet the needs of their customers. They were also told that some utilities planned to offer a limited number of systems to their customers. After all the interviews were completed, the 250 names were given to the candidates' respective utility companies for follow-up contacts.

Selected on a first-come, first-served basis, 140 respondents representing 120 households were interviewed. The principal investigator (PI) (a senior social scientist at NREL), a doctoral candidate in sociology, and a writer conducted the interviews; the PI trained and supervised the other two interviewers in open-ended, focused interviewing.

Interviews focused on the following topics: (1) reasons respondents said they were willing to pay $8,000 or $12,000 for a 2- or 3-kW system mounted at their property; (2) any preferences they mentioned for system features; and (3) information they needed (including any concerns they had) to make a purchase decision. No interview guide was used. The 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 interview 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. Volunteered responses have particular value because respondents developed their own statements rather than responding to questions. This 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).

The face-to-face interviews lasted from 1.25 hours to 3 hours; field notes were subsequently word processed. Three doctoral candidates in sociology coded each relevant sentence in the 450 pages of field notes, resulting in 9,431 coded responses, organized into such groupings as motivations to adopt GPV and attitudes toward utilities (Farhar and Buhrmann 1997). Code categories were derived from the data (Glaser and Strauss 1967); some categories overlapped because of the difficulties inherent in coding text.

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. 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. 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.

Respondent Characteristics

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." 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.

The sample was composed of those who had heard about the GPV systems through their 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, 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.

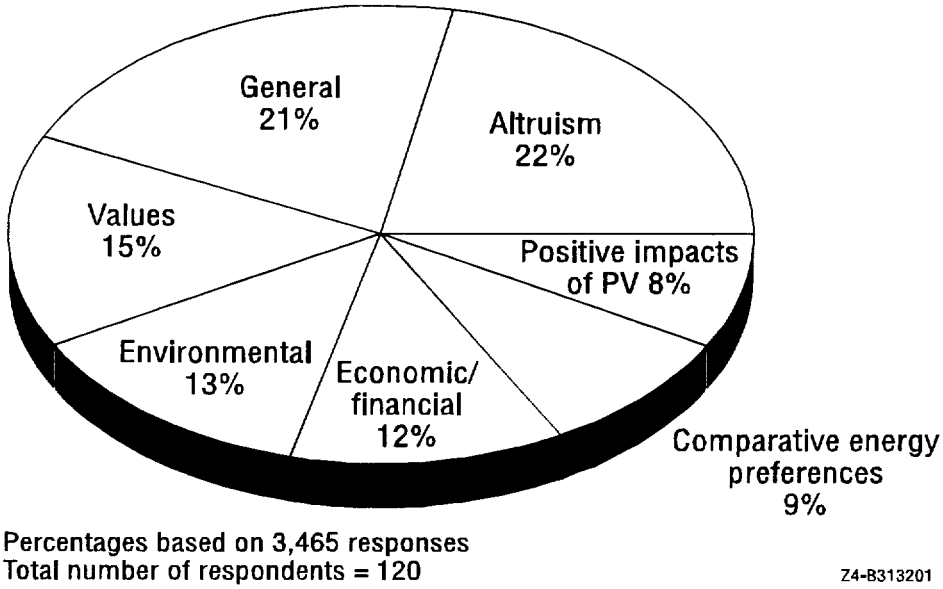
This profile would fit the pattern of earlier adopters of innovation (Rogers 1995), who tend not to differ in age from others, but tend to have other distinguishing characteristics. Generally, earlier adopters tend to have higher socioeconomic status than later adopters. They tend to have more years 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.

Motivation

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 1 presents an overview of the categories of motivation that respondents brought up during the interviews and the percentage of all responses mentioning motivations each type received. 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 3,465 responses on motivation, motivations classified as altruistic occurred most frequently. Those classified as "general" occurred 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 GPV, 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.



Source: Constructed by the authors.

Figure 1. 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%.

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 (much as those who purchased the early Texas Instruments

calculators and paid top dollar for them paved the way for the calculator 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.

One third of respondents said that 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 that 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" covered 21% of the responses on motivation (734 responses). A majority (55%) of respondents mentioned self sufficiency; 49% mentioned perceived benefits to utilities; and 45% said they were curious, particularly in cases where they were building homes and wondered about including GPV in construction as a reason to purchase a system. About one 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 GPV. 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 GPV is practical and feasible rather than for more self-serving motives. Some people just thought GPV would be "fun"—a new technology to enjoy.

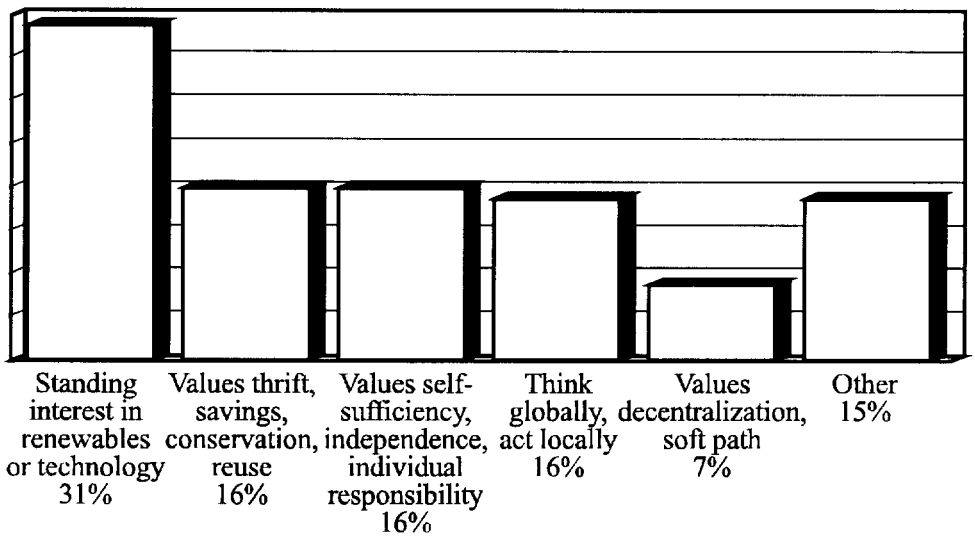
As mentioned previously, motivations coded as "general," mentioned by half of the sample, pointed toward perceived benefits to utility companies if customers purchased a system. Among the benefits identified were cost advantages of not having to build more power plants (25% of respondents) and help in 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 GPV, helping provide a public relations advantage to the utility company, and reducing utility risk by customers paying most of the costs of the GPV 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 2 shows the relative emphasis of the values responses.



Percentages based on 527 responses
Total number of respondents = 120

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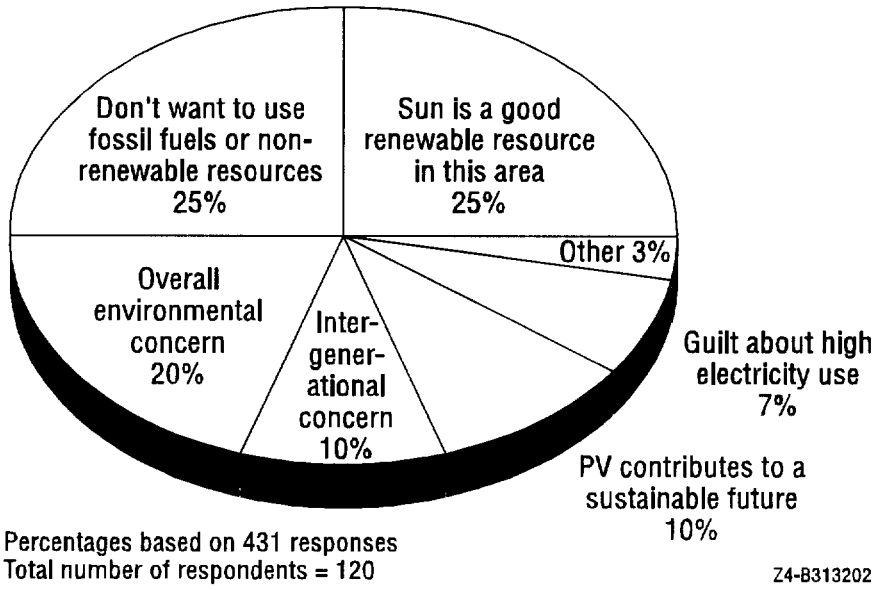
Source: Constructed by the authors.

Figure 2. Values Mentioned Most Frequently

Environmental

It is generally thought that environmental reasons are the most important motivations for adopting renewables. 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 3 shows the distribution of these types of environmental responses.



Source: Constructed by the authors.

Figure 3. 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.

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. Twenty-six percent said that they expected not to break even; they would be purchasing for reasons other than economics. 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.

Comparative Energy Preferences

Virtually all 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%).

Of the comments the sample made 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.

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.

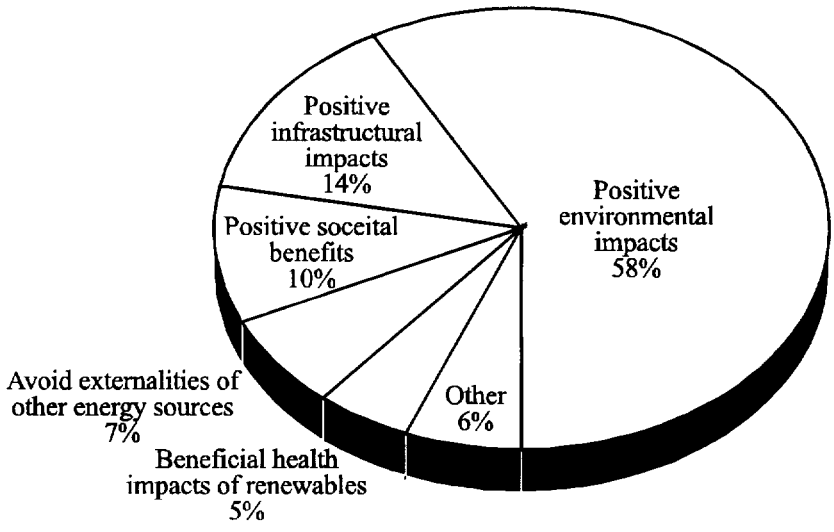
When respondents mentioned wind energy, 66% of comments were positive and 34% were negative. Fourteen percent of respondents volunteered a positive remark about wind energy; 8% said wind is abundant, and 3% mentioned that it is a renewable resource. On the negative side, a few said that wind could be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

Positive Impacts of GPV

Coded responses were classified into an impacts category to show that the sample was thinking about broad 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) were also 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 infrastructural 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 4 shows the relative emphasis of the 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.

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 4. Positive Impacts of GPV Mentioned Most Frequently

Summary

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 had thought a good deal 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 far 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.

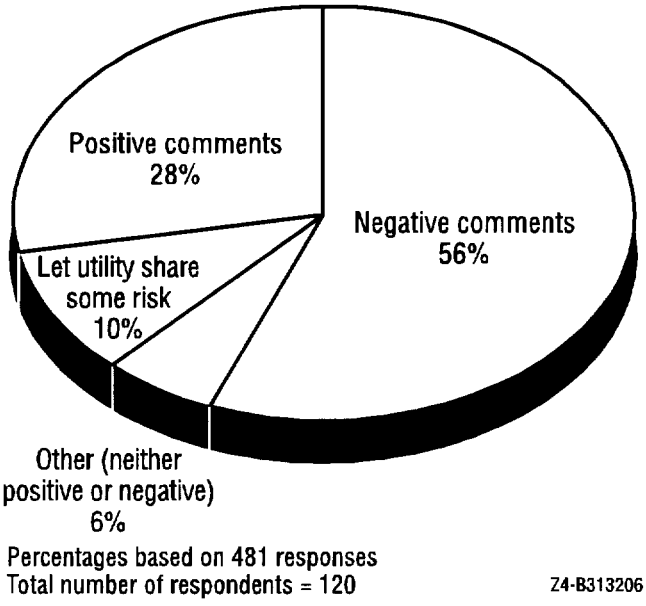
The emphasis on personal values is theoretically relevant as well. The compatibility of an innovation with cultural values increases its rate of adoption. At least for these respondents, GPV was highly compatible with their personal values.

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.

Attitudes toward Utility Involvement in GPV

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 GPV program. Total responses were grouped into positive comments, negative comments, and comments about how the utility should run the GPV program. More than half (56%) of the comments about utilities were negative, 28% were positive, and the remainder were neither positive nor negative (Figure 5).

One third of respondents were skeptical of the utility company's motives in offering a GPV system. Fourteen percent of respondents believed that utilities don't like independent power producers, and 12% were dissatisfied with the utility apart from the GPV program. Nine percent said that their utility company was inexperienced with offering GPV; 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 GPV.



Source: Constructed by the authors.

Figure 5. Types of Attitudes Toward Utility Company Mentioned Most Frequently

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 GPV 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 GPV program (a win-win situation). A few respondents reported being satisfied with the utility apart from the GPV program, believed that the utilities have safety and technology concerns about GPV, or reported being contented shareholders in the utility company.

Additional comments on attitudes toward the utility focused on how utilities should run the GPV program. About a quarter of respondents (28%) said that the utility should take some of the risks in developing the GPV program rather than letting customers take all the risks. A 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, belief that utility companies will have to adapt to the standards of PV technology, that power providers in the metropolitan areas of Colorado will have to look seriously at wind power, and that developing economies of scale would drop the price of PV dramatically. Additional comments included the belief that utilities should offer larger subsidies to GPV 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 GPV 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 GPV

program for public relations reasons. A few respondents believed that utilities fear restructuring, saw the GPV program only as a "do-good" program, believed that the utilities will charge whatever the market will bear, or saw the GPV program as a financial write-off for utilities.

Conclusions

Motivations to purchase GPV are multiple and complex. Environmental concern is a major theme among the reasons people gave for wanting to adopt GPV. However, their motivations were more extensive, including, for example:

- A desire to help their communities and the larger society through GPV adoption, to be part of creating the future, to expand the PV market, and to educate others on renewable electricity and its potential.
- Personal enjoyment through satisfaction of their technological interests by owning and working with an expensive and practical (electricity-producing) "gadget." For example, seeing solar-produced electricity plotted on their computer screens would be a plus for many.
- Feeling empowered, figuratively as well as literally, by having a choice and an opportunity to take actions seen as a lifestyle choice to enhance the expression of personal values, such as self sufficiency, a standing interest in renewables, and environmental concern. By and large, the existing electricity system does not permit such a lifestyle choice.
- A sense of being on the cutting edge, wanting to be a part of the way of the future and of making a contribution to future generations and to emerging industries.
- A sense of wisdom in investment of personal financial resources in GPV, whether breakeven was expected or not. A sense of getting a bargain because of the subsidized cost; also, a sense of receiving some return if electricity were sold back to the utility company. Even among those not expecting an immediate financial return or breakeven over 20 years (the expected system lifetime), the investment seemed warranted in other ways (retirement electricity or furtherance of career, for example).

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 socially acceptable policy decisions.

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