Advertising, Customer Awareness and Energy Conserving Behaviour

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This paper reports on the impact of B. C. Hydro's Power Smart communications initiative. The issues examined include: effect of advertising on customer awareness of Power Smart; identification of key product and behaviour segments and extent of market penetration by segment; and impact of energy efficient behaviors and purchases on energy consumption. In analyzing these issues, a multiple lines of evidence approach was used, drawing on a series of longitudinal customer surveys, end-use metering and engineering analysis. Three main data techniques were employed: time series modelling; market penetration analysis; and engineering algorithms. Key results included the following. First, time series modelling was able to identify and quantify the effects of successive communications campaigns on customer awareness. Second, changes in market penetration associated with the program ranged from a low of one percent to a high of thirteen percent, depending on the measure, over two years. Third, energy savings were estimated at about 20 GW.h per year.

INTRODUCTION

As funding for incentive-based demand-side management activities declines in the face of competitive pressures in utilities markets, the alternative of information, marketing and education activities will become more important. These soft approaches to market transformation may have the potential to significantly affect energy use without significantly increasing energy bills.

A number of recent papers have explored various dimensions of energy-efficient information, education and marketing. Hanson and Siegel (1995) demonstrated that implementation of the eight units of the Energy Source Education Program had a dramatic overall effect on energy interest, knowledge and conservation behaviour among elementary school students. Sabo, Reed and Erickson (1995), comparing households which cited environmental benefits as reason for participating in an energy conservation program with households which did not, found that environmentally aware households expressed greater confidence in the value of energy efficiency recommendations. Harrigan and Gregory (1994) concluded that when education and a setback thermometer were added to a residential weatherization program, savings increased significantly above those for the group receiving an alternative treatment of weatherization measures only. Relevant literature is surveyed in Lutzenhiser (1993).

The articles cited above either compare a treatment with a control group or use two treatment groups to determine the impacts of soft approaches to transforming energy consumption patterns. However, when an advertising or education campaign is directed at all of a utility's residential customers, finding an appropriate comparison group may be difficult and expensive. Auch and McDonald (1994) is one of the few studies to examine a utility advertising campaign in detail. Their study used a baseline survey and two annual tracking surveys on customer attitudes and behaviors to assess the effects of a comprehensive advertising campaign at Puget Sound Power and Light.

The present paper extends this line of research through an examination of B. C. Hydro's Power Smart communications program. The paper examines three related issues: the effect of B. C. Hydro's Power Smart advertising campaign on residential customer awareness of Power Smart; the identification of key product and behaviour segments and the extent of market penetration by segment; and the impact of energy-efficient behaviors and purchases on residential energy consumption.

BACKGROUND AND METHODOLOGY

In 1989, B. C. Hydro began a new communication initiative as part of its Power Smart program. A key objective of Power Smart was to promote the efficient use of energy by the utility's customers. The focus of the communications strategy was on raising awareness of energy conservation issues, changing attitudes towards energy consumption and encouraging energy-efficient behaviors.

Power Smart's advertising promotes energy efficiency through a variety of communications vehicles. These include television and radio broadcasting; radio, magazine and newspaper advertisements; bill stuffers and other printed material; displays and information kiosks; and a variety of other mechanisms. The rationale for the advertising program is that

without continued communication support, customer awareness of energy efficiency will dissipate over time. The budget for communications and advertising has been around three million Canadian dollars per year, but most of this expenditure has been in support of individual Power Smart programs. General television campaigns, which are the most relevant activity for the purposes at hand, have been relatively modest at about one-half million Canadian dollars per year.

A review of program documentation and relevant literature together with interviews with program staff identified three key issues to be examined in this study. In brief, these issues included the following:

- assess the effect of advertising on customer awareness of Power Smart;
- identify key segments and the extent of market penetration for each;
- estimate the impact of behaviors and purchases on energy consumption.

A multiple lines of evidence approach was used in this study. Evaluation issues, data sources and methodologies for the work are summarized in Table 1. The study uses three major data analysis techniques: statistical modelling, market penetration analysis, and engineering algorithms. Different data sources were used for the different analyses.

Statistical modelling was used to examine the determinants of unaided and total awareness of Power Smart, in particular the effect of alternative advertising strategies. To determine unaided awareness of Power Smart, survey respondents were asked general questions about energy efficiency to see if the name Power Smart would surface in their responses. This was felt to be a useful, albeit general, indicator of the level of awareness of energy efficiency. Total awareness was determined by asking respondents if they were familiar with Power Smart and asking what images the term brought to mind. A number of detailed questions were also asked, but there wasn't enough consistency across surveys to allow for more specific indicators to be tracked over time. Both ordinary least squares and maximum likelihood estimation were used to fit a variety of regression models.

Data sources for the statistical modelling included semi-annual advertising tracking studies, the continuous advertising tracking studies which replaced them and program records and documentation. Twelve semi-annual observations were available for this analysis. Each of the twelve semi-annual observations was based on about 1440 respondents surveyed in the relevant period. The sampling frame for these surveys is the set of all residential customers not surveyed within the previous twelve months. The demographic characteristics of the survey respondents is similar enough to that of the residential customer population that non-response bias is not viewed as an issue. It should be noted, however, that twelve observations is a fairly short time series for this type of regression discontinuity model, and it would be useful to repeat the analysis as more observations are available.

The key point of the market penetration analysis was to estimate the change in ''market share'' for energy efficient products and behaviors. The initial step was to determine which energy using products should be examined. This was based mainly on data availability, although all critical areas were covered. Change in market share was then defined as the difference between pre-treatment and post-treatment shares, adjusted for changes due to Power Smart incentive programs. Penetration due to Power Smart programs was on a net basis, ie. gross penetration adjusted for free riders and free drivers.

Data sources for the market penetration analysis included a 1990 tracking study used as a pre-treatment baseline, the

Table 1. *Evaluation Issues, Data Sources and Methodologies*

Evaluation issue	Data sources	Methodologies
Effect of advertising on unaided awareness of Power Smart	Semi-annual advertising tracking studies Program records	Regression modelling
Identification of market segments and extent of market penetration by segment	Semi-annual advertising tracking studies Appliance saturation studies Program records Program evaluations	Market penetration analysis
Impact of energy-efficient behaviors and purchases	Program evaluations Conservation Potential Review	Engineering algorithms

1992 monitoring project survey used for post-treatment observations, Power Smart program evaluations used for penetration of Power Smart rebate activities and program records for background and information on advertising strategies. The surveys each included some 3000 respondents. A stratified random sample was used with the strata including housing types (single family, duplex, multi-family and other), geographical region (Northern, Southern Interior, Lower Mainland and Vancouver Island) and main space heating fuel (electricity and other). Market penetration rates for each energy efficient purchase or behaviour was calculated for each cell in the sampling frame. Appropriate weights were then used to estimate the market penetration rates for the population as a whole. This should minimize the potential impact for non-response bias.

Simple engineering algorithms were used to estimate changes in energy consumption associated with changes in market penetration. These algorithms used information on the stock of relevant residential homes, changes in penetration and net energy savings per unit to estimate total impact on energy consumption for each measure or behaviour examined. Consideration was given to the alternative of using weather adjusted billing data to estimate changes in energy consumption. However, this idea was not followed up because the expected changes in consumption for some measures was expected to be too small to be identifiable with billing analysis.

Data sources here included the findings of a variety of B. C. Hydro impact evaluations for per unit energy savings, the market penetration analysis described just above for changes in market penetration rates, and Power Smart data for the number of households in the various categories of houses by fuel types. Power Smart evaluations, which are the source of the unit savings estimates, utilized on-site metering, regression analysis, and survey data to generate gross and net per unit savings estimates for retrofit measures. The Conservation Potential Review (1994) was the source of savings estimates for behavioral changes.

RESULTS

For purposes of this work it is useful to divide the history of Power Smart's general communications into four periods as shown in Table 2. This table also indicates the level of total and unaided awareness of Power Smart achieved at the end of the period. Period 1 (up to March 1989) is the pre-Power Smart period. As indicated in Table 2, unaided awareness of Power Smart was negligible as expected at the time of program launch. Period 2 (April 1989–July 1990) is the initial period of television support. Major campaigns for this period included ''The Good Life'', ''Quality Plus Homes'', a series of fifteen second ''Shorts'', and incentive offers. Period 3 (August 1990–March 1993) featured Power Smart Night, ''Pulling the Plug'', and a series of fifteen second ''Do Your Part'' television commercials, again with continued advertising of incentive offers. Period 4 (April 1993–April 1995) featured ''Hole in the Wall'', three shorter fifteen second ''Tips'', and advertising for the incentive offers.

A variety of regression models were fitted using unaided and total awareness of Power Smart as the dependent variable. A review of program documents and interviews with staff suggested that the key determinants of the level of awareness of Power Smart were: first, a time related variable to account for gradual dissemination of the Power Smart message; and, second, indicator variables for the key campaigns, of which Power Smart Night and the Hole in the Wall advertising campaign were the most important. To save space, only the

Table 2. *Major Advertising Campaigns and Power Smart Awareness*

Period covered	Main campaigns	Unaided awareness	Total awareness
Pre-launch benchmark (survey Dec. 88)	Not applicable	1%	15%
April 89-July 90 (survey July 90)	The Good Life Q Plus Homes Shorts	11%	71%
Aug. 90–Mar. 93 (survey Feb. 93)	Power Smart Night Pulling the Plug Do Your Part	48%	94%
April 93–April 95 (survey April 95)	Hole in the Wall Tips	51%	92%

results of the regressions for unaided awareness are shown here, but results for total awareness are similar. Results for the regressions using total awareness as the dependent variable are available from the authors. Definitions of the variables employed in the regression analysis and sample characteristics are presented in Table 3.

Table 4 provides the results of the initial ordinary least squares regressions. The standard errors for the coefficients are shown in parentheses below the relevant coefficient. The adjusted R^2 and F values which are conventional measures of goodness of fit are also shown. Model 1 regresses the level of unaided awareness on time and a constant, and can thus be viewed as a simple diffusion model. The model has a good fit with a highly significant coefficient on the variable Time and an R^2 of about 0.73. Model 2 adds a dummy variable for Power Smart Night. The explanatory power of the equation is increased substantially with an R^2 of about .89. The coefficient on Power Smart Night is significant at the 1 percent level and has a positive sign as expected. Model 3 adds a dummy variable for Hole in the Wall. Again, the explanatory power of the Model increases compared to Model 2, but rather surprising The Hole in the Wall variable has a negative and significant sign. This may be due to the fact that individual campaigns reflect changes in delivery vehicles for communications rather than increases in expenditures, which remained fairly flat for the period covered. That is, Power Smart Night was relatively effective compared to the messages it replaced (The Good Life, Shorts), while Hole in the Wall was relatively ineffective compared to the messages it replaced (Pulling the Plug, Do Your Part). Alternatively, the level of unaided awareness may be asymptotically approaching a maximum value, so that the relative effectiveness of Hole in the Wall is underestimated compared to the effect it would have had if used earlier in the campaign.

Table 3. *Definition of Variables and Sample Characteristics*

Variable	Definition
Unaided	Percentage of survey respondents with unaided awareness of Power Smart (mean = 31.7; st. dev. = 19.1)
Time	Date of survey in years measured from baseline survey of December 1988 (mean = 2.75; st. dev. = 1.80)
Power Smart Night	Dummy variable for post Power Smart Night campaign (mean = .417; st. dev. = .515)
Hole in the Wall	Dummy variable for post Hole in the Wall television campaign (mean = .250; st. dev. = .452)

Table 4. *Determinants of Unaided Awareness: OLS Results*

Variable	Model 1	Model 2	Model 3
Constant	6.321 (5.342)	4.979 (3.489)	1.853 (3.471)
Time	9.217*** (1.645)	3.362 (1.865)	7.529** (2.723)
Power Smart Night	–	26.165*** (6.828)	18.559** (7.191)
Hole in the Wall	–	–	−13.059* (6.816)
Adjusted R^2	.734	.888	.914
F	31.38 (.000)	44.51 (.000)	39.20 (.000)
DW	1.537	2.345	2.552
Rho	.231	−.172	−.276

Figures in parentheses are standard errors for regression coefficients and probability values for F statistics. Degrees of freedom are (1,10) for Model 1, (2,9) for Model 2 and (3,8) for Model 3. Significance levels are represented by * at the 10% level, ** at the 5% level and *** at the 1% level. DW is the Durbin-Watson statistic and Rho is the estimated autocorrelation.

One statistical problem is present in the equations in Table 4. The Durbin-Watson statistics suggest the possible presence of autocorrelation in the residuals. In other words, the residuals may be correlated over time rather than being independent, identically distributed white noise series as assumed for the ordinary least squares regressions. Table 5 shows the results of the maximum likelihood regressions using a first order autocorrelation scheme. The method of Beach and MacKinnon (1978) is used. Inspection of Models 4, 5 and 6 suggests that use of the first order autocorrelation scheme has successfully deal with the problem. Comparing the results in Tables 4 and 5 on a model-by-model basis,

Table 5. *Determinants of Unaided Awareness: Maximum Likelihood Results*

Variable	Model 4	Model 5	Model 6
Constant	5.390 (6.245)	5.555** (2.692)	2.522 (2.386)
Time	9.311*** (1.900)	2.989* (1.540)	7.349*** (2.207)
Power Smart Night	–	26.760*** (5.650)	17.931*** (5.642)
Hole in the Wall	–	–	−12.782** (5.299)
Iterations	2	3	3
Log-likelihood	−43.09	−37.09	−34.01
DW[e(t)]	1.536	2.338	2.565
Rho[e(t)]	.207	−.301	−.492
DW[u(t)]	2.137	2.256	2.127
Rho[u(t)]	−.068	−.128	−.064

Figures in parentheses are standard errors for regression coefficients. The Durbin-Watson statistic and the estimated autocorrelation for the original residuals are given by DW[e(t)] and Rho[e(t)] and for the transformed residuals by DW[u(t)] and Rho[u(t)] respectively. Significance levels are represented by * at the 10% level, ** at the 5 percent level and *** at the 1% level.

the coefficients have the same signs for both the ordinary least squares and maximum likelihood regressions, and the magnitudes of the coefficients are quite similar. In, particular, the sign of the coefficient for Hole in the Wall is still negative and significant.

Market penetration rates for important hard and soft customer behaviors are shown in Table 6. Hard measures involve retrofits and are the first seven measures listed. Soft measures involve behavioral change and are the last three measures listed. For each measure examined, the market penetration rates for 1990 and 1992 are shown based on information from B. C. Hydro residential customer surveys as described above. The results reported here are for the whole residential customer population, based on the appropriate weights for each of the underlying cells.

Net change in penetration is defined as [(penetration rate in the 1992 survey) minus (penetration rate in the 1990 survey) minus (increased penetration due to Power Smart programs)]. This formulation implicitly assumes that there would be no significant change in penetration in the absence of Power Smart advertising and program activities. Since examination of previous surveys indicated that there was no significant movement in penetration rates in the period prior to the years covered by the analysis, this assumption seems plausible, but it must be recognized that it is quite a strong assumption. Several neighbouring utilities were queried to determine if they had a series of similar surveys, which would allow them to be used as comparison groups, but no suitable source of data was found.

Over the two years between surveys, changes in penetration rates for the behaviors examined varied substantially from a high of thirteen percent for draft proofing measures to a low of one percent for installation of water heater blankets and turning lights off when leaving the room. For each measure, there was an increase in the penetration rate. Generally, the improvement in the penetration rate was greater for hard measures involving retrofit activity than for soft measures involving modification of behaviors. Although the numerical differences in penetration rates are sometimes small, they are each statistically significant at the one percent level. This is due, in part, to the fact that the larger sample sizes reduce the estimated variance of the difference.

Estimated reduction in residential energy consumption for each of the measures is shown in Table 7. In each category, savings over the two year period are equal to [(unit savings for the measure) times (the number of houses relevant for that measures) times (the net change in the share)]. For example, in the case of draftproofing, the unit savings per house draftproofed were determined to about 216 kW.h per year from previous research, some 231,000 homes in B. C. Hydro's service territory had electric space heating, and the net change in penetration is thirteen percent from the previous table. Savings by category varied substantially from 17.6 GW.h per two years for insulation to a low of 0.5 GW.h per two years for aerators.

SUMMARY AND CONCLUSIONS

This paper has examined three related issues: effect of advertising on unaided awareness of Power Smart; identification of key market segments and extent of market penetration by segment; and impact of energy-efficient behaviors and purchases on energy consumption. In analyzing these issues, a multiple lines of evidence approach was used drawing on a series of longitudinal surveys. Key results include the following. First, time series modelling was able to identify and quantify the effects of successive communications cam-

Table 6. *Market Penetration for Conservation Measures and Behaviors (percentages)*

Measure or behaviour	1990 survey	1992 survey	Other DSM programs	Net change
Draft proofing	54	69	2	13
Insulation	49	56	2	5
Windows/doors	49	56	2	5
Controls	13	17	1	3
Lowflow showerheads	37	45	6	2
Faucet aerators	29	37	6	2
Water heater blankets	9	13	3	1
Heater thermostat setback	75	77	–	2
Lights off	90	91	–	1
Dishwasher, no dry	31	33	–	2

Table 7. *Energy Savings for Conservation Measures and Behaviors*

Measure or behaviour	Unitsavings (kW.h/yr.) (1)	No. homes (thousands) (2)	Net change (share) (3)	Savings (GW.h.) (4)
Draftproofing	216	231	.13	6.486
Insulation	1526	231	.05	17.624
Windows/doors	632	231	.05	7.300
Controls	208	231	.03	1.442
Lowflow showerheads	290	435	.02	2.523
Faucet aerators	57	435	.02	.496
Water heater blankets	208	435	.01	.905
Heater thermostat setback	277	231	.02	1.280
Lights off	52	1138	.01	.592
Dishwasher, no dry	84	645	.02	1.084
Total (1991 and 1992)				39.732

paigns on customer awareness. Here having an on-going program of communications tracking was essential for undertaking the analysis. Second, changes in market penetration of energy efficient behaviors ranged from about one percent to about thirteen percent over the two years covered by the study. Hard measures, such as the installation of insulation or draftproofing, seem to have been influenced more by general advertising activities, than have soft measures, such as thermostat setback or not using the dry cycle in a dishwasher. Third, energy savings associated with the program were about 20 GW.h per year. This is a quite significant result given the relatively modest expenditures for non-program specific communications.

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