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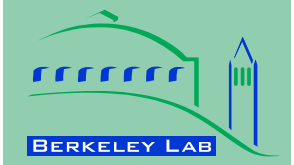

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Utility Green Pricing Programs: A Statistical Analysis of Program Effectiveness

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Executive Summary

Utility green pricing programs represent one way in which consumers can voluntarily support the development of renewable energy. Such programs have grown in number in recent years. The design features and effectiveness of these programs varies considerably, however, leading a variety of stakeholders to suggest specific marketing and program design features that might improve customer response and renewable energy sales.

This report analyzes actual utility green pricing program data to provide further insight into which program features might help maximize both customer participation in green pricing programs and the amount of renewable energy purchased by customers in those programs. Statistical analysis is performed on both the residential and non-residential customer segments. Data comes from information gathered through a questionnaire completed for 66 utility green pricing programs in early 2003. The questionnaire specifically gathered data on residential and non-residential participation, amount of renewable energy sold, program length, the type of renewable supply used, program price/cost premiums, types of consumer research and program evaluation performed, different sign-up options available, program marketing efforts, and ancillary benefits offered to participants.

While there are significant limitations to the approach used in this study, and our analysis yields fewer statistically significant relationships than had been hoped, this assessment does yield several interesting results.

- First, we find that program length has a substantial impact on customer participation and purchases – to achieve higher levels of success, utilities will need to remain persistent and committed to their product offering for some time (e.g., on average, we find that each year of program operation leads to an increase in residential participation rates of ~0.25%).
- Second, our findings suggest that utilities should consider higher purchase thresholds for residential customers – those utilities with larger renewable energy block sizes (>200 kWh) or percent-of-use products (>25%) also tend to have higher levels of residential renewable energy sales, with no obvious negative impact on the overall level of customer participation.
- Third, neither the volumetric price premium (for non-residential customers) nor the minimum monthly cost (for residential customers) are found to be primary determinants of program success, at least over the relatively narrow range of premiums embedded in our data set.
- Fourth, while larger utilities benefit from a greater number of *potential customers*, smaller utilities appear able to achieve higher levels of residential customer participation on a *percentage basis*. Interestingly, *once size is controlled for*, we find little evidence that utility ownership (private vs. public) is a principal determinant of green pricing success.
- Fifth, we find some evidence that providing private benefits to non-residential participants (e.g., business recognition) can enhance success.

While the results presented in this paper are suggestive, we urge readers to not place undue emphasis on them. Green pricing programs in the United States are still relatively new and have yet to gain a foothold in many markets. As these programs continue to grow and mature, more data will be available from which to assess the key aspects to program success.

1. Introduction

1.1 Background

Consumer choice in electricity markets is a relatively new occurrence in the United States and throughout the world. As consumers have been given greater freedom in selecting the electricity supplier and products of their choosing, a small but growing number have voluntarily opted to support renewable energy sources.

Green pricing programs represent one way in which consumers can voluntarily support renewable energy: wind, solar, biomass, landfill gas, geothermal, or hydropower. Green pricing programs are offered by electric utilities as a voluntary "add-on" product to the standard utility electric service in noncompetitive electricity markets.[1] Through these programs, participating customers typically agree to pay a premium on their electric bills to cover the incremental cost of renewable energy. The renewable generation supported by green pricing is generally intended to be additional to what the utility would otherwise have purchased due to either the favorable economics of certain renewable sources or regulatory mandates to purchase renewable energy.

What started as three green pricing programs in 1993 had evolved into more than 90 programs offered by more than 300 utilities throughout the United States by the end of 2002. Utilities in at least 32 states offered green pricing programs, reaching roughly 20% of the nation's electricity consumers. Approximately 270,000 customers (including 3,900 non-residential customers) had elected to participate in a green pricing program by the end of 2002. Green pricing programs were responsible for the development of 290 MW of renewable generation capacity by the end of 2002, with another 140 MW expected by the end of 2003. The median premium among these programs is 2.5 cents/kWh, equating to a monthly cost of $5 for a residential household that purchases 200 kWh/month of renewable energy (Bird and Swezey 2003). Outside the United States, green pricing programs have also been established in Canada, Japan, Australia, and at least 12 European countries (Bird, Wüstenhagen, and Aabakken 2002).

While green pricing programs have been successful in offering consumers a growing array of electricity choices, and in stimulating some incremental demand for renewable energy, the effectiveness of these programs varies considerably. Residential participation in these programs, for example, ranged from under 0.1% to nearly 6.5% at the end of 2002. With a median value of 1%, typical program response is well below the 40-80% of customers who express a willingness to pay for renewable energy in opinion surveys.[2] Of the 290 MW of new renewable energy capacity brought on line by these programs as of the end of 2002, 90% can be attributed to just 17 programs; some 75 additional programs added under 0.5 MW each on average.

[1] Alternatively, where retail electricity competition is allowed, consumers can sometimes select a competitive retail electricity provider that offers a "green" power product. Regardless of electricity market structure, consumers can also purchase renewable energy certificates to help support renewable energy separate from their standard electricity service (see Bird and Swezey 2003 and Wiser, Bolinger and Holt 2000 for more information on these markets).

[2] For more information on stated willingness to pay for renewable energy and related survey research, see, e.g., Farhar (1999), Wiser (2003), Zarnikau (2003), and Roe et al. (2001).

1.2 Report Objectives and Structure

A variety of authors have suggested marketing and program design tactics to improve customer response rates and increase the amount of renewable energy supported by green pricing programs (see, e.g., Lieberman 2002, Holt and Holt 2004, Mayer et al. 1999, Swezey and Bird 2001, Wiser 1998). A large number of electric utilities have also learned important practical lessons on how to enhance customer response, and how to do so cost effectively.[3]

The present study uses statistical analysis of actual utility green pricing program data to provide further insight into what program features might help maximize the effectiveness of utility green pricing programs. We define "effectiveness" to include residential and non-residential participation rates in utility green pricing programs (in percentage terms), as well as the percent of residential and non-residential load that is being served with renewable energy. We are aware of no previous studies that have performed similar statistical analysis of the possible drivers to the relative success of green pricing programs.

Data for our analysis was obtained from a questionnaire sent to utility green pricing program managers, which covered program features and customer participation rates as of the end of 2002. (For additional results from that survey, see Bird et al. 2004). The questionnaire gathered data not only on basic program components such as price/cost premiums, amount of green power sold, and number of participants, but also on marketing tactics, program features, sign-up options, and other aspects of program design. Rigorous statistical analysis then provided insight into how these program components affect success.

The remainder of this report is organized as follows:

- Section 2 highlights the data sources and methods used in our evaluation, the variables included in the statistical analysis, and the key limitations to our approach.
- Section 3 provides quantitative information on the dependent variables used in our analysis.
- Section 4 offers the results of the bivariate statistical analysis.
- Section 5 describes the results of the more rigorous multivariate data analysis, and identifies program features with statistically significant relationships with program success variables.
- Section 6 concludes by reviewing the key implications of the analysis.

The questionnaire used to gather the data analyzed in this report is reproduced in Appendix A. Appendix B highlights explanatory variables that were considered, but not included in the final statistical analyses provided in this report. Appendix C provides graphs and tables of some of the interesting bivariate analysis results.

[3] Perhaps the best source of information on these "case studies" comes from utility presentations to the annual national green power marketing conference (see http://www.eere.energy.gov/greenpower/conference/).

2. Data Collection and Methods

2.1 Data Collection

Data for our analysis comes from a questionnaire sent to U.S. utility green pricing program managers. The questionnaire was distributed by the National Renewable Energy Laboratory (NREL) to the program managers of 90 known green pricing programs. Of these 90 programs, four were subsequently found to be no longer active, reducing the potential data pool to 86. After multiple contacts, including phone reminders, we received completed questionnaires for 66 green pricing programs in January 2003, for a response rate of 77%.[4]

The questionnaire contained a range of questions on program design, marketing approaches, and customer response. The questions are included in Appendix A. The questionnaire specifically gathered data on program length, residential and non-residential participation, amount of renewable energy sold, the type of renewable supply used, program cost premiums, types of consumer research and program evaluation performed, different sign-up options available, program marketing efforts, and ancillary benefits offered to customers. The data provided in response to the questionnaire were current as of the beginning of 2003.

2.2 Variables and Hypotheses

The principal purpose of the statistical analysis is to evaluate the relationship of various program design and marketing features (independent/explanatory variables) to program effectiveness (dependent variables). For example, do programs that embody lower premiums or more aggressive marketing result in higher customer participation rates or support more renewable energy? Does the size of the utility, or its ownership structure, affect program success? Do programs that have been operating for a longer time period have systematically higher levels of customer participation?

The questionnaire was designed such that a number of independent (program design and marketing features) and dependent (program effectiveness) variables could be constructed based on the data collected.[5] Below we identify and explain the variables that are used in our analysis. (Additional independent variables that were considered, but that are not included in our final analysis, are highlighted in Appendix B).

Dependent Variables: Measures of Program Effectiveness

There are a variety of ways to gauge the success of individual green pricing programs (Swezey and Bird 2001). Some groups have looked at the total number of customers subscribed or the revenue generated, for example, while others have focused on the amount of new renewable generation capacity built as a result of program participation.

[4] With some exceptions, the majority of the respondents completed the entire questionnaire. Where possible, gaps in individual utility responses were filled with information from previous NREL surveys and with data from the Renewable Northwest Project, the U.S. Energy Information Administration, and utility Web sites.

[5] Based on the data type, both continuous and dummy variables were chosen.

The four measures of program effectiveness or success that we chose to include as our dependent variables are listed and summarized in Table 1, and described below:

TABLE 1: DEPENDENT VARIABLES: MEASURES OF PROGRAM EFFECTIVENESS

Dependent Variables	Explanation[6]
Residential Participation (%)	Total number of residential program participants divided by the total number of eligible residential program participants.
Non-Residential Participation (%)	Total number of non-residential program participants divided by the total number of eligible non-residential program participants.
Residential Renewable Energy Purchases (%)	Total renewable energy purchases of residential program participants in megawatt-hours divided by total eligible residential electrical usage.
Non-Residential Renewable Energy Purchases (%)	Total renewable energy purchases of non-residential program participants in megawatt-hours divided by total eligible non-residential electrical usage.[7]

- **Customer Segments:** The four dependent variables cover the two major customer segments targeted to varying degrees by utility green pricing programs: residential customers and non-residential customers. Many programs have historically focused only on the residential sector, but non-residential customers have received increased attention in recent years.
- **Participation and Renewable Energy Purchase Percentages:** The variables also reflect two basic measures of program effectiveness: customer participation and renewable energy purchase amounts, expressed on a percentage basis. Reporting of participation rate data – the number of residential or non-residential green pricing participants divided by the number of eligible participants – is common among utility green pricing programs. Renewable energy purchases percentages – the amount of renewable energy purchased by residential or non-residential green pricing participants divided by the total amount of eligible utility residential and non-residential load – are less commonly reported. Nonetheless, this variable is arguably of more value than participation rates because it considers not only the number of customer participants, but also the amount of renewable energy being supported by those participants.[8]

[6] Note that in most – but not all – cases, the number of eligible residential or non-residential customers equals the total number of such customers in the utilities' service territory.

[7] Six utility survey respondents were not able to provide data on non-residential usage, due to limited data tracking capabilities. For these six programs, an approximation was made for this variable based either on information about large renewable energy purchasers, average non-residential usage for other programs, or other specific program information.

[8] A program that has a high level of customer participation, but that sells a green pricing product that contains only a small amount of renewable energy, may not be doing much to support new renewable generation.

- **Percentage Representation:** All four of the dependent variables used in the study are presented in percentage terms, in order to take into account utilities of varying size.[9]

Independent/Explanatory Variables: Program Design and Marketing Features

The independent variables are those program design or marketing features that are hypothesized to potentially impact the four program effectiveness measures identified earlier. Based on the data collected, as well as a review of the broader green pricing literature,[10] the independent variables included in our analysis are listed and summarized in Table 2. Additional potentially important independent variables that were considered, but that are not included in our final analysis for a variety of reasons, are highlighted in Appendix B.[11]

Note that the independent variables used in our analysis of *residential* participation and renewable energy purchases are in some cases different from those used in our analysis of *non-residential* participation and renewable energy purchases. This reflects our view of possible differences in the nature of customer response between these two segments, as well as data limitations. These differences are highlighted in Table 2.

Each of these independent variables was included to test a particular hypothesis.

- **Price Premium/Minimum Monthly Cost:** One might expect that green power products that have higher volumetric price premiums (cents/kWh; used for non-residential customers) or that have a higher minimum monthly cost ($/month; used for residential customers) would also receive lower levels of customer participation and purchases.
- **Program Length:** Those programs that have been operating for a longer period of time are expected to have a higher level of customer response.
- **Research and Evaluation:** Utilities that have conducted consumer research and evaluated the success of their programs might be expected to reach higher levels of program success.
- **Sign-Up Options:** As with most everything in life, most customers want to avoid hassle—especially when signing-up for a program that will cost them more and provide few tangible benefits in return. Green pricing programs that make it easy for customers to join through multiple sign-up options (e.g., Web-site, electric bill check-off, special events, mail-in card, utility call center) may achieve greater levels of success.
- **Size of Utility:** Some analysts have hypothesized that smaller utilities may be able to generate a level of community interest in a green pricing product that larger utilities may be hard pressed to achieve, due in part to the ease of communication in a smaller community.
- **Investor-Owned Utility**: Similarly, some believe that investor-owned utilities may have a harder time achieving success with a green power program than publicly owned electric

[9] If, instead, we simply used the number of customers or amount of renewable energy supported as the dependent variables, then utilities with a larger base of eligible customers would (on average) naturally be ranked higher in terms of program effectiveness.

[10] For example, Lieberman (2002), Holt and Holt (2004), Mayer et al. (1999), Swezey and Bird (2001), and Wiser (1998).

[11] These variables include, for example, whether a program is verified/certified by a third party, whether a utility offers multiple green pricing programs, and whether a program is mandated by state law. Exploring whether some of these variables have a significant influence on green pricing success is an important area of future research, though it would require additional data that were not available for the present study (see Appendix B).

utilities, due perhaps to a greater level of trust in publicly owned utilities, or alternatively a higher level of motivation among publicly owned utilities in achieving program success (publicly owned utilities may arguably be more interested in the public benefits that can be derived from these programs, while investor-owned utilities may be driven by shareholders interests).

- **Contribution Program**: Green pricing programs are often designed around different product concepts. The most common designs include fixed-quantity block products (e.g., 100 kWh/month of renewable energy at a cost of $3/block) and percent-of-use products (e.g., renewable energy to cover 25% of a consumer's energy demand, at a premium of 2 cents/kWh). Less common are contribution programs, which seek voluntary payments but with no specific promise of energy delivery. These latter programs sometimes have unclear goals and impacts, and contribution programs may therefore not fare as well as other green pricing product types.
- **High Purchase Threshold**: High renewable energy purchase thresholds for customers may reduce customer participation rates by requiring higher levels of financial commitment. On the other hand, such thresholds may increase the amount of renewable energy purchased by any individual consumer, thereby improving renewable energy purchase percentages.
- **Contract Length**: Those utilities that require long-term contracts for green pricing program participants might be expected to achieve lower levels of customer interest in their programs.
- **Private Benefits**: Green power is an intangible product that benefits everyone. As such, utilities that provide consumers with direct private incentives (e.g., recognition, discounts at participating stores, or compact fluorescent light bulbs) may benefit from higher levels of customer interest.
- **Biomass**: Solar, wind, and hydropower are generally ranked highest among the renewable energy sources in terms of consumer preferences, while biomass is not rated as highly. All else equal (e.g., assuming equivalent pricing), those programs that offer biomass as a component of their product offerings might therefore be expected to garner less participation than those that emphasize solar and wind.
- **Marketing Repetition**: Programs that are competitively priced and have attractive benefits are worthless if no one knows about them. All else equal, greater levels of marketing would therefore be expected to lead to greater levels of program success.

TABLE 2: INDEPENDENT VARIABLES: PROGRAM DESIGN AND MARKETING FEATURES

Variable	Explanation
Price Premium/ Minimum Monthly Cost	Residential Customers: *Minimum monthly incremental cost* ($/month) for participating in the program. If a block product is offered, this variable represents the cost of a single block. (The model does not account for programs that require customers to purchase multiple blocks). For percent-of-use product (e.g., 25%, 50%, or 100%), the variable represents the incremental cost of the smallest percentage product offered for a customer with average electricity use. For contribution programs, the variable represents the smallest contribution amount allowed. We hypothesized that minimum monthly cost would be a more important cost variable than the actual premium charged (cents/kWh), and this variable construction allowed all green pricing program types to be included in the analysis. Non-Residential Customers: *Price premium* charged for renewable energy on a cents/kWh basis. With varying but much larger levels of electricity usage than residential customers, the minimum monthly incremental cost in $/month is less relevant (e.g., large non-residential customers are not likely to purchase just one small block of renewable energy). Because contribution programs do not have a defined cents/kWh premium, contribution programs were eliminated from our multivariate analysis of non-residential customers (also note that contribution programs do not generally target non-residential customers).
Program Length	The number of years a utility green pricing program has been in existence.
Research and Evaluation	A dummy variable indicating if a utility claims that is has *both* (1) performed consumer research to aid in the design of the green product, and (2) evaluated the performance of its program.
Sign-Up Options	The number of ways a customer can sign-up for the program, among a list of five options given in the questionnaire (Web-site, electric bill check-off, special events, mail-in card, utility call center).
Size of Utility	The total number of (residential and non-residential) customers in a utility service area.
Investor-Owned Utility	Dummy variable indicating if a program is offered by an investor-owned utility as opposed to a publicly owned utility or co-op.
Contribution Program	Dummy variable for programs structured as "contributions." This variable is not included in the non-residential analysis, as discussed above.
High Purchase Threshold	Dummy variable that indicates if a program has a larger-than-average minimum renewable energy purchase requirement for participants. Residential programs with block sizes of 200 kWh or more, or a minimum percent-of-use product of 25%, are qualified for this category. From an analysis of the data, this breakpoint represents a significant increase in minimum consumer purchases when compared to other programs. This variable is not included for non-residential customers due to data limitations and difficultly in defining an appropriate threshold level.
Contract Length	Minimum number of months customers are obligated to remain in the program. Programs that allow customers to come and go on a monthly basis as they choose were assigned a contract length of zero.
Private Benefits	Residential Customers: The total number of different types of "private" benefits offered to residential customers, among a list of eight specific possibilities listed in the questionnaire: compact fluorescent light-bulb giveaways, discounts at participating stores, newsletters and other literature, tours, school programs, individual recognition, fuel surcharge exemptions, environmental cost exemptions, and any other private benefits. Non-Residential Customers: The total number of different types of "private" benefits offered to non-residential customers, among a list of four specific possibilities listed in the questionnaire: specific recognition of the business by the utility, decals for use at the business, fuel surcharge exemptions, environmental cost exemptions, and any other business benefits.
Biomass	Dummy variable for if biomass generation was used for part of the green pricing program.
Marketing Repetition	Total number of rounds of bill inserts, direct mailings, and newsletters used to market the green pricing program in the last year, according to the questionnaire (See Appendix B for alternative marketing variables that were attempted).

2.3 Analysis Techniques

Both bivariate and multivariate statistical analyses are used. Bivariate analysis simply shows the direct relationships between individual independent variables and the dependent variables of choice. Multivariate analysis is more rigorous, and can more completely account for the impact of multiple independent variables on the selected dependent variable. Only complete data sets that encompass all the explanatory variables were used for the multivariate regressions; this reduced the number of possible observations.

2.4 Study Limitations

There are significant limitations to our analysis that should be acknowledged in advance:

- **Sample Size:** Perhaps most importantly, green pricing programs are still relatively new in the United States. As a result, the maximum number of programs available to analyze is small relative to the number of independent variables that are explored. A number of independent variables that might be expected to have an effect on program success may therefore not be found to be statistically significant. Moreover, non-residential customers have not been strongly targeted by many of the green pricing programs; as such, statistical results from the non-residential analysis that follows are not as robust as those for the residential sector.
- **Outliers:** Program outliers were not found to be a significant problem in much of our analysis. In both the non-residential participation rate and renewable energy purchase rate analyses, however, a single (top-performing) utility program has the possibility of greatly affecting the results of the analysis. Accordingly, in the analysis that follows, we exclude the top-performing program in each of the non-residential regressions.
- **Missing or Blunt Variables:** While the independent/explanatory variables used in our analysis encompass a number of items previously identified to explain program success, some omitted variables may still remain. Similarly, some of the independent variables used in the present analysis are bluntly defined, for example, (1) the marketing repetition variable does not capture the full range of marketing efforts attempted by the various utilities, nor does it distinguish between the relative efficacy of different marketing approaches (2) the research and evaluation variable does not effectively distinguish among the wide scope of possible research and evaluation efforts, and (3) the biomass variable is triggered if *any* biomass is included in the product offering.[12] As such, those independent variables that *are not* found to be statistically significant in our analysis should not then be viewed as unimportant; sharper tools and a larger sample of data in the future may help to refine this analysis.
- **Time-Lag Issues:** Our analysis was performed based on *aggregate* customer participation and renewable purchases as of the end of 2002 (not year-to-year changes). The cost premium and marketing repetition variables, however, represent data for 2002 (i.e., the cost premium

[12] The marketing variable might best be defined as the amount of funds spent in aggregate on marketing, though utilities are often reluctant to provide such data. The research and evaluation variable could be more tightly defined if information was obtained on (1) when the research or evaluation was performed (2) the overall comprehensiveness of the efforts, and (3) whether action had been taken to react to research findings. The biomass dummy variable might best be triggered if biomass is the *primary* source of renewable energy supply.

in 2002 and the amount of marketing in 2002), not for the full program life. To the extent that these variables were very different in 2002 than in previous years, they may not be optimally specified. Similarly, the questionnaire did not specify whether market research or program evaluations were conducted in 2002, or earlier, and may have resulted in different interpretations based on the respondent.

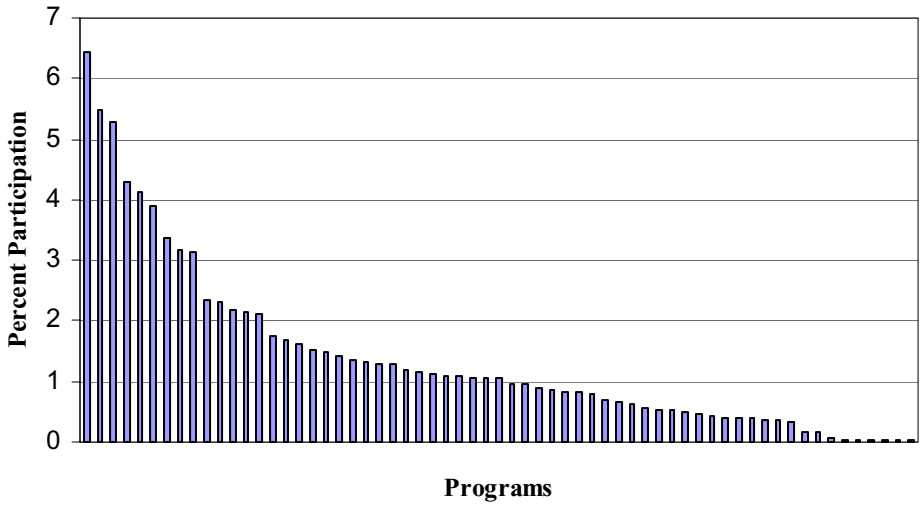
- **Multicolinearity:** Some of the independent variables display correlation with other independent variables, raising the concern of statistical multicolinearity. While we sought to define a model that minimized this concern (see Appendix B for variables that were removed due to concerns over multicolinearity), any remaining multicolinearity may reduce the significance of some potentially important variables.

Because of these limitations, one must view the results of our analysis with some caution. While our results do provide some insight into the success factors of green pricing programs, the results are only as good as the data that are analyzed.

3. Measures of Program Effectiveness

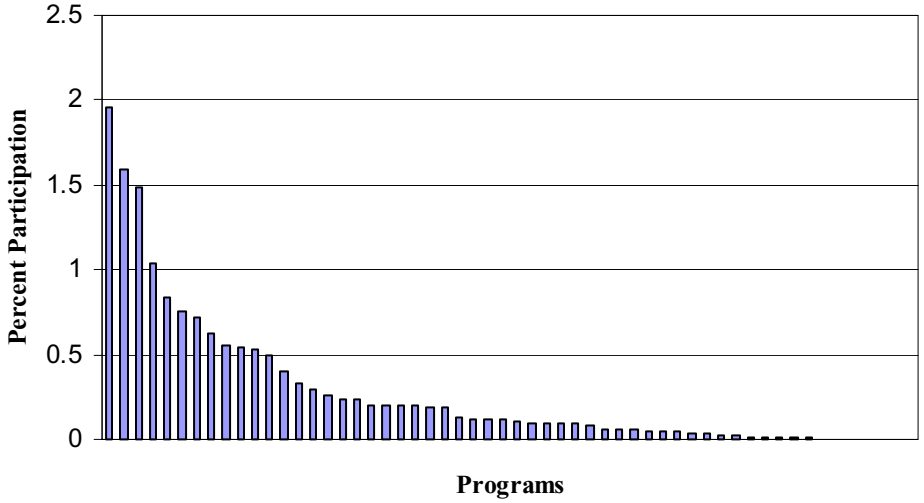
Before proceeding with the statistical analysis, it is first useful to review the range of results for each of the four dependent variables. As shown in Figure 1, at the end of 2002, residential participation rates ranged from a high of 6.45% to a low of 0.02%. The average participation rate was 1.39%, with and a median value of 1.06% (n=63).

FIGURE 1: RESIDENTIAL PARTICIPATION (%)



Non-residential participation rates – shown in Figure 2 – were lower, ranging from a high of 1.96% to a low of 0.00%. The average was 0.28%, with a median of 0.11% (n=56).[13]

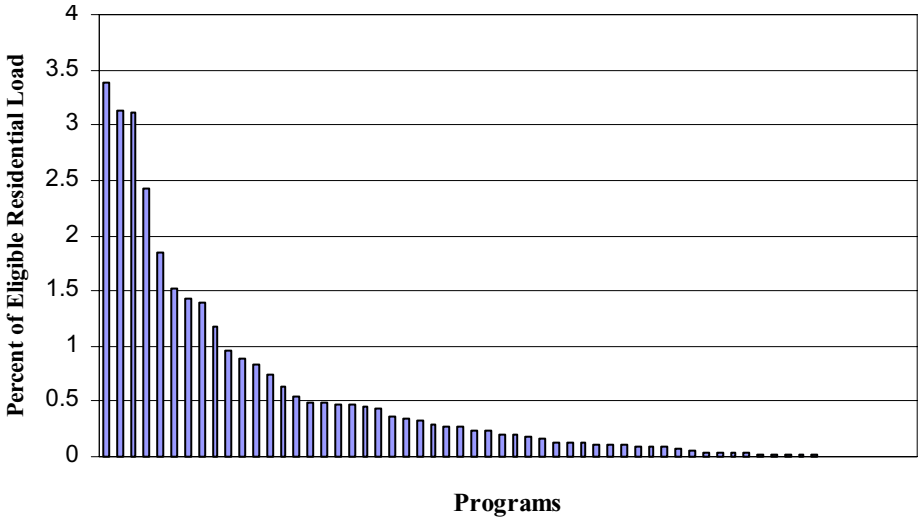
FIGURE 2: NON-RESIDENTIAL PARTICIPATION (%)



[13] Note that Figure 2 does not include data on a single outlier, whose non-residential participation rate was reportedly 30%. If this program is included, the average becomes 0.80%, with a high of 30%, a low of 0.00%, and a median of 0.11% (n=57).

As noted earlier, *renewable energy purchases* (in percentage terms) are arguably a more valuable indicator of program success than are *customer participation* rates. As shown in Figure 3, residential renewable energy purchases through green pricing programs (as a percentage of total eligible residential customer load) ranged from a high of 3.38% to a low of 0.00%. The average was 0.52%, and a median of 0.20% (n=60).[14] Many programs require customers to place only a portion of their entire load on the green pricing option, which explains why renewable energy purchase percentages are lower than customer participation rates.

FIGURE 3: RESIDENTIAL RENEWABLE ENERGY PURCHASES (%)

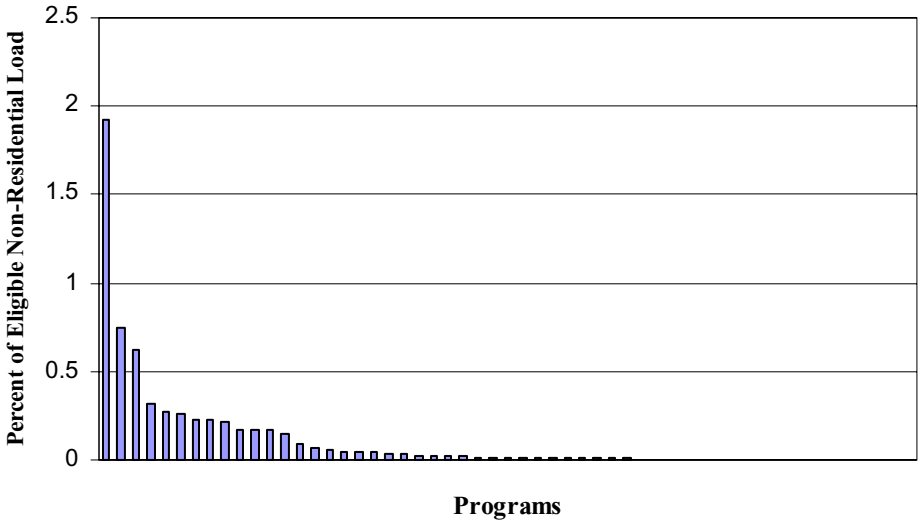


The distinction between participation and purchase percentages is also stark when it comes to the non-residential customer segment. This is because those few non-residential consumers that have purchased renewable energy through a green pricing program have generally purchased far less than their total load. As shown in Figure 4, non-residential green pricing purchases at the end of 2002 ranged from a high of 1.92% to a low of 0.00%. The average was just 0.11%, with a median of 0.01% (n=55).[15]

[14] Note that contribution programs are included in these figures, calculated as the total amount of renewable energy supported through the contribution program divided by the total eligible load of the customer class.

[15] Note that in this case, the single program outlier is included in the Figure and the data. If that outlier is excluded, the average becomes 0.08%, with a high of 0.75%, a low of 0.00%, and a median of 0.11% (n=56).

FIGURE 4: NON-RESIDENTIAL RENEWABLE ENERGY PURCHASES (%)



4. Bivariate Analysis Results

Bivariate analysis was performed between the independent and dependent variables, which helps in developing an understanding of the correlation between these variables.[16] While bivariate results are briefly presented here, we note that the multivariate results presented later provide a more defensible assessment of the impact of various program design factors on the metrics of green pricing success. This is because the multivariate results can account for interrelationships between the various independent variables.

4.1 Residential Customer Analysis

Focusing initially on the residential customer segment, Table 3 shows the relationship between the independent variables listed in Table 2 and the dependent variables of: (1) residential participation (in percentage terms), and (2) residential renewable energy purchases (in percentage terms). Pearson correlation coefficients are used to define this relationship, and represent the strength and direction of any linear relationship that exists between the two variables. Also shown are the number of observations (n) and the statistical significance of the relationships (p-value). Variables with 90% statistical significance or better have been bolded. Appendix C presents the results of some of these relationships in more detail.

TABLE 3: PEARSON CORRELATION COEFFICIENTS, RESIDENTIAL DATA

	Participation (%)			**Purchases (%)**		
	Coefficient	*n*	*P-value*	*Coefficient*	*n*	*P-value*
Minimum Monthly Cost	0.002	63	0.986	0.210	60	0.108
Program Length	**0.411****	**63**	**0.001**	**0.315***	**60**	**0.014**
Research and Evaluation	-0.052	61	0.689	-0.024	59	0.859
Sign-Up Options	-0.186	60	0.154	-0.112	58	0.407
Size of Utility	**-0.255***	**63**	**0.044**	-0.212	60	0.103
Investor-Owned Utility	**-0.219†**	**63**	**0.084**	**-0.243†**	**60**	**0.062**
Contribution Program	-0.084	63	0.513	-0.023	60	0.860
High Purchase Threshold	**0.240†**	**63**	**0.058**	**0.451****	**60**	**0.000**
Contract Length	0.105	63	0.412	**0.232†**	**60**	**0.074**
Private Benefits	0.112	60	0.396	0.114	57	0.400
Biomass	0.073	63	0.571	0.111	60	0.400
Marketing Repetition	0.038	60	0.771	0.119	58	0.374

† Correlation is significant at the 10% level
* Correlation is significant at the 5% level
** Correlation is significant at the 1% level

[16] We also analyzed the correlation among the various independent variables, in order to diagnose and remedy any multicolinearity problems that might exist. That analysis is not presented here.

Though the bivariate results must be viewed with some caution, some of the hypotheses presented in Section 2 are confirmed statistically.

- Those programs that have been operating for a longer period of time have garnered a greater percentage of residential participants, and have generated higher levels of residential renewable energy sales. For example, based on the statistical analysis, both residential participation and purchase rates appear to (on average) double between the first and fourth year of program operation.
- Investor-owned utilities (IOUs) have, on average, been less successful in generating high participation and purchase rates relative to publicly owned utilities. For example, the average residential participation rate for IOUs is 1% compared to 1.6% for publicly owned utilities, while the average residential renewable energy purchase rate is 0.3% for IOUs compared to 0.7% for public utilities.[17]
- Smaller utilities have, on average, been more successful than larger utilities, though this relationship is statistically significant at the 10% level only for the residential participation rate variable.
- Finally, a high renewable energy purchase threshold was found to have a positive relationship with both residential participation and renewable energy purchases. Programs offering green power in at least 200 kWh blocks or for 25% of a customer's usage averaged a 2% residential participation rate and a 1.2% residential purchase percentage, while programs with lower thresholds averaged a 1.2% participation rate and 0.3% purchase rate.

Oddly, a longer contract length initially appears to *increase* residential purchases of renewable energy, rather than the expected negative relationship between these variables; this finding, however, is greatly influenced by a single successful program with a long contract length, and removing that program makes the correlation insignificant.

A number of additional hypothesized relationships are not found to be statistically significant. The minimum monthly cost variable, for example, does not appear to have an obvious effect on residential program effectiveness. Those utilities that offer a greater number of green pricing sign-up options (e.g., Web-site, electric bill check-off, special events, mail-in card, utility call center) appear to fare more poorly, but the relationship is not statistically significant. Marketing repetition has the expected positive relationship with the two residential program effectiveness variables, but that relationship is also far from statistically significant. The private benefits and contribution program variables also have the expected signs (greater private benefits lead to greater levels of program success, while contribution programs result in lower levels of success), but neither relationship is statistically significant. While the average residential participation rate for contribution programs was lower than for other program types (1.10% for contribution programs versus 1.44% for block and percent-of-use products), the small number of contribution programs in the sample (n=9) prevented a finding of statistical significance. The research and evaluation and biomass variables, meanwhile, are also not statistically significant.

[17] Note that once utility size is controlled for in the multivariate results presented later, utility ownership is no longer found to be a significant determinant of green pricing success. Accordingly, the bivariate results presented here should be viewed with caution.

4.2 Non-Residential Customer Analysis

Table 4 provides corollary bivariate results for the non-residential customer segment. Appendix C again presents the results of some of these relationships in more detail. Our analysis of non-residential renewable energy participation and purchases (in percentage terms) was performed without the top-performing green pricing program. This is because the top-performing program is significantly different from the rest of the programs analyzed (see Section 3), and a better picture of "typical" programs is gained by excluding this single outlier.

TABLE 4: PEARSON CORRELATION COEFFICIENTS, NON-RESIDENTIAL DATA

	Participation (%)			**Purchases (%)**		
	Coefficient	*n*	*P-Value*	*Coefficient*	*n*	*P-Value*
Price Premium	-0.207	49	0.155	-0.111	48	0.452
Program Length	**0.246†**	**49**	**0.088**	**0.403****	**48**	**0.005**
Research and Evaluation	-0.192	48	0.191	-0.211	48	0.151
Sign-Up Options	**-0.305***	**48**	**0.035**	-0.124	48	0.400
Size of Utility	**-0.300***	**49**	**0.036**	-0.199	48	0.175
Investor-Owned Utility	**-0.295***	**49**	**0.048**	**-0.253†**	**48**	**0.082**
Contract Length	0.163	49	0.264	**0.291***	**48**	**0.045**
Private Benefits	0.114	48	0.439	**0.234***	**48**	**0.025**
Biomass	0.014	49	0.924	-0.044	48	0.769
Marketing Repetition	-0.041	48	0.783	-0.023	48	0.876

† Correlation is significant at the 10% level
* Correlation is significant at the 5% level
** Correlation is significant at the 1% level

These results provide some indication of the success factors of green pricing programs that target the non-residential sector. Unfortunately, some of the relationships vary among the participation and purchase comparisons, making interpretation challenging. Perhaps this is due to the fact that few utilities have heavily marketed their green pricing programs to the non-residential sector.

Nonetheless, many of the variables found to be significant in our residential customer analysis are also significant here. Program length again appears to be related to participation and purchase decisions: programs that have operated for a longer duration have garnered a greater percentage of non-residential participants and non-residential renewable energy sales. Investor-owned utilities have been less successful in generating high participation and renewable purchase percentages than publicly owned utilities, and smaller utilities appear to have higher success rates.

The sign-up options variable has a sign that is the opposite of what would otherwise be expected, and is significant with respect to participation rates. The contract length variable also has an unexpected sign, but is significant only with respect to renewable energy purchases. The price

premium variable (in cents/kWh) is not found to be statistically significant; however, it is at least of the expected sign – higher cost green pricing products result in lower levels of participation and purchases. The biomass, research and evaluation, and marketing repetition variables do not have statistically significant impacts on non-residential program effectiveness, as is the case for the residential sector.

In contrast to the earlier residential customer analysis, the private benefits variable rises to significance in the purchase percentage correlations shown in Table 4, suggesting that programs that provide non-residential customers with private benefits have resulted in greater renewable energy sales.

5. Multivariate Analysis Results

Many of the results of the bivariate analysis could be dismissed for not controlling for the impacts of other independent/explanatory variables. For this reason, multivariate regression analysis was performed against the four dependent variables.

5.1 Residential Customer Analysis

The results of the residential regressions are shown in Table 5. Regression coefficients, t-scores, and p-values (again representing statistical significance) are displayed. Variables that are significant with 90% confidence or better have been bolded. The significance of the overall model, indicated by the R^2 and F scores, is shown at the bottom of the table.

TABLE 5: RESIDENTIAL MULTIVARIATE REGRESSION RESULTS

	Participation (%)			**Purchases (%)**		
	Coefficient	*T-Score*	*P-Value*	*Coefficient*	*T-Score*	*P-Value*
Constant	0.899	1.09	0.280	-0.077	-0.20	0.844
Minimum Monthly Cost	0.021	0.18	0.854	0.020	0.36	0.717
Program Length	**0.264****	**2.83**	**0.007**	**0.094***	**2.18**	**0.034**
Research and Evaluation	0.374	0.78	0.441	0.156	0.72	0.475
Sign-Up Options	-0.261	-1.31	0.197	-0.066	-0.73	0.472
Size of Utility	**-7.98×10^{-7}***	**-2.20**	**0.033**	**-3.04×10^{-7}†**	**-1.88**	**0.067**
Investor-Owned Utility	-0.148	-0.34	0.739	-0.254	-1.29	0.204
Contribution Program	-0.418	-0.77	0.445	-0.233	-0.88	0.382
High Purchase Threshold	0.562	1.13	0.264	**0.764****	**3.40**	**0.001**
Contract Length	0.046	1.66	0.103	**0.025†**	**1.99**	**0.053**
Private Benefits	0.082	0.62	0.539	0.054	0.89	0.379
Biomass	0.253	0.66	0.511	0.185	1.09	0.284
Marketing Repetition	0.091	1.38	0.173	**0.051†**	**1.72**	**0.092**
N	59			57		
R^2	0.42			0.58		
Adjusted R^2	0.27			0.46		
F	2.8			5.0		

† Correlation is significant at the 10% level
* Correlation is significant at the 5% level
** Correlation is significant at the 1% level

The F scores for both regressions show that each model has some predictive capability, but the model of residential renewable energy *purchases* has significantly higher F and R^2 values due to

strong correlations from several specific independent variables. The small number and relative youth of green pricing programs may bias the models against finding statistical significance in the explanatory variables.

The multivariate regression results confirm some of our earlier hypotheses, as well as results from the bivariate analysis, but also lead to a few surprises:

- **Program length has a significant impact on residential participation and purchases.** Confirming the bivariate analysis results, the regression results suggest that, on average, each year of program operation leads to an increase in residential participation rates of ~0.25% and an increase in residential renewable energy sales of ~0.1%. Data quality is not high enough to determine whether there is a tapering off of this increase over time, or whether the increase actually accelerates over some limited period.
- **Smaller utilities have been able to generate greater levels of green pricing success.** This confirms the bivariate analysis results presented earlier.
- **Higher purchase thresholds appear to maximize residential renewable energy sales while not negatively influencing customer participation rates**. This finding suggests that a sizable number of residential participants are willing to participate at whatever minimum level is allowed. In other words, initial customer participants in green pricing programs may not be highly sensitive to cost, and may be willing to purchase higher quantities of renewable energy if that is what is *required* to participate.
- **Marketing levels impact residential customer purchases of renewable energy.** While this was not found in the bivariate analysis, we find some statistical evidence that marketing levels do impact purchase rates.
- **A longer contract length appears, initially, to increase residential purchases.** As with the bivariate analysis, a longer contract length appears to *increase* residential purchases of renewable energy; this finding, however, is greatly influenced by a single successful program with a long contract length.

Additional variables are not found to be statistically significant. For example, the minimum monthly cost variable shows no effect on residential participation or sales. While common sense suggests that cost should be a factor in participation decisions, over the limited cost range embedded in our data and with the low levels of current participation in green pricing programs, we find no such statistical evidence. Similarly, unlike the bivariate results, once utility size is controlled for, the investor-owned utility variable is not statistically significant. Accordingly, utility size appears to be a better determinant of green pricing success than the form of utility ownership. We also find weak evidence that contribution programs garner lower levels of customer response, and that providing private benefits increases program success; these effects, however, are not found to be statistically significant. Finally, while it may be a result of inadequate data or variable definition, the following additional independent variables are found to have no statistically significant impacts on residential green pricing effectiveness: biomass, research and evaluation, and sign-up options.

5.2 Non-Residential Customer Analysis

Results for the regressions performed on the non-residential data sets are presented in Table 6. As we did in the bivariate analysis, we excluded the top-performing green pricing program.

TABLE 6: NON-RESIDENTIAL MULTIVARIATE REGRESSION RESULTS

	Participation (%)			**Purchases (%)**		
	Coefficient	*T-Score*	*P-Value*	*Coefficient*	*T-Score*	*P-Value*
Constant	**0.699***	**2.28**	**0.029**	-0.033	-0.32	0.752
Price Premium	-0.026	-1.47	0.149	-0.004	-0.62	0.538
Program Length	0.058	1.53	0.135	**0.033***	**2.64**	**0.012**
Research and Evaluation	-0.021	-0.12	0.902	-0.067	-1.16	0.252
Sign-Up Options	**-0.139†**	**-1.85**	**0.073**	-0.004	-0.18	0.861
Size of Utility	-2.33×10^{-7}	-1.15	0.259	1.08×10^{-10}	0.00	0.998
Investor-Owned Utility	0.031	0.14	0.887	-0.051	-0.90	0.375
Contract Length	-0.001	-0.21	0.834	6.63×10^{4}	-0.25	0.801
Private Benefits	0.091	1.40	0.171	**0.052***	**2.56**	**0.015**
Biomass	-0.039	-0.28	0.782	-0.037	-0.83	0.409
Marketing Repetition	-7.00×10^{-5}	-0.00	0.998	0.002	0.31	0.762
N	48			48		
R^2	0.30			0.40		
Adjusted R^2	0.11			0.24		
F	1.55			2.49		

† Correlation is significant at the 10% level
* Correlation is significant at the 5% level
** Correlation is significant at the 1% level

Overall, model fit is reasonably poor, as documented by the F and R^2 statistics. Accordingly, few conclusions can be definitively reached based on this analysis. In the regression with participation rate as the dependent variable, for example, only the sign-up options variable (negative coefficient) shows some correlation with participation rates. The low F score for this data set limits the evaluative capacity of this model, however. Even in the purchase rate regression – which does yield a better model fit – only two independent variables are shown to be statistically significant at the 10% level.

Clearly, with limited utility focus on this customer segment historically and with widely different program offerings and results, it is difficult to come up with an adequate model of non-residential renewable energy participation and purchases. Taking the purchase percentage regression as the best model of the two, only two independent variables rise to the level of statistical significance.

- First, **program length** again influences green pricing success. This confirms our bivariate analysis results, and is consistent with the residential analysis as well.
- Second, the provision of a greater number of **private benefits** (recognition of the business by the utility, decals for use at the business, fuel surcharge exemptions, environmental cost exemptions, and any other business benefits) is found to increase purchase rates.

Other variables that were found to be significant in the bivariate non-residential analysis, such as utility size, IOU, and contract length, have become less important once other independent variables are considered in the multivariate regression results. The price premium of the product is again not found to be a significant explanatory variable in these results, though it nearly rises to significance (at 10%) in the participation rate regression.

6 Conclusions

Utility green pricing programs currently in operation in the United States vary in their product design, features, and marketing tactics, and by the type and size of the utilities offering them. With a growing number of green pricing programs, and experience that varies substantially across utilities, a variety of analysts and market participants have proposed program design elements that may enhance chances of success.

In this report we have statistically analyzed actual utility green pricing program data to provide further insight into what program features might help maximize the effectiveness of these efforts. Data for our analysis was obtained from utility green pricing program managers in early 2003.

Our analysis yields fewer statistically significant relationships than had been hoped, especially among the non-residential customer segment. A relatively small data set, and limited experience with green pricing programs more generally, may be contributing to the weak predictive capacity of the regression models. Lack of utility focus on and marketing to the non-residential customer segment is likely a key contributor to the weak statistical results. Additionally, some of the independent variables used in the present analysis are bluntly defined. As such, those independent variables that *are not* found to be statistically significant should not necessarily be viewed as unimportant; sharper tools and a larger sample of data in the future may help to refine this analysis.

Despite the limitations, our analysis does yield several interesting results:

- **Program duration impacts customer response.** The longer a program has been operating, the more likely its message has spread and the higher the probability of strong program success. This is perhaps the most consistent of our statistical findings – both for residential and non-residential customers – and provides support for the idea that new products generally follow a "diffusion curve" of increased penetration over time.[18] To achieve higher levels of success, utilities need to remain persistent and committed to their product offering for some period of time. An initially low level of customer participation can be remedied over time. Further data would be necessary to better understand the actual shape of the green power diffusion curve.
- **Higher purchase thresholds for residential customers should be considered.** Those utilities with larger renewable energy block sizes (>200 kWh) or percent-of-use products (>25%) also tend to have higher levels of residential renewable energy sales, and with no obvious negative impact on the overall level of customer participation. In other words, initial customer participants in green pricing programs may not be highly sensitive to cost, and may be willing to purchase higher quantities of renewable energy if that is what is *required* to participate. If purchase thresholds are low, on the other hand, those same customers may only choose to purchase that minimum quantity of renewable energy. Within reason, utilities should therefore consider slightly higher minimum purchase thresholds, in order to maximize residential renewable energy sales. This is especially the case for those utilities focused on maximizing renewable energy sales, not customer participation rates.

[18] See Wiser et al. (2001) for further discussion of the diffusion curve as applied to green power markets.

- **Price premiums and minimum monthly costs are not the primary determinants of program success.** There can be little doubt that price does matter: common sense and economic theory tell us that higher priced products can and should result in lower levels of customer participation and renewable energy purchases. Nonetheless, using minimum monthly cost as the independent variable for residential customers, and volumetric price premiums for non-residential customers, we find little statistical evidence of this effect. This suggests that over the relatively narrow range of volumetric price premiums and minimum monthly costs embedded in our data set (for virtually every residential program, the minimum monthly cost is under $10) and given that most green pricing programs are only capturing the first wave of customer participants, the premium is not a primary determinant of success. Price may become a more important determinant as green pricing programs expand to target more than the early innovator customers; in the meantime, other factors appear to play more important roles in shaping program effectiveness.
- **Smaller utilities appear to have a greater likelihood of achieving success.** While larger utilities will always benefit from a greater number of *potential customers*, smaller utilities appear able to achieve higher residential customer participation and renewable purchases on a *percentage* basis (the same effect is not as strongly observed among non-residential customers). This may be due to stronger community ties and favorable standing among the customer base. Interestingly, *once size is controlled for*, we find little evidence that utility ownership (IOU vs. public) is a principal determinant of green pricing success.
- **Providing private benefits to non-residential customers may enhance success.** Especially among non-residential customers, we find some evidence that offering a greater number of private benefits – including business recognition – can increase renewable energy sales. Additional data would be needed to refine our analysis of this issue.
- **Higher levels of marketing may positively impact sales and participation:** We were unable to develop a robust metric for the level of marketing used by each program, instead resorting to a marketing repetition variable that is, as discussed earlier, not ideal for our purpose. This variable was positively related to the level of residential renewable energy purchases, but additional analysis of the impact of marketing levels on customer response is merited.

A number of other variables are found to have little statistical effect on program success, or to have an effect opposite of what might be expected. For example, we find little empirical evidence that the type of renewable supply plays a major role. In addition, consumer research and program evaluation is not found to be statistically significant. Oddly, if anything, our data suggest that providing more sign-up options (e.g., Web-site, electric bill check-off, special events, mail-in card, utility call center) might even reduce customer participation. Future research should explore these relationships in more depth, ideally with a greater quantity of data and tighter and more detailed definitions of independent variables.

While the results presented in this paper are suggestive, we urge readers to not place undue emphasis on them. Green pricing programs in the United States are still relatively new and have yet to gain a foothold in many markets. The limited data that do exist do not allow as comprehensive a statistical analysis as might be hoped. As green pricing programs continue to grow and mature, more data will be available from which to assess the key aspects of program success. These additional data will allow a more rigorous and thorough evaluation of the

determinants of program effectiveness. In the meantime, readers interested in gleaning additional design lessons for utility green pricing programs would be well served to review some of the documents referenced earlier that offer qualitative insights into the determinants of green pricing success.[19]

[19] See, e.g., Lieberman (2002), Holt and Holt (2004), Swezey and Bird (2001), and http://www.eere.energy.gov/greenpower/conference/.

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Appendix A: Green Pricing Program Questionnaire

1. Utility name _____
2. Name of green power program _____ (if you have multiple programs, please fill out a separate form for each program)
3. Year program was launched _____
4. Which states is the program offered in? _____

Participation

5. In the table below, please provide participation data as of December 31, 2002. If data is provided for a different month (e.g., November) please specify _____

Question	*Response*
Number of current residential green power participants	
Number of current non-residential green power participants	
Number of residential customers (or members) eligible to participate	
Number of non-residential customers (or members) eligible to participate	
Is the program open to new customers? Yes/no	
Number of customers on waiting list	
Number of participants who have dropped out of the program this year	
Minimum period of time residential customers must participate in program (e.g., 1 year)	
Minimum period of time non-residential customers must participate (e.g., 2 years)	

6. For programs that are jointly offered to multiple distribution cooperatives or municipal utilities, please indicate the highest overall participation rate achieved by a utility participating in the program. _____

Sales for the last year

7. In the table below, please indicate the sales of green power to customers during the previous 12-months. Please also indicate the top 3 non-residential purchasers and the amount purchased during the last 12 months.

Green power sales for most recent 12 months	*Blocks*	*Block size*	*KWh/year of green power*
Green power sales to residential customers			
Green power sales to non-residential customers			
Top 3 non-residential purchasers:			
1.			
2.			
3.			

Renewable Energy Supplies

8. Of the renewable energy used to supply your program, what percentage comes from the following?
   - ____Renewable projects owned or partially-owned by your utility
   - ___ Renewable energy purchases from others
   - ____Renewable certificate purchases

9. In the table below, please indicate the type and amount of renewable resources used to supply your green pricing program during 2002.

	Nameplate Capacity Installed (kW)	*Energy Purchases in 2002 (kWh/yr)*	*Nameplate Capacity Planned (kW)*
Wind			
PV			
Solar Thermal			
Landfill methane			
Other Biomass			
Hydro			
Geothermal			

Premium

10. Please indicate the price premium charged for this green power product _____

11. Was there a change in the premium in 2002? Yes/no _____

If so, why? _____

12. Are green power customers protected, by virtue of their green power purchase, from increases in fuel costs (i.e., natural gas) or increases in the price of conventional electricity? Yes/no If so, how?

_____

_____

Program Design and Implementation

13. Have you done your own customer research to aid in the design of your green power product or development of your marketing plan? Yes/no

14. Have you performed an evaluation of the program? Yes/no

15. In which of the following ways can customers sign up for your green power program? (check all that apply)

Utility web site		By returning a mail-in card	
Checking a box on their electric bill		Over the phone through the utility call center	
Sign up at special events		Other?	

Marketing

16. What percentage of the green power program budget was spent on marketing in 2002? _____

17. On average, how much does it cost to sign up each residential customer ($/customer)? _____

18. In the table below, please indicate how many times, if any, you have used the following marketing strategies for your green power program in the past year. For example, if bill inserts, direct mail or newsletters were sent to 30,000 customers during the year, please indicate 30,000. Also, please rank the cost-effectiveness of the strategy on a scale of 1 to 5 with 5 being the most cost-effective strategy for obtaining customers.

Strategy	*Frequency*		*Cost-effectiveness (1-5, 5=Best)*
Bill inserts		# of inserts/year	
Direct mail		# of mail pieces/year	
Utility newsletter that mentions green power		# of newsletters/year	
Television		# of commercials aired/year	
Radio		# of announcements/year	
Newspapers		# of ads/year	
Telemarketing		# of calls/year	
Billboards		# of billboards	
Events		# events/year	
Publicity/feature stories (non-paid)		# of articles/year	
Other?			

Value for Consumers

19. What other value-added products or services do you provide to your green power customers? Please check as many as are applicable.

Compact fluorescents or efficiency products		Decals for display in store windows	
Recognition of business customers in program ads or local media		Installations on schools/renewable energy education programs	
Discounts or promotions at local businesses		Plaques or other items for recognition	
Newsletters that provide program updates		Protection from fuel cost increases	
Tours to renewable energy project sites		Exemption from environmental fees	
Other (please list)			

Appendix B: Other Independent Variables Considered

A variety of independent variables were considered for inclusion in the regression models. The following text lists variables that were at one point used in the multivariate regressions, and describes the reasons for the removal of these variables in the final models.

- **Research and Evaluation** – While we included a combined "Research and Evaluation" variable in the final model, we also tested for the separate influence of each variable; neither individual variable was found to be significant. We chose to combine the two to ensure a higher standard for determining whether a utility had performed critical analysis of its program.
- **Renewable Portfolio Standard** – We considered including a variable representing whether a utility was required by state law to purchase renewable energy. Some stakeholders have suggested that such a mandate may affect the success of the green market. Only six utilities that responded to the questionnaire had to abide by such a policy, however, ensuring that this variable would not be found to be statistically significant.
- **Marketing Activity** – We considered multiple variables to try to represent marketing activity, ultimately selecting the "Marketing Repetition" variable included in the final model. One approach that we considered was a dummy variable that signified if a utility had used bill stuffers, direct mail, *and* newsletters to market their program. This variable could not distinguish between different quantities of these mailings, however, and could not compensate for small utilities that do not have the capability to undertake all three activities. Additional measures were also considered, but ultimately rejected as being inferior.
- **Multiple Green Pricing Programs** – Some utilities offer more than one green pricing program, and the provision of multiple programs may impact customer response. Only a few utilities responding to the questionnaire could be classified as having multiple programs, however, making the inclusion of this variable unnecessary.
- **Solar and Wind** – As an alternative to the "Biomass" dummy, we also considered dummies for wind or solar. The vast majority of green pricing programs include wind power, so including this variable had little value. A solar dummy was found to be statistically insignificant, and experienced colinearity with the "Cost Premium" variable.
- **No Fuel Surcharge** – This dummy signified if customers are exempt from fuel surcharges that non-green pricing customers are required to pay. Very few green pricing programs offer this benefit, so its significance as an independent explanatory variable was small.
- **Independent Certification** – We considered including a variable indicating whether a program was certified by the Green-e program, operated by the Center for Resource Solutions.[20] Few programs were certified by Green-e at the time, however, so this variable was excluded from the final analysis.
- **Mandated Green Pricing Programs** – Some green pricing programs are mandated by state law, and a dummy was considered to assess whether such requirements have an effect on participation. There was very strong correlation between this and the "Program Length" variable, so to remove colinearity problems this variable was removed.

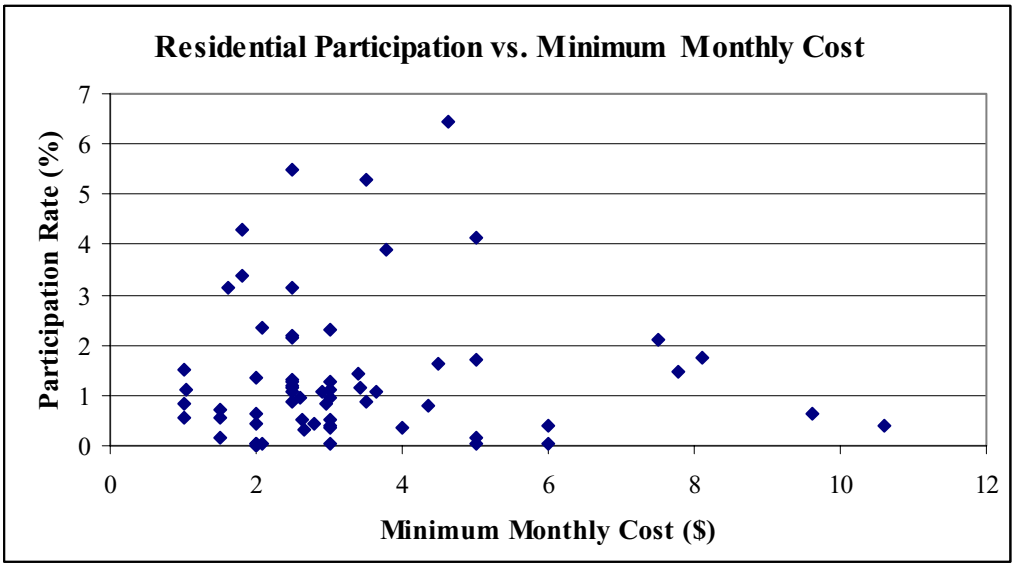
[20] http://www.green-e.org/

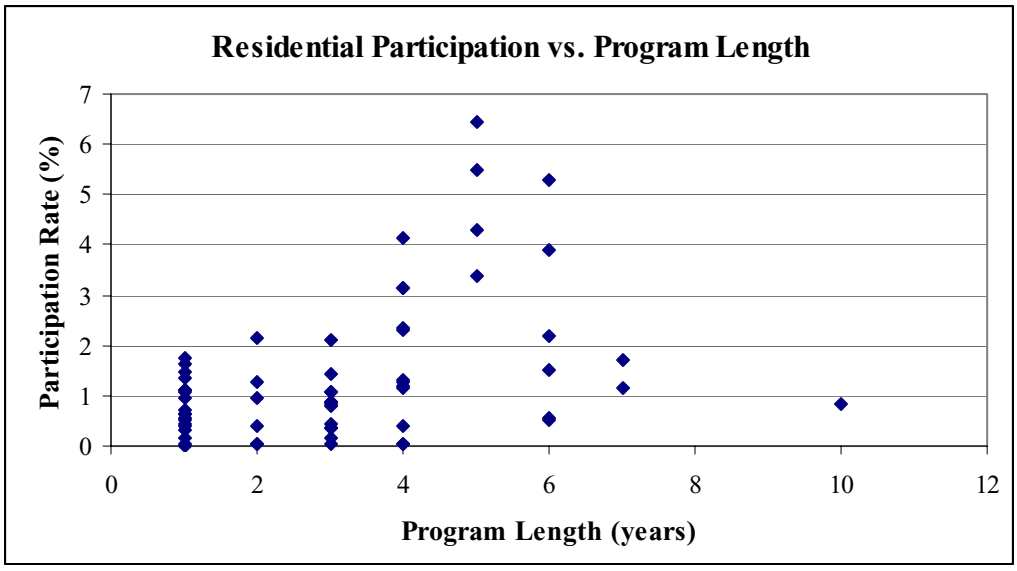
Appendix C: Further Detail on Bivariate Results

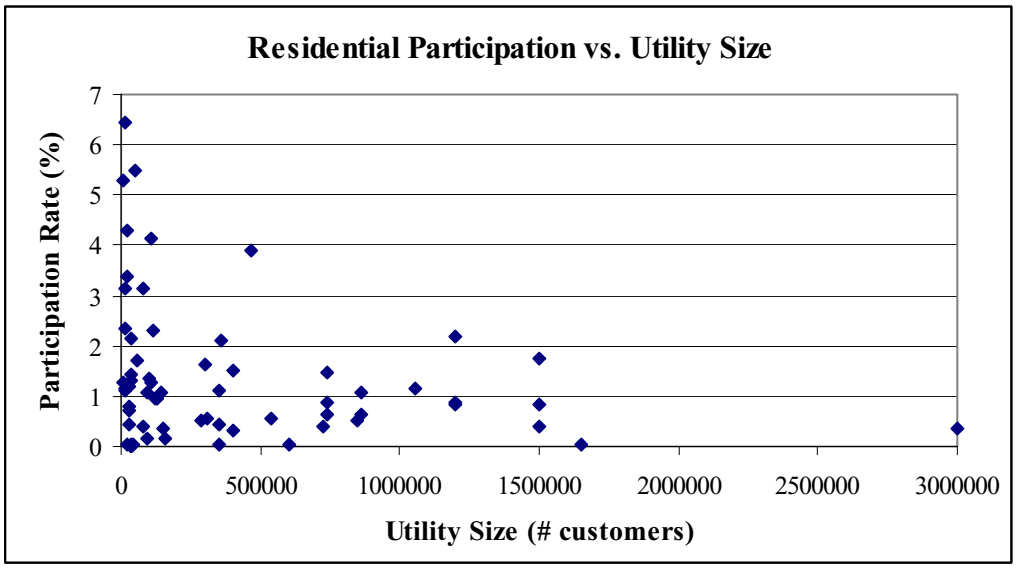
Included below are select additional results from the bivariate analysis presented in the body of the report.

Residential Customer Analysis

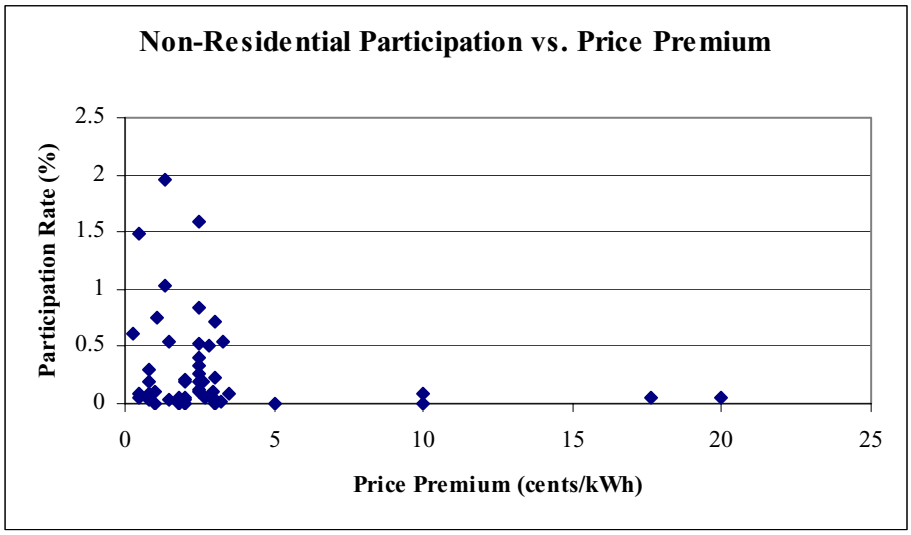
	Average Residential Participation Rate	Average Residential Renewable Energy Purchase Percentage
IOUs	0.97%	0.26%
non-IOUs	1.62%	0.66%
High Purchase Threshold (>200kWh or 25%)	2.02%	1.17%
Low Purchase Threshold (<200kWh or 25%)	1.21%	0.32%
Contribution Programs	1.10%	0.47%
Energy-Based Programs	1.44%	0.53%

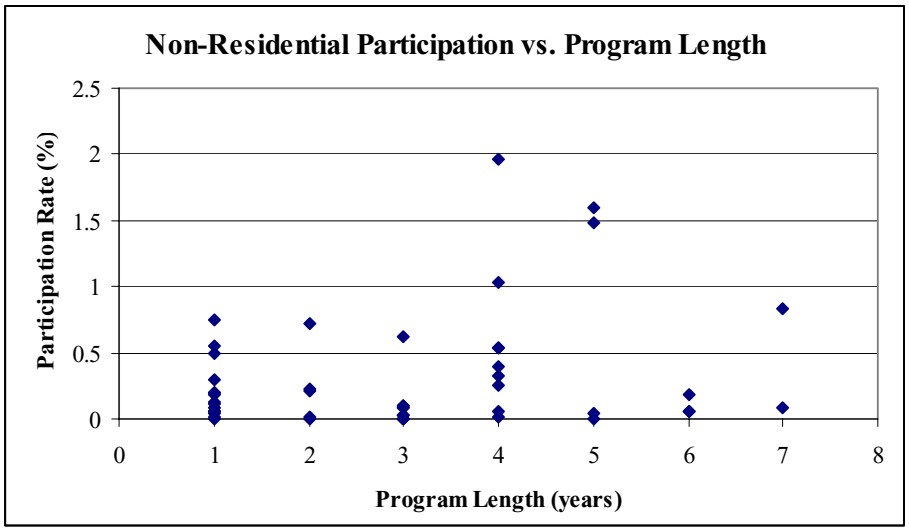


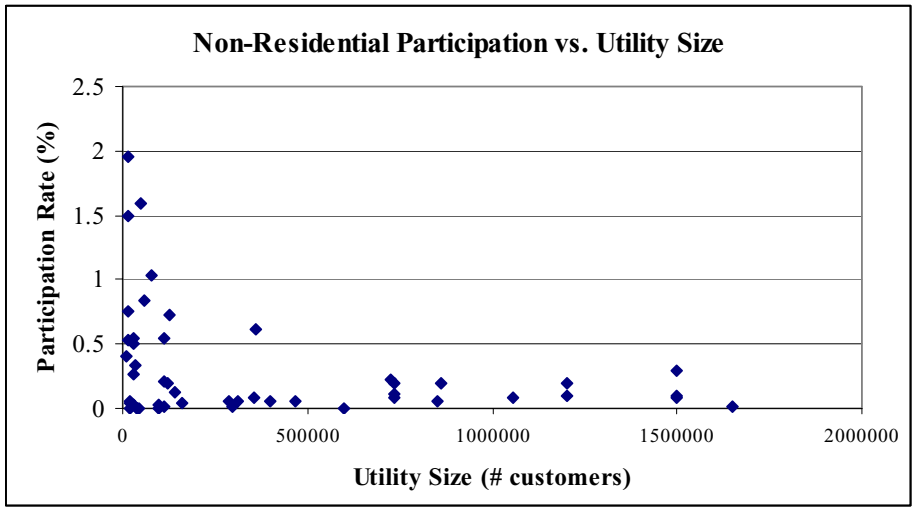

Residential Participation vs. Program Length
Participation Rate (%)
0
1
2
3
4
5
6
7
0
2
4
6
8
10
12
Program Length (years)


Residential Participation vs. Utility Size
Participation Rate (%)
0
1
2
3
4
5
6
7
0
500000
1000000
1500000
2000000
2500000
3000000
Utility Size (# customers)

Non-Residential Customer Analysis







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This report analyzes actual utility green pricing program data to provide further insight into which program features might help maximize both customer participation in green pricing programs and the amount of renewable energy purchased by customers in those programs

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