Pre-purchase barriers to photovoltaics within Marin County

Gwendolyn Johnson

Abstract Pre-purchase barriers to photovoltaic (PV) systems within Marin County were studied. Four areas were investigated: 1) the residential sector, 2) the PV-retail sector, 3) the Marin County government and 4) educational information. The emphasis of the project was on the residential sector. The retail sector, county government and educational information were examined to determine their individual impacts within the residential sector. Surveys were administered to homeowner's without PV, with scenario questions used to quantify the variables willingness-to-pay (WTP), degree of familiarity (DF), homeowner interest (HI) and customer initiative (CI). A multi-stage cluster technique was used to randomly pick the survey sample for residents without PV, unstructured interviews were conducted with PV-sales engineers from various retail sites and semi-structured interviews were conducted with three government officials. Educational information was gathered in the form of pamphlets, booklets and website pages, which are distributed by local solar energy organizations. Major trends show that while there is a low DF with PV, WTP and HI is high. Whereas most of the current PV-users were initially interested in PV systems because of the perception that they are environmentally benign, potential PV-owner interest stems from a desire for reliable electricity service, in light of California's energy crisis. Other barriers include siting limitations that prevent significant solar energy uptake as well as surface area constraints in relation to high electricity consumption and/or swimming pools using solar thermal panels. A strong interest exists within county government to implement campaign programs for PV, but there is a lack of direct responsibility within a single department, which acts as a barrier, though easy to overcome. PV retailers themselves do not appear to be barriers, but rather their lack of marketing and advertising to new audiences.

Introduction

Photovoltaics (PV) refers to a technology that utilizes the sun's energy in order to produce a direct electric current. For localized production of electricity, this technology is employed in centralized forms, such as power plants, and decentralized forms, such as on the rooftops of houses or commercial buildings. This research project examined the role of PV systems within the residential sector. The basic components of a home-use PV system includes PV panels and an inverter. The PV panels are semiconductive and create a direct current when hit by sunlight and the inverter changes direct current (dc) into alternating current (ac), which is used in most houses and buildings in the United States. If the PV system is a stand-alone system, then it also requires an electricity-storing component, typically a battery, but if the system is interconnected with the local utility grid, electricity storage is not always necessary.

Understanding local perceptions of PV systems is potentially important for several reasons. First, there is the increasing volatility of electricity markets. Specifically in California, deregulation has created uncertainty in electricity prices. Second, utilities have had difficulty adequately meeting rising electricity demand. Particularly, prolonged heat waves, power plant maintenance leading to temporarily decreased generating capacity, and an ever-growing population that uses power in similar peak patterns have combined to create stress on California's electricity-generation capacity. Current methods of meeting increasing electricity loads are institutionally biased, limited to building new power plants and making efficiency improvements to existing equipment. In California, the capacity to do this is being strained by the rapidly growing population, space constraints, and in general, the increasing costs of fuels and building new plants. To this end, it is important that we explore other methods of providing electricity, with PV as one of many options.

One benefit of using PV is that consumers are likely to become more aware of their energy consumption patterns and in turn may begin to reduce overall energy use as well as shift consumption patterns (Haas, 29). Done on a large scale, distributed PV could greatly ease the strain on California's energy market. Yet, despite uncertainties in price and electricity supply, and the potential benefits of PV, use of PV systems in Marin is presently very low.

In the existing body of research on renewable energy markets, barriers to photovoltaic systems are most commonly addressed from the perspective of technology transfer programs in developing countries where there is a strong need for decentralized energy distribution. Other

research on PV systems is very broad, analyzing its place in commercial markets, but only focusing on the average, middle-income consumer. In this sector, photovoltaics can be prohibitively expensive, requiring large capital investments and long payback times. Most barriers can be categorically described as financial, technological, institutional, regulatory or structural (Jackson et al, 380).

There is not much research on market barriers within affluent communities in the United States. Marin, specifically, represents a unique population: it is an affluent area, a large percentage of its population lives on hills and water, which receive a good amount of annual sunlight, and it is a community that prides itself on being environmentally aware. With these factors combined, I felt that barriers would take on a different form, with a lack of public awareness being a more important barrier. In fact, one study cites that affluent homeowners, in general, are actively interested in microgeneration, i.e.finding new means of generating and storing their own electricity, in response to the current state of the electricity market (RKS press release, 01). The issues I investigated in Marin include the familiarity level of residents in regards to PV systems, its relationship to the homeowner's willingness-to-pay for a PV system as well as the effect of a PV system's typical investment cost on willingness-to-pay. There is currently a rebate in California that subsidizes purchases of certified PV systems by $3 per watt. I examined how this might affect a homeowner's interest and whether or not customer initiative (or lack of) was an important factor. Finally, I looked at the role of local government in PV information dissemination and promotion of use as well as the effectiveness of marketing and sales forces and the strategies pursued to attract their customers. I attempted to address possible barriers that are locally relevant. One recent study directly targeted at California residents and PV suppliers investigated issues similar to these, but did not focus on affluent customer and used the Internet to gather its survey sample (CEC, 03). The problem with this method, in terms of residential surveys, is that the Internet is likely to be biased towards younger electricity consumers who are already looking for information on renewable energy issues. I approached these issues in several ways: door-to-door surveys, semi-structured and informal interviews and collection of all available PV education and marketing materials. Hypotheses to be statistically analyzed are:

Hypothesis #1: as the degree of familiarity with PV increases, willingness-to-pay also increases.

Hypothesis #2: as the degree of familiarity with PV increases, customer interest also increases.

Methods

Four areas comprised this study: homeowners, local government, PV retailers and education.

Homeowners To analyze specific variables within the residential sector, two different surveys were conducted and compared: one for homeowners who do not own PV systems and a separate one for homeowners who do. The style for administering the surveys was personal door-to-door interviewing, in order to validate demographic information and informally gauge participants' understanding of subject matter. As this research targets affluent communities within Marin, the definition of affluence for purposes of this section of the study was a neighborhood where a typical Marin homeowner's property value is above $1.5 million. By defining affluence this way, two assumptions were made: 1) the homeowner has the ability to afford the high initial cost of a PV system, if the homeowner chose to purchase one and 2) the homeowner can gain access to information on PV systems. As obtaining information on every individual homeowner's property value was not feasible, I narrowed the sample to homeowners in Sausalito, Mill Valley and Tiburon where average property values are between $1.5-1.9 million, according to publicly available information on real estate assessments (Thayer, internet).

Homeowner Surveys: not using PV Three neighborhoods from each city were selected, for a total of nine neighborhoods, with three households per street being surveyed. Total sample size was eighty-one homeowners. Each neighborhood represented a 0.25 square mile area. Three alphabet letters were randomly generated to find a street from each city with the closest matching name. This was done nine times to give a total of twenty-seven streets. In order to create a list of houses for each particular street, numbers were assigned to every house and then three numbers were randomly generated. Only those houses were surveyed. To minimize the non-response rate, I generated a second list using the same processes. Houses from the second list were approached after I had either visited the same house from the first list three times or if the homeowner refused to participate in the survey.

Using this technique fifty-seven surveys were collected. The main survey questions were in the form of scenarios that determined degree of concern for high initial cost, defined by their willingness-to-pay. Other questions were used to determine relative degree of knowledge of photovoltaics and interest in purchasing photovoltaics. The independent variable in this study was the degree of familiarity (DF). This was addressed by questions 8,9,10,12,13 and 16. The

dependent variables were willingness-to-pay (WTP) and homeowner interest (HI). WTP was addressed by questions 14, 31-34 or 35-38. HI was examined in questions 7, 15, 17 and 18. The statistical method for analyzing these variables was a linear regression test. I also tested for customer initiative (CI), defined by how actively an interested homeowner has looked into PV systems. This is addressed by questions 23-28, as those surveyed who have gathered information from sources such as PV distributors, solar energy organizations, state or local government, and the Internet (Appendix A1).

Homeowner Surveys: in-use PV systems Due to the low population of people who do own PV systems, any homeowners living in either incorporated or unincorporated areas of Marin County were surveyed. I approached houses where PV systems were clearly visible from the street, and asked them to participate in the survey. Using this method, 10 surveys were collected. The results of this survey were not analyzed statistically. Its purpose was to serve as a qualitative comparison with homeowners that do not use PV systems.

Local Government In order to assess local government involvement with renewable energy, the following government officials were interviewed: Bob Beaumont (Public Works), Dawn Weisz (Planning Commission) and Annette Rose (Board of Supervisors). The interviews were semi-structured except for the interview with Annette Rose, which was an informal, on-going dialogue. Questions were used to determine what the level of interest is in terms of local government influence on the general populaces' energy use. The Marin Countywide Plan (MCP) was used to supplement these interviews. The MCP provides a number of directives in regards to growth, including the areas of housing and energy. Policies that relate to renewable energy were reviewed and then checked for consistency between the plan's goals and the interests of those who implement those goals.

PV Retailers Market barriers at the retail level were addressed by examining four local suppliers of PV systems: Holly Solar Products of Petaluma, Solar Depot of San Rafael, AstroPower of Concord and Sun First! of Muir Beach. To begin this section of the study, I conducted an email interview with a PV sales engineer at Solar Depot, Milton Noguiera. He guided me through the design of a set of basic questions with which to conduct semi-structured interviews and participant observations. The interviews were conducted with a sales engineer from each distributor location. Then, someone I trained, Zander Rose, contacted the same representatives by assuming the role of a potential customer. I checked the consistency of the

information as well as informally gauged how they present their products and relate to their customers. One rumor about the PV sales force is that they can be dogmatic (Norgaard, pers. comm.), and if this is true, it is likely to be a turn-off, and therefore a barrier, to purchasing a PV system. Available marketing information, and web-based customer interfaces were examined as well, to critique marketing strategies.

PV Education Educational information was gathered from Northern California Solar Energy Association (NCSEA), California Solar Energy Industries Association (CalSEIA), Independent Energy Producers Association (IEPA) and the California Energy Commission (CEC). Educational information, in the form of booklets, pamphlets and webpages were collected from the local renewable and solar energy organizations mentioned before. These materials were critiqued on accessibility of information and clarity of content. PV information was categorically divided into levels of depth. The primary level of PV education is defined as 'topical': its function is to create an interest in renewable energy. This can be done in several ways: by providing background information, Frequently Asked Questions (FAQs), better advertising for workshops and fairs and better employment of sales and marketing techniques for products. The second level aids in building a PV infrastructure, defined as 'detailed': it provides more in-depth information on PV and involves linking people with renewable energy organizations and businesses that can also provide detailed information of PV.

Results

Residential sector

Hypothesis #1: Results from survey 8,9,10,12,13 and 16 and 14, 31-38 indicated that there was no relationship between degree of familiarity with PV and willingness-to-pay (Fig. 1).

R^2= -0.03 and p-value = 0.9353

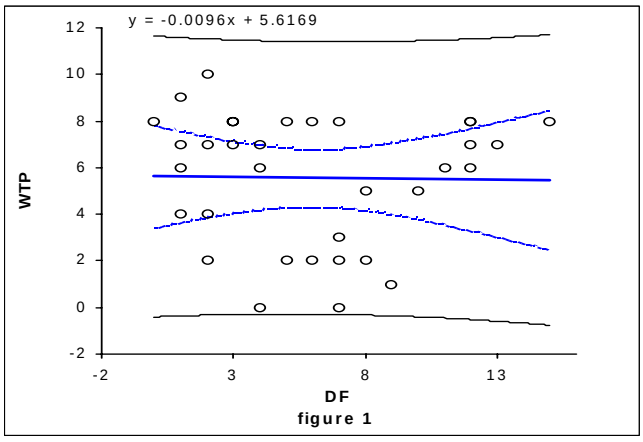


figure 1

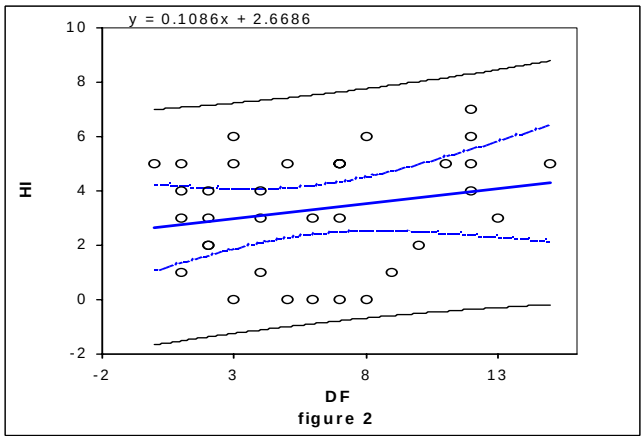
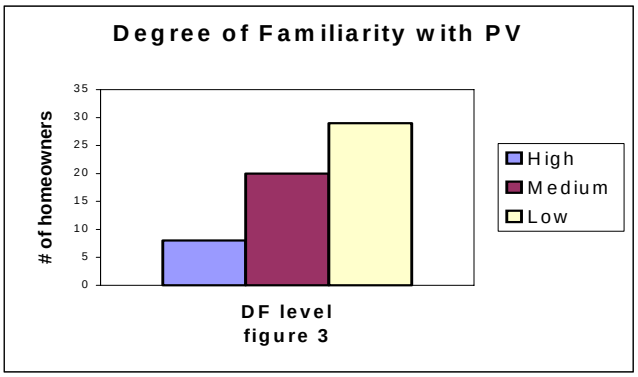


figure 2

Hypothesis #2: Results from survey questions 8,9,10,12,13 and 16 and questions 7, 15, 17 and 18 indicated that there was no relationship between DF with PV and homeowner interest I (Fig. 2). R^2=0.05 and p-value = .2092

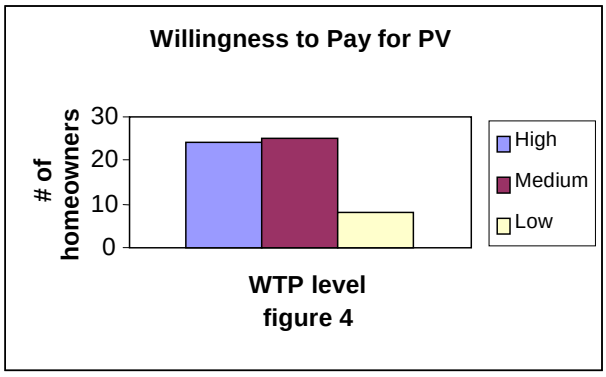
Despite the lack of correlation between the variables, DF and WTP and DF and HI, my initial predictions were correct that capital investment would not be as large of a barrier as education. Figures 3 through 5 show individually, the varying levels of familiarity, willingness-to-pay and interest.

Figure 3 demonstrates that that the majority of homeowners surveyed are unfamiliar with PV



Willingness-to-pay. 76% of homeowners surveyed stated that they felt the costs were reasonable and would be willing to pay for the prices given in the scenario questions 14, 31-38 (A1), either using a home-equity loan or as a cash purchase. Only eight homeowners said that they would not be willing to pay for a PV system for any reason, and five of those homeowners said it was because they were too old to expect a return on the investment.

Figure 4 demonstrates that only 14% were unwilling to pay for PV under certain conditions



Homeowner Interest. Customer interest in a personal PV application is relatively high (fig 5), with 50% of homeowners are interested in owning, but only 11% of those interested have

actively looked into purchasing a PV system. In conversations with homeowners, many stated that while they were interested, they though the process of having a system installed would be difficult and involved. Some implied that they would be willing to purchase a system if they knew that the design and installation process was a non-invasive "no brainer."

Figure 5 shows that there is a high level of interest among the homeowners surveyed. 63% of homeowners were very interested, 22% were mildly interested and 14% were uninterested in owning a PV system

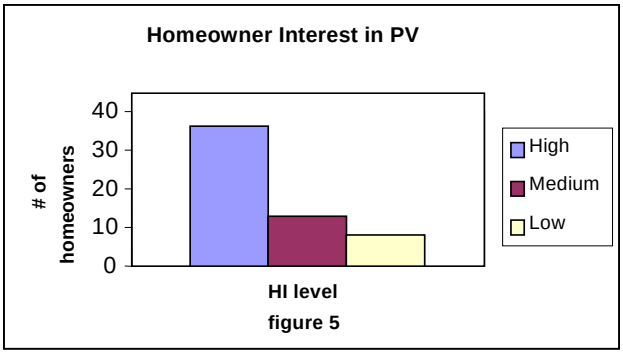


figure 5

Figure 6 demonstrates that CI, as a fraction of HI, is very small

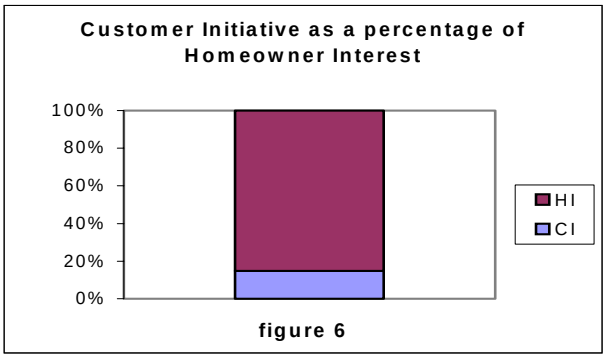


figure 6

Economics. A number of the customers have been willing to share their utility bills. The lowest electricity bill was $60/mth. The highest was $400/mth. The values that were most common in Marin were between $100-200/mth, corresponding to about 20-40 kwh/day of electricity consumption. Using these approximate figures, I have calculated the various sizes, simple payback times and surface areas needed for a "generic" PV system. By generic, I refer to a system with mid-range efficiency, i.e. a polycrystalline panel and an inverter. This table also assumes a grid-connected system where no battery is used (table 1). These values were checked through a program called "Clean Power Estimator," which is available on the CEC website.

Energy consumption	System size	Surface area needed (ft^2)	Cost of system after CEC rebate ($US)	Payback time (yrs)
10 kwh/day	2.5 kW	240	8000	14.3
20 kWh/day	5 kW	480	14,000	12.7
40 kwh/day	10 kW	960	27,000	11.3

table 1

It is important to mention that the cost of PV systems varies greatly from one retailer to another. The prices listed here were taken from a PV distributor that sells in bulk to homeowners and businesses.

Local Government The Community Development Element, in the Marin Countywide Plan has directives in policies 4.2-4.5 regarding renewable energy issues (table 2).

Policy	Function of Policy	Status
4.2a	Review of planning and regulatory documents so as to facilitate and promote energy efficiency and renewable energy use	Review of documents are in process within Planning Commission and Public Works
4.2b	Incorporate renewable energy into project review, making cost effective renewable energy use a criteria for design review, grant application and other programs	Green Building Program: incentive-based. Developers move to front of review/permit boards for meeting "green criteria." PV is one of many criteria
4.5a	Solar energy and other renewables should be used in all structures to the extent feasible Eliminate barriers to solar energy Evaluate local regulations to eliminate barriers to conservation and solar energy	**Business sector:** Green Business program: eco-label based. Certifies that businesses are "green" if certain criteria are met. PV is one of many criteria **Municipal:** No municipal buildings currently use renewable energy sources. Bob Beaumont states that the county is open to considering proposals for retrofitting municipal buildings **Residential sector:** No education or incentive programs are planned that address homeowner use of renewable energy

table 2

The information from interviews with county officials is summarized in table 3.

Name and Title	Role in PV	Additional information
Bob Beaumont Assistant Director, Public Works	Energy issues in municipal buildings	Unfamiliar with MSR program, CEC program Suggested that I draw up a proposal to retrofit a municipal building
Annette Rose Supervisor, District #5	County budget, all programs and proposals >$5000 need to first pass approval with Board of Supervisors	Unfamiliar with MSR, CEC program Would like to see an educational program created Is working with state legislators to remove mortgage disincentive for PV
Dawn Weisz Sustainability Planner, Planning Commission	Implement countywide policies 4.2-4.5	Unfamiliar with MSR program Her projects include Green Building and Green Business Program Doesn't know of any planned project with focus on incentive or education for general populace

table 3

PV Retailers The information given to me as well as to my mock customer was consistent. Cost concerns were addressed by discussing the CEC rebate and financial institutions that could provide secure and unsecured loans. All of the sales people were unable to get very specific about the costs of installation or the time it takes to install. Each cited considerations including the amount of energy a household uses, the surface area available, the material and shape of the roof and the particular contractor that does the actual installation. All maintained that the process of designing and installing a PV system has been streamlined greatly just over the past few years. "Turn-key" systems are widely available, which include the inverter and balance of system components, ready for installation. In light of California's energy crisis, PV distributors have dramatically increased the number of consultations performed each week. The PV distributor, Sun First! charges $100/hour for a consultation. In terms of marketing and advertising, Holly Solar, Solar Depot and Astropower use websites for advertising and providing sales information, with the exception of Sun First!. They also use some magazine and radio advertising but no television advertising was reported.

PV Education

Source	Information Access	Information Provided	Additional Comments
NCSEA Educational non-profit	Website and call center	Membership information. Community-based programs and seminars include: National Solar Homes Tour, Junior Solar Sprint Challenge and Residential Solar Energy Workshop Well linked to other websites that provide customer education on retail, legal, scientific and political aspects of PV.	Well- rounded base of info, great presence at energy fairs and earth day events This organization has leadership and decision-making deficiencies→ strategic planning retreats.
CEC State agency	Website and call center	Provides free copies, through download or mail, of a guide to buying PV systems. Information available on their rebate program, financial institutions that provide loans, and retailers, distributors and contractors of PV systems. Energy Web Directory.	Provides plenty of easily accessible information, both educational and marketing.
CalSeia Industry trade	Website and call center	4 pages on scope of PV applications such as lighting, water pumps, disaster prevention and rural electrification. Well linked to other websites, which provides customer education on retail, legal, scientific and political aspects of PV (detailed).	Doesn't provide information directing customers on what kinds of questions to ask and where to go for specific answers (topical).
IEPA Industry trade	Website and call center	< 1 page of educational information. Well linked to other websites that provide customer education on retail, legal, scientific and political aspects of PV (detailed).	Doesn't provide information directing customers on what kinds of questions to ask and where to go for specific answers (topical).

table 4

All PV educational information is most easily accessed through the Internet. What I have found is an abundance of (detailed) secondary level education and a lack of (topical) primary level education (table 4).

Discussion

Residential Sector No statistical significance was found between degree of familiarity and willingness-to-pay or between degree of familiarity and homeowner interest, which contradicts my hypotheses that these variables would be positively correlated. This lack of correlation needs to be treated cautiously. There were potentially other factors that could have confounded the relationship between familiarity and willingness-to-pay. For example, in Mill Valley and some areas of Sausalito, trees and lack of southern exposure makes solar penetration limited and therefore use of PV systems is impractical. Several homeowners in these areas had a high degree of familiarity but were not willing to pay for PV specifically for this reason. In the future, I suggest controlling for other factors influencing willingness-to-pay.

My predictions were correct that high initial investment is not an overriding concern for Marin homeowners. That reliability is the greatest issue for electricity consumers currently and also the biggest motivation for considering a PV system is supported by the study done by RKS Research (01), as well as CEC's Market Analysis Report (02). Desire for reliability appears to be a direct response to the increasing frequency of rolling black and brownouts that many California residents have experienced. The fact that of the homeowners currently using PV, all of whom have systems that are over 5 years old, all stated that their main motivation for purchasing a PV system was less impact on the environment highlights a shift in consumer awareness. I believe that my results support the notion that there is an opportunity to widen the base of PV users from homeowners that are purely environmentally-motivated to a customer-base that is looking for economically viable alternatives to the current electricity production. In terms of widening PV's customer-base and shrinking the distance between homeowner interest and customer initiative, these gaps can be most effectively addressed by aggressive public awareness campaigns as well as marketing and advertising through television and radio.

One significant confounding factor in this study is the idea of "sample maturation," which refers to the knowledge base and opinions of the sample changing while the study is being

conducted. During the course of this project, there have been two electricity price increases: one for 10%, which effects all residents and one for 46%, which will certainly effect Marin homeowners. The latter rate increase has not taken effect yet, but customers are definitely aware of it.

Ironically, one of the largest confounding factors in the survey was swimming pools. The majority of the homeowners with swimming pools used a solar water heating system and so had solar thermal panels on their roofs; therefore they lacked the additional surface area needed for a photovoltaic application. There were other cases in which lack of surface area was a significant barrier: as mentioned before, some households averaged 40 kwh/day. With such high electricity consumption, many homeowners can only hope to use PV as a supplemental means of providing electricity. Fortunately, this is complementary to my findings that homeowners are mostly interested in an interconnected PV system (98%). While this creates a barrier to homeowners who wish to be off-grid and self-sufficient, hybrid systems that combine wind generators and/or fuel cells are possible solutions.

Marin County Government Marin's residents, the Marin Countywide Plan and many members of the Marin County government all stated that use of renewable energy is important. In fact, 95% of residents surveyed felt it was "extremely important" for the county to encourage use of renewable energy. This encouragement was qualified in two ways: 1) leading by example and 2) offering education and/or incentive programs to the general public. The county officials appear to be in agreement. Mr. Beaumont encouraged me to write a proposal to install a PV system on a Marin municipal building and Mrs. Rose was unhesitatingly supportive about the idea of creating an educational program. She also maintains that the entire board is very interested in renewable energy proliferation within the government, business and residential sectors.

Dawn Weisz was the most involved in energy affairs concerning the general public. Her primary role with the county's Planning Commission is to update the countywide plan and assist with the goal of enacting practices that create a "foundation of sustainability." This "foundation of sustainability" is a completely new directive within Marin County and has lead to several different programs. In our interview, she informed me that in publicly held meeting residents' loudest criticism was that the countywide plan had a lot of creative and ambitious policies that headed in the right direction but were being ignored. When I specifically inquired about policies

4.2 - 4.5, Mrs. Weisz cited the creation of the Green Business and Green Building programs. In both cases, how the criteria for PV is weighted relative to other “green” criteria will determine if use of PV increases; at present the criteria have not been fully worked out. As mentioned, there are no projects with the aim of increasing awareness and education of residents. When asked where educational campaigns and programs for PV would come from, she responded that there are several potential places, including the Planning Commission and Community Development. She then agreed that it is probably the biggest reason why these programs do not exist; no single entity has direct responsibility for creating it. My conclusions are that while substantial support for increasing use of photovoltaics exists at significant levels of county government the impetus, or stimulus, for creating such outreach programs does not. This opens up a good opportunity for anyone interested in creating programs that address both the educational needs of the public and/or identifies county projects that have the ability to incorporate PV, and more broadly, renewable energy applications.

PV Retailers As mentioned previously, many homeowners considered the process of having a system installed to be difficult and involved. In response to this, all three suppliers replied that they offer turn-key systems. I have not found any PV-owners who have installed a system recently enough to verify this statement. At this stage, I do not see the sales persons themselves as a barrier to PV at this stage. All suppliers returned my calls within a few days, they were forthright and able to answer questions regarding the design and installation process to my satisfaction, with the exception of Sun First! whom I found to be uneconomically feasible to interview. None were overly anxious or aggressive in trying to sell PV systems; they were more intent on gauging whether it would be an appropriate application for the particular site.

Most of the customer awareness regarding PV has come from newspapers and television segments that mention renewable energy in connection with the energy crisis (Appendix A1, questions 23-28). This has lead to an increase in call volume for PV suppliers. Aside from ads on the radio, in magazines and newspapers, which are still sparse, there is no direct use of television to advertise PV. This may be a barrier to increasing interest in PV as it provides an audience that is potentially unaware of the product.

PV Education Workshops and seminars provide informational sources that are essential to the creation of a strong infrastructure for the PV industry because they help disseminate information, but their weakness is that the audience base is still small; those who are already

interested in PV tend to be the ones attending the workshops, reading the books and perusing the very involved links associated to sites such as IEPA. Most of the information that is readily accessible is too in-depth for the newly interested customer, and I have found that it takes a lot of searching on the Internet in order to find the more remedial explanations and background information for PV. The best sites for this information have been on suppliers' websites, rather than on solar energy organizations' websites. Astropower and Solar Depot both do a good job in directing customers on how to start the design process as well as what the economic considerations are.

Content does not seem to be the real barrier for PV education at this stage. The primary barriers appears to be its limited reach, in terms of access and availability. This could be addressed with better access to topical information, and expanding the target audience by using sources beyond the Internet, though funds for advertising may be a barrier to implementation. Improvements in the marketing of products and workshops would also be an effective way of reaching new audiences.

Additional comments A particular issue that I have not received an adequate answer to is the question of lifecycle costs. I think that the amount of energy used and waste generated through the manufacturing process should be taken into consideration if PV systems are to prove themselves a viable option. One retailer has said that it is believed to take between 4 to 8 years for a system to pay itself off in terms of the energy that goes into manufacturing it, but he was not sure. National Renewable Energy Laboratories (NREL) cites the energy payback for certain amorphous panels to be less than 3 months (Zweibel, 245)! I have also heard that some of the chemical by products in certain types of panels are cascaded back into the production process, which decreases the net amount of waste generated. I have not been able to gather more specific information directly from the manufacturers.

Acknowledgements

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Appendix 1

Survey: Non-PV system owners

1. Do you own the house you live in?
    a. yes
    b. no

If no skip 2
If yes skip 3.

2. You expect to live here for at least the next:
    a. 0-5 years
    b. 5 years
    c. 10 years
    d. 15 years or longer

3. Who pays your electricity bill?
    a. Landlord
    b. me/significant other

4. Do you produce any of your own electricity?
    a. yes
    b. no

Sub-question :
How? (If using PV, skip to PV-owner survey)

5. Do you track your household's level of energy use? kwh $$$ both
    a. yes
    b. no

6. In terms of your electricity provider, what is most important to you:
    a. low cost:
    b. customer service:
    c. reliability:
    d. environmental effects:
    e. other (please specify):

7. Do you have interest in generating your own electricity? (5-1)
    a. Very
    b. Somewhat
    c. mildly
    d. not really
    e. not at all
    f. Haven't considered it

8. How familiar are you with solar electric technology? (5-1)
    a. Know it well
    b. somewhat
    c. acquainted with it
    d. heard of it
    e. never heard of it

If answered e, skip

9. How familiar are you with the basic components of a PV system?
    a. very
    b. somewhat
    c. not at all

10. How well do you understand PV technology? (5-1)
    a. know it well
    b. moderately well
    c. familiar with it
    d. heard of it
    e. do not know it

11. Do you think current PV technology is reliable?
    a. Extremely reliable
    b. Sufficiently reliable
    c. no
    d. don't know

12. Do you know if this particular house is a good site for installing a PV system?
    a. yes it a good site
    b. moderately good
    c. no it is not
    d. don't know

13. How familiar are you with the associated costs of a PV system?
    a. Very familiar
    b. Moderately familiar
    c. Somewhat
    d. Not very familiar
    e. not at all

describe perception of costs:

If answer c, skip .

14. In your opinion, the costs are:
    a. worth paying
    b. not worth paying
    c. undecided/no opinion

15. Would economic incentives such as rebates and tax credits, create interest in favor of purchasing a PV system?
    a. yes
    b. no

16. Are you familiar with net metering?
    a. yes
    b. no

17. Have you considered purchasing a solar electric system for your roof?
    a. yes
    b. no

If no, skip

Individually asked yes and no:

18. Have you actively looked into purchasing a solar electric system?

19. Was information easy to access?
20. Were you satisfied with available information?

21. Under what condition would you most likely purchase a PV system?
    a. While remodeling rest of my home
    b. Adding/replacing roof
    c. As its own project
    d. Other: (including “none of the above’)

22. What way would you most likely finance the purchase?
    a. Home-equity loan
    b. cash
    c. through a leasing program

Individual yes and no:
Have you specifically gone to the following sources for information?
23. Friend/neighbor
24. Internet
25. PV distributor/ retailer
26. media
27. Government agency/department
28. Other:

29. Are you interested in grid or off-grid application?
    a. grid
    b. off-grid
    c. both at this stage

If a, go to

30. Why are you interested in off-grid?
    a. self-reliance
    b. concern for environment
    c. concern for reliability of current electricity supply
    d. security
    e. other:

OFF GRID SCENARIOS

Scenario 1:

31. You have the option to purchase a PV system that provides for all of your electricity needs. After the rebate, the investment is $25K which includes the entire system plus cost to have it installed. You are:
    a. willing to pay
    b. not willing to pay

Scenario 2:

The California Energy Commission is offering ½ of the purchase for a PV system. Consider a solar electricity system that provides for all of your electricity needs, for the next 20-30 years:

32. What do you consider a reasonable investment for this system?
    a. $5-10K
    b. $10-15K
    c. $15-25K
    d. $25-40K
    e. other:

33. What do you consider a reasonable payback time (time for system to generate enough electricity for it to pay itself off) for a system that can provide this service?
    a. 1-5 years
    b. 6-10 years
    c. 11-15 years
    d. 15-20 years
    e. other:

Scenario 3:

34. I. You have the option to purchase a PV system that costs $25K. Using a home-equity loan, the amortized monthly payment is $200 for 20 years. You are:
    a. willing to pay
    b. not willing to pay

II. With an intial capital investment of $5K, and a home-equity loan for $20K, the amortized monthly payment is $160/mth. You are

    a. willing to pay
    b. not willing to pay

ON GRID SCENARIOS

Scenario 1:

35. You have the option to purchase a 2kW system for $15K which includes the labor cost to have it installed. You are:
    a. willing to pay
    b. not willing to pay

Scenario 2: You purchase a system that will be interconnected to the utility grid, in a process called net-metering. Net-metering allows you to feed your surplus electricity to the utility grid. You can use an equivalent amount of elecrticity later (within the year) at no additional cost to you. The system is warrantied for 20 years and the California Energy Commission offers ½ off the system price as a rebate.

36. What do you consider a reasonable price for this type of electricity service?
    a. $0-5K
    b. $5-10K
    c. $10-15K
    d. $15-20K
    e. $20-30K

37. What do you consider a reasonable payback time (time to pay itself off) for this system?
    a. 1-5 years
    b. 5-10 years
    c. 10-15 years
    d. 15-25 years

Scenario 3:

38.I. Using a home-equity loan for the $15K purchase, the amortized monthly payment is $117/mth. You are:
    a. willing-to-pay
    b. not willing-to-pay

II. Using a home equity loan for $10K, with $5K as an initial investment. The amortized monthly payment is roughly $78/mth.You are:
    a. willing to pay
    b. not willing to pay

39. Why are you interested in generating electricity for personal consumption?
    a. lower cost
    b. reliability
    c. environmental concerns
    d. other

40. How important is local government's involvement in encouraging use of renewable energy? (1-5)
    a. very important
    b. somewhat important
    c. mildly important
    d. not very important
    e. not important

Survey: PV system owners

1. Who is the original purchaser of your system:

a. I am/Spouse
b. Previous tenant
c. Other

2. How many years have you had your system?_____

3. Are you grid-connected or off-grid?
   a. grid-connected
   b. off-grid

4. How familiar were you with solar electric technology before buying your system? 5-1
   a. very
   b. moderately
   c. somewhat
   d. not very
   e. not at all

5. Before purchasing your system, how concerned were you with personal energy use patterns:
   a. Very
   b. moderately
   c. somewhat
   d. not very
   e. not at all

Read each reason as individual questions:
Please tell me if these were reasons for you buying a PV system:
6. Far from transmission lines
7. Utilize sunny area
8. Concern with uncertain electricity market:
9. Concern for high electricity bill:
10. Environmental concerns:
11. Desire for self-sufficiency:
12. Other (please specify):

13. How important was initial cost as a factor in your decision?
   a. Very important
   b. moderately important
   c. somewhat important
   d. not very important
   e. not important

How would you describe the following processes?
14. To get the information that aided in your decision to purchase:
   a. Easy
   b. Somewhat easy
   c. Moderate
   d. difficult
   e. very difficult

15. Purchasing your system?
   a. Very easy
   b. Easy
   c. moderate

d. difficult
e. very difficult

16. Getting system installed?
    a. Very easy
    b. easy
    c. moderate
    d. difficult
    e. very difficult

17. Overall maintenance?
    a. Very easy
    b. easy
    c. moderate
    d. difficult
    e. very difficult

18. Day-to-day operation?
    a. Very easy
    b. easy
    c. moderate
    d. difficult
    e. very difficult

19. Did/Are you using a loan to finance your system?
    a. yes
    b. no

If no, skip 16.

20. How was loan process?
    a. Very easy
    b. easy
    c. moderate
    d. difficult
    e. very difficult

21. What is your level of satisfaction with your system?
    a. very satisfied
    b. satisfied
    c. moderately
    d. not very satisfied
    e. unsatisfied

22. Are you using net metering:
    a. yes
    b. no

23. Did you participate in any rebate/incentive programs for purchasing your system?
    a. yes
    b. no