A Unified Approach to the Estimation of the Free Ridership and Spillover Components of Net Savings

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It is often difficult to measure each of the components that comprise DSM program savings; particularly, naturally occurring savings, free ridership, and spillover impacts. This paper describes a methodology that allows the isolation of each of these impacts. By using two distinct discrete choice modeling techniques in tandem, estimates of naturally occurring savings, free ridership, participant spillover impacts, and the net-to-gross ratios can be derived. The method is applied to the Pacific Gas & Electric Co. CIA Retrofit rebate program and the results and implications of the methodology are discussed.

Introduction

Many utilities offer customers rebates for the implementation of energy conservation measures. The rebates are designed to stimulate the adoption of energy efficient technologies, which help reduce energy use. The energy savings associated with these programs are defined as follows:

- **Gross Savings** of the program are represented by the total energy savings from rebated measures installed as part of the rebate program.

- **Total Savings** with the program include both the savings that occur within the program (gross savings) and savings that occur from measures installed outside of the program.

- **Free Rider Savings** are the savings that occur as gross savings, that would have occurred without the program. Some customers would implement measures without rebates, but accept them because they are offered.

- **Naturally Occurring Savings** are the savings which would occur if the program did not exist. They are a combination of the free rider savings and savings which occur outside of the program.

- **Spillover Savings** are the additional energy savings induced in those customers who implement measures and do not receive rebates that are the direct or indirect result of the program. They may be attributed to program-related publicity and education efforts which increase awareness in energy efficiency, or may occur as vendors shift their equipment stock to meet changing demand.

- **Net Savings** are the savings which are attributable to the program. They can be defined in two ways.

  Net Savings = Gross Savings - Free Rider Savings + Spillover Savings, and
  Net Savings = Total Savings - Naturally Occurring Savings.

This implies:

Total Savings = Gross Savings - Free Rider Savings + Spillover Savings + Naturally Occurring Savings.

Finally, the Net-to-Gross Ratio is the proportion of gross savings which are attributable to the rebate program.

Net-to-Gross = Net Savings/Gross Savings.

For regulatory and planning purposes, utilities are often interested in untangling the various components that comprise DSM program savings. To accomplish this, it is necessary to understand the choices customers have made and why they have made them. In this paper, we describe a procedure to estimate technology adoption and program participation. We utilized two distinct discrete choice modeling techniques to isolate and estimate naturally occurring savings, free ridership, spillover impacts, and the net-to-gross ratio. This method has been applied to the Pacific Gas & Electric Company's (PG&E) Commercial, Industrial, and Agricultural (CIA) retrofit program.

PG&E's CIA customers were offered a rebate program (treatment group) and had three options available. They could have chosen to not implement measures, implement measures without a rebate, or implement measures with a rebate. A three-choice nested logit model was used to estimate their decision process, and derive estimates of gross and total program savings that exclude spillover impacts. The model was then used to simulate the decision process when the option of receiving a rebate was not available. This allows an estimate of the naturally occurring savings. Net savings are then calculated as the difference between total savings with the program and the naturally occurring savings. A net-to-gross ratio can also be derived which necessarily excludes spillover impacts. Because spillover is excluded, the free ridership can be calculated as one minus the net-to-gross.

Municipal electric CIA customers, embedded in and surrounding PG&E's service territory were not offered a similar rebate program (control group) and had only two options available. They could have chosen to implement measures, or not implement measures. No rebate option was available. A binary logit model was used to estimate the implementation decisions of the treatment and control group combined, with a treatment group indicator variable to capture the program effect. As with the three-choice model, the model was used to simulate behavior without the rebate program. Estimates of the total savings with and without the program were calculated. The difference is the net program savings with spillover impacts included. A net-to-gross with spillover can be estimated. Spillover can then be isolated by subtracting the first net-to-gross ratio from the second.

A full discussion of the methodology and data are given in the next section followed by the results. The Conclusions section addresses some conclusions about the strengths and weaknesses of the methodology.

Methodology

Modeling Approach

Discrete choice models can be used to estimate the probability of a customer choosing one of their available alternatives. For the treatment group (PG&E customers) these options were:

1a. Not implementing conservation measures;

2a. Implementing conservation measures without a rebate; or

3a. Implementing conservation measures with a rebate.

The control group (municipal customers) had fewer options. Their choices included:

lb. Not implementing conservation measures; or

2b. Implementing conservation measures (without a rebate).

Customers choose the alternative that offers the greatest overall benefit or utility. This includes a combination of economic and other factors. We would expect that the savings, the cost and the rebate associated with implementing measures would all influence a customer's choice among alternatives. In addition, the inconvenience of implementing measures, and potentially the visual or audible aesthetic appeal of the conservation measures, in comparison to existing equipment, may affect the decision process. There are likely other unmeasurable effects as well.

Three-Choice Model of Measure Implementation and Program Participation. Customers offered rebate programs choose among three alternatives, 1a (do not implement measures), 2a (implement measures without a rebate), and 3a (implement measures with a rebate). Because alternatives 2a and 3a are similar in that both entail the decision to implement a measure, it is necessary to use a model structure that accounts for the similarity of options. A nested logit structure accounts for such similarity between options. [1]

The utility of selecting each alternative is specified as linear function of influential factors. Specifically,

$U_i = B_{0i} + B_{1i}x_1 + B_{2i}x_2 + \ldots + B_{ni}x_n$ for i= la, 2a, or 3a, (where $x1..x_n$ are variables which influence the utility of each alternative).

Each of the three alternatives is not necessarily influenced by all variables which impact the choice. For instance, the savings associated with implementing a conservation measure impacts the utilities of implementing without a rebate (U_{2a}) and implementing with a rebate (U_{3a}) in relation to the utility of not implementing (U_{1a}), as it influences the decision to implement or not implement. Similarly, the size of the rebate offered influences the utility of implementing with a rebate (U_{3a}) in relation to not implementing (U_{1a}), but is unlikely to influence the decision to implement measures without a rebate (U_{2a}).

The coefficients B_{0i}. .B_{ni} are estimated through a simultaneous nested logit estimation procedure. Based on the utility of each option, the probability of selecting the option can be estimated as follows:

$P(1a) = e^{U1a}/e^{U1a}+e^{g*logsum}$,
$P(2a) = P(2a)'*(1-P(1a))$, and
$P(3a) = P(3a)'*(1-P(1a))$, where

$P(2a)' = e^{U2a}/e^{U2a}+e^{U3a}$,
$P(3a)' = e^{U3a}/e^{U2a}+e^{U3a}$,
logsum $= \log(e^{u2a}+e^{u3a})$, and g is the coefficient which captures the difference between alternatives 2a and 3a. The similarity between the two options can be represented as (l-g).

Thus for each customer, we can estimate the likelihood of choosing each of the three alternatives. With these probabilities, we can estimate several components of savings.

For i customers:

Gross Savings $= \Sigma_{(all\ i)} P(3a|1a,2a,3a)_i*Savings_i$, (where P(3a|1a,2a,3a) is the probability of implementing with a rebate when all three options are available, and $Savings_i$ is the estimated savings for implementing the conservation measure).

Total Savings $= \Sigma_{(all\ i)} (P(2a|1a,2a,3a)_i+ P(3a|la,2a,3a)_i)*Savings_i$, (where P(2a|la,2a,3a)i is the probability of implementing without a rebate when all three options are available).

If we remove the possibility of choosing alternative 3a, we can simulate the probability of customers choosing between alternatives la and 2a and estimate the naturally occurring savings.

Naturally Occurring (NOC) Savings $= \Sigma_{(all\ i)} P(2a|la,2a)_i*Savings_i$, (where P(2a|la,2a)i is the probability of implementing a measure when the rebate option is not available).

Net savings are then estimated by subtracting the naturally occurring savings (that which would have occurred without the program) from the total savings which occurred with the program. That is:

Net Savings = Total Savings - Naturally Occurring Savings.

The Net-to-Gross ratio can then be estimated by dividing net savings by the gross savings. That is:

Net-to-Gross = Net Savings/Gross Savings.

If spillover exists, it will result in an increase in P(2a), because the chances of implementing measures outside of the program is enhanced. Therefore, when we estimate the total savings, it includes spillover impacts. Also, when we estimate naturally occurring savings, spillover impacts are included. This is true because customers who choose alternative 2a when the rebate is available, will still choose it if the rebate is not available. This overstates the naturally occurring savings by the amount of the spillover impacts, because spillover impacts would be denoted as customers choosing alternative 2a. Total savings and naturally occurring savings could be represented as follows:

Total Program Savings = Net Program Saving + Actual NOC Savings + Spillover Savings, and
Estimated NOC Savings = Actual NOC Savings + Spillover Savings.

When we subtract the estimated NOC Savings from the Total Program Savings, the Spillover Savings are removed. The Gross Savings are the result of only measures implemented as part of the program, so by definition they cannot include Spillover Savings. As a result, we have a Net-to-Gross ratio which is free from spillover impacts. Because of this, we can subtract the Net-to-Gross ratio from one and estimate the free ridership.

Two-Choice Model of Measure Implementation. The two-choice model specification is much simpler. It is a standard binary logit model. Customers are allowed to choose between two alternatives lb (not implementing measures), or 2b (implementing measures). For this approach, the decisions of both treatment group customers (those eligible for rebates), and control group customers (those not eligible for rebates) are used. In this case there are only two utility functions. U_{1b} is the utility of choosing alternative lb and U_{2b} is the utility of choosing alternative 2b.

To capture the rebate program impact, a program dummy variable is included in the utility of implementing measures. The variable has a value of one when the customer is a member of the treatment group, and zero when the customer is part of the control group. Thus, the estimated coefficient for this variable gives an indication of the program impact. The probabilities of choosing alternatives lb or 2b are:

$P(1b) = e^{U1b}/e^{U1b} + e^{U2b}$, and
$P(2b) = e^{U2b}/e^{U1b} + e^{U2b}$.

In this case, the total savings with the program is specified as follows:

For i customers:

Total Savings With Program $= \Sigma_{(all\ i)} P(2b|_{pa})_i$*Savings$_i$, (where $P(2b|_{pa})$ is the probability of Implementing measures with the program impact included).

The total savings without the program can be estimated by removing the program dummy variable from U_{2b} and re-calculating the probabilities of implementing and not implementing measures. So,

Total Savings Without Program = $\Sigma_{(all\ i)} P(2b|_{pna})_i$*Savings$_i$, (where $P(2b|_{pna})$ is the probability of implementing measures with the program impact excluded).

Net program savings can then be calculated as the difference between the total savings with and without the program.

Net Savings = Total Savings With Program-Total Savings Without Program.

This model does not directly and separately estimate the Gross Savings, as customers who implement with rebates are imbedded with those who implemented without rebates and control group customers who had no rebate option. However, we can determine the percentage of treatment group customers who receive a rebate for a measure, given that they are implementing a measure. Gross Savings are then estimated as the probability of implementing and receiving a rebate times the savings. That is:

Gross Savings $= \Sigma_{(all\ i)} [P(rebate|_{imp})_i * P(2b|_{pa})_i *$ Savings$_i$ (where P(rebate|imp) is the probability of receiving a rebate given that the customer implemented a measure).

The Net-to-Gross ratio is then calculated as follows:

Net-to-Gross = Net Savings/Gross Savings.

Because the program impact dummy measures all program impacts, including spillover, the Total Savings with the program includes Spillover Savings. Furthermore, since the Total Savings without the program was calculated by removing the program dummy, spillover impacts are removed. Thus, the Net Savings include Spillover Savings. By subtracting the Net-to-Gross without spillover from the Net-to-Gross with spillover, we can determine the Spillover/Gross ratio. We can multiply the estimate of Spillover/Gross times the estimate of Gross savings to derive Spillover Savings.

With the Spillover Savings, we can also find a pure estimate of NOC Savings. We know Net Savings/Gross Savings and Spillover/Gross Savings, and we can compute the Total Program Savings/Gross Savings. Since Total Program Savings is equal to the sum of Net Savings, Spillover Savings, and NOC Savings, we can subtract the Net Savings/Gross Savings and the Spillover Savings/ Gross Savings from the Total Savings/Gross Saving to derive a NOC Savings/Gross Savings ratio.

Thus through the combination of the two methods, we can derive estimates of the Gross Savings, Total Savings with the program, Naturally Occurring Savings, Net Savings, Spillover Savings, and Net-to-Gross Ratio.[2]

Data Collection

In order to properly model the customers' decision-making process, it was necessary to have accurate data that indicated not only which measures were implemented, but also which measures could have been implemented and were not. On-site visits were conducted to gather the information. Inspections determined current equipment and equipment changes since the inception of the program. In addition, a survey was administered during the visit to gather customer characteristics and attributes as well as business and building descriptors. Finally, it was determined if any installations were done as part of the utility's retrofit rebate program.

The on-site audit data were gathered for 1,416 sites, 926 of which were for customers within the PG&E service territory who were eligible for the rebate program, and 490 which were not. The sites within the service territory represent the treatment group of businesses exposed to the CIA retrofit program. Those sites outside the service territory are the control group who had no similar program offered. Neighboring municipal electric customers were chosen as the control group.

Each site was broken into "inventory groups" or collections of similar measures that would be affected by a retrofit decision. In total, there were a 9,840 inventory groups which represented different implementation decisions for all measures combined. For each inventory group it was determined if the customer chose to:

1. Not implement the conservation measure;
2. Implement the conservation measure without a rebate; or
3. Implement the conservation measure with the rebate (not available for the control group).

In addition, the cost of implementing measures, the savings from implementing the measure, and the rebate available were estimated.

Finally, because a stratified sampling plan was utilized to ensure adequate representation for those who chose each of the three alternatives, the observations were weighted to represent the actual saturations of each choice in the population. This weighting is essential to proper model estimation as the proportion of customers who choose each alternative will have a major impact on the B_0. (constant) coefficient, and subsequently other coefficients, in each of the utility functions. If the population used to estimate the logit models is not representative of the overall customer populations, the probability of choosing the alternatives will be incorrectly estimated, which in turn results in incorrect estimates of Total, NOC, and Gross Savings.

Results

Measures

In order to enhance the reliability of estimated models, different categories of conservation measures were modeled separately. Models were developed for the following:

- Conversion of lighting fixture types;
- Installation of lighting control devices;
- Upgrade of fluorescent lighting fixtures;
- Replacement of HVAC systems;
- Installation of HVAC control devices; and
- Maintenance of HVAC systems.

Estimates of the Net-to-Gross ratio were calculated for each measure category. An overall program Net-to-Gross ratio was then derived using a weighted average, based on the percentage of savings each measure contributed overall. These measures accounted for roughly 60 percent of the CIA program savings. Other measures were either too diverse to be modeled together or had minimal impacts individually.

Models were derived for all six measure categories. Since the approach was similar for all, only the lighting upgrade models will be presented as an example in this paper.[3]

Definition of Utility Functions

The utility functions for all models were specified as a series of differences between alternatives. Therefore, in the three-choice models, U_{1a} (the utility function of not implementing lighting upgrade measures) is set to zero. Variables which appear in both U_{2a} and U_{3a} are variables which will affect the decision to install. Variables which are found in only U_{3a} influence the decision to install with a rebate. Similarly, in the two-choice models, U_{1b} is set to zero. The variables which appear in U_{2b} influence the decision to implement measures.

There are also a few potential variations of these options for the three-choice models. Variables such as the net cost/savings ratio may appear in U_{2a} and U_{3a} with the same coefficient, but with slightly different variable definitions for the two functions. The net cost/savings ratio will be affected by the decision to accept a rebate, so in U_{2a} it is defined as cost/savings, while in U_{3a} it is (cost-rebate)/savings. Similarly, a variable may appear in both U_{2a} and U_{3a}, but with different coefficients. This means the variable will have an impact on both the implementation and rebate decisions, but will impact each differently. This particular variation was not found in any of the lighting upgrade models, but was found in the model specifications for other measure types. Similar variations are not possible in the two-choice model because there is only one alternative to not implementing measures.

Lighting Upgrade Models

Five different variables were used to model the implementation and rebate decisions in the lighting upgrade three-choice model. The variables and their definitions are listed in Table 1.

The net cost/savings ratio (cost/savings for implementing without a rebate and (cost-rebate) /savings for implementing with a rebate) is in both U_{2a} and U_{3a} (the implementation alternatives) with a negative coefficient as would be expected. As the relative cost rises in relation to the savings customers are less likely to implement lighting upgrade measures. If lighting upgrade measures were recommended by a repair person, sales person, or utility representative, there is an increased probability of implementing them either with or without a rebate. Similarly, if the customer knew the difference in energy use between high and low efficiency lighting measures, the probability of implementing the measures either with or without a rebate is increased. This is realized with positive coefficients for both variables in both U_{2a} and U_{3a}. Finally, two variables, if the customer was aware of the rebate program and if the customer had a utility account representative, affect the probability of implementing with a rebate. Knowledge of the program, and having an account representative each had positive coefficients in U_{3a}. The full model specification can be seen in Table 2. The resulting Net-to-Gross ratio without spillover impacts was .84.

Table 1. Lighting Upgrade Model Variable Descriptions

Variable Name	Description
Net Cost/Savings	= Net Cost/Savings, where net cost is the cost for implementing the measure without a rebate (appears in U_2), and the cost minus the rebate received for implementing with a rebate (appears in U_3). Cost is the incremental cost of implementing the measure over existing or alternative measures, and savings is the incremental savings over existing or alternative measures.
Net Cost/Savings *Treat	= Net Cost/Savings as above, enters only when the customer is part of the treatment group.
Account Rep	= 1 if the customer had a utility account representative, = 0 otherwise.
Recommend	= 1 if the customer received a recommendation from a repair or salesperson, or from a utility representative to improve lighting efficiency, = 0 otherwise.
Aware	= 1 if the customer was aware of the rebate program for lighting, = 0 otherwise.
KnowDiff	= 1 if the customer knew the difference in consumption between high- and low-efficiency lighting products, = 0 otherwise.
Program Impact	= 1 if the customer is a utility electric customer; that is the customer was exposed to the rebate program, = 0 otherwise.

There was some difficulty in deriving the two-choice implementation model, possibly because the control group was not entirely representative of the treatment group. It was suspected that there were behavioral differences that would influence the decision processes.[4] These differences had to be incorporated into the model to accurately predict customer decisions.

In general, the same variables used to model the three-choice implementation model were used in the two-choice model. Receiving recommendations, and knowing the difference in energy use between high and low efficiency measures each increased the likelihood of implementing lighting upgrade measures. The net cost/savings ratio is specified twice in the model, once for all observations, and again for just the utility customers (treatment group). Both variables have negative coefficients. This indicates that utility customers are even less likely to implement measures than control group customers as the relative cost increases in relation to the savings. This is one of the behavioral differences that we suspect but could not empirically test. Finally, a program impact variable enters with a positive coefficient. This is expected as it indicates that the program induces measure implementation. The final model specification can be seen in Table 3. The resulting Net-to-Gross ratio with spillover was estimated as .85. This indicates a very low spillover/gross ratio of .01 for lighting upgrade measures.

The t-ratios of the coefficient estimates are also shown for the models in Tables 2 and 3. These give an indication as to the significance of each of the variables. For the lighting upgrade models, the t-ratios are at least reasonable for nearly all coefficient values. In most cases they indicate at least 80 percent confidence that the values do not equal zero. This is not the case for all models however. Many variables which were thought to be important, such as the net cost/savings ratio and rebate size were often insignificant.

The weighted average of Net-to-Gross for all six measure categories yielded an overall program Net-to-Gross Without Spillover of .73. The measure Net-to-Gross ratios for two-choice models were combined to derive an overall program Net-to-Gross With Spillover of .75. This indicates a low spillover level of .02.

Table 2. Three Choice Lighting Upgrade Model

Utility Function	Coefficient Estimate	Variable	"T" Ratio of Coefficient Estimate
U_1 =	0		
U_2 =	-4.090	(Constant Term)	-1.5[b]
	+ -0.514	[a] Net Cost/Savings	-2.2[d]
	+ 0.989	[a] Recommend	1.4[b]
	+ 1.090	[a] KnowDiff	1.3[b]
U_3 =	-7.909	(Constant Term)	-2.7[d]
	+ -0.514	[a] Net Cost/Savings	-2.2[d]
	+ 0.989	[a] Recommend	1.4[b]
	+ 1.090	[a] KnowDiff	1.3[b]
	+ 2.665	[a] Aware	2.7[d]
	+ 1.321	[a] Account Rep	2.1[d]

Coefficient of Similarity = .0783 T - Ratio for coefficient of similarity = 1.6[b]
Rho-Squared with Respect to Zero = .7859
Resulting N/G Ratio = .84

(a) Coefficient not equal to zero with at least 50 percent confidence.
(b) Coefficient not equal to zero with at least 80 percent confidence.
(c) Coefficient not equal to zero with at least 90 percent confidence.
(d) Coefficient not equal to zero with at least 95 percent confidence.

Conclusions

Both methods yielded estimates of Net-to-Gross which are plausible. Their reliability is also enhanced based on the fact that they are born from actual data rather than customer responses. This eliminates an area of potential (and likely) bias. However, the method is certainly not foolproof. Spillover was estimated at only .02 which seems quite low. There are several potential explanations.

The difference could simply be the result of random error in the estimated Net-to-Gross ratios. There is little that can be done about this other than increasing the samples used in model estimation (a very costly endeavor). There is potential that there is just low spillover in the program. However, the most likely scenario is that two-choice model was mis-estimated because of behavioral differences between the control and treatment groups.

As with most impact analyses, finding appropriate control groups is difficult. In order to be a proper control group for this analysis, the control population must be representative of the treatment group both characteristically and behaviorally, In addition, the control group can not be exposed to any programs which may alter their behavior. These requirements rule out many groups traditionally (and improperly) used as control groups such as non-participants or customers “in the participation pipeline,” as both are different behaviorally than the treatment population as a whole. Furthermore, both would have been exposed to spillover impacts of the program by simply being part of the treatment group.

There is potential for choosing another utility’s customers who have not been offered similar rebate programs as a control group, but this introduces many potential biases. The most obvious difference between groups could be the weather in their area. For instance, it is unlikely that customers from Texas and Minnesota are going to be behaviorally similar in their adoption of energy efficient products, if for no other reason than they would be unlikely to be interested in similar measures. In addition, there are societal influences that may not be similar for each group. Residents of California will probably have a much higher propensity to adopt conservation measures

Table 3. Two Choice Lighting Upgrade Model

Utility Function	Coefficient Estimate	Variable	"T" Ratio of Coefficient Estimate
U_1 =	0		
U_2 =	-3.737	(Constant Term)	-11.2[d]
	+ -0.803	[a] Net Cost/Savings	-1.6[a]
	+ -0.935	[a] Net Cost/Savings x Treat	-1.2[a]
	+ 1.271	[a] Recommend	6.7[d]
	+ 1.128	[a] KnowDiff	4.5[d]
	+ 0.380	[a] Program Impact	1.0

Rho-Squared with Respect to Zero = .7255
Resulting N/G Ratio = .85

(a) Coefficient not equal to zero with at least 80 percent confidence.
(b) Coefficient not equal to zero with at least 90 percent confidence.
(c) Coefficient not equal to zero with at least 95 percent confidence.
(d) Coefficient not equal to zero with at least 98 percent confidence.

than residents of Arkansas, simply because there is greater social pressure to conserve energy in California.

In this study, municipal utility customers who are from geographically similar regions who were not exposed to rebate programs were used as a control group. The geographical similarity removes many potential behavioral differences because weather and other outside influences would be similar for both the treatment and control groups. Unfortunately, it is possible that some of the spillover impacts from the control group could have bled into the control group areas. If this occurred, it could also explain the unexpectedly low spillover impact.

While this two-step approach does offer potential insight in to many levels of savings, it has serious potential flaws. The benefits of using actual implementation data to remove bias can be overwhelmed if models are not specified properly. This mis-specification should be expected if the control group behavior is not an accurate representation of treatment group behavior in the absence of the program.

Endnotes

1. See Train, et al., (1994) for a full description of the necessity of using nested logit models to predict implementation and participation decisions.
2. If very precise estimates of Gross Savings exist through metering or other analytic techniques, estimates of all of these savings components can be derived using each of the ratios developed to find the naturally occurring savings.
3. See Cambridge Systematic (1) and (2) for the model specifications of all six measure categories.
4. See Cambridge Systematic (2) for details on the differences between control and treatment groups.

References

Cambridge Systematic, Inc. 1993. (l), *Net-to-Gross Ratios for PG&E's CIA Rebate Program: Study D-Decision Analysis Model,* report to Pacific Gas & Electric Company.

Cambridge Systematic, Inc. 1993. (2), *Net-to-Gross Ratios for PG&E's CIA Rebate Program: Study C-Treatment/Control Comparison,* report to Pacific Gas & Electric Company.

Train, K., S. Buller, B. Mast, E. Paquette, and K. Parikh. 1994. "Estimation of Net Savings for Rebate Programs," ACEEE Conference Proceedings.