Appropriate Treatment of Free Riders in Impact Evaluations: What Is a Free Rider Anyway?

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Evaluations that calculate free ridership solely as a fraction of participation can distort cost-effectiveness results. Many evaluators calculate the net load impacts by first calculating free ridership as a fraction of total participants, second calculating average load impacts from an analysis of all participants (including both free riders and net participants), and finally calculating total load impacts as the product of net participants and average impacts. This approach implicitly assumes that free riders and net participants are identical in all attributes important to the load impact calculation. In fact, evaluation data can show that the two populations differ significantly. In addition to load impacts, this issue also arises for calculations of participant costs and, in some cases, useful equipment life.

This paper demonstrates this point by presenting impact evaluation results for a commercial cooling program at a Midwestern utility. It presents evaluation results separately for net participants, free riders, and gross participants to demonstrate differences in evaluation results among the three groups. It also compares evaluation results for two approaches: a "standard" analysis that calculates net results as the product of average results and net participants and a revised analysis that calculates results based solely on the net participant sample.

The paper concludes that implementation of the recommended approach requires better coordination between process and impact evaluations. Process evaluations will need not only to identify free riders as a percent of participants, but to identify free riders in a manner that allows impact evaluators to draw evaluation samples from net participant populations.

Introduction

The California Standard Practice Manual (CPUC 1987) defines the benefits of the total resource cost, societal cost, utility cost, and ratepayer impact measure tests to include avoided supply costs "using net program savings, savings net of changes in energy use that would have happened in the absence of the program." In addition, the Standard Practice defines participant costs for the total resource cost and societal tests as costs net of those that would have been incurred in the absence of the program. That is, the Standard Practice directs evaluators to calculate costs and benefits for most cost-effectiveness tests net of free ridership.[1]

In practice, many evaluators derive net program results by first calculating average savings per gross participant (including both net participants and free riders) and then applying a free ridership rate defined as a fraction of participants. This approach implicitly assumes that free riders are identical to net participants in their costs, load impacts, and equipment life. While this may be true in some cases, for a number of DSM measures and programs, free riders will differ significantly from net participants. When this is the case, evaluators must design evaluation approaches that identify costs and impacts solely for the net participant sample and avoid approaches that consider the entire participant sample.

The following section provides a case study of a commercial cooling program that illustrates this point, The section describes the evaluation approaches used to calculate each data element and then provides the evaluation results. Following the case study the paper provides a discussion of its implications.

Case Study: Commercial Cooling

A utility program offered rebates to commercial customers that installed efficient cooling equipment. One program component addressed small central air conditioners (smaller than 65,000 Btu per hour) that are regulated by federal efficiency standards. Equipment exceeding the minimum efficiency level required by the standards qualified for a rebate.

The utility's evaluation approach addressed all the inputs necessary to complete a cost-effectiveness analysis of the program. For the purpose of this paper, the following data elements were most important:

- Participation and free ridership
- Load impacts
- Equipment costs
- Equipment life

Participation and Free Ridership

The utility evaluated gross participation by tracking rebate application forms and calculated free ridership using responses to a question included on the application. Participant responses to the question allowed the utility to assign all respondents as free riders or net participants.

Load Impacts

The utility used an engineering approach for evaluating energy and demand impacts. It first calculated the savings in installed load based on the average equipment capacity and efficiency for participants in each building type. The utility calculated energy savings by multiplying these installed load savings by equivalent full load hours (developed from building simulations) for a number different building types. For the purpose of illustration, we report only the results for the office building type.

The utility relied on the following engineering formulas to calculate savings in installed load and annual energy:

$$\textit{INSTALLED LOAD SAVINGS} = \textit{CAPACITY} \times (1/\textit{EFF}_b - 1/\textit{EFF}_p)$$

$$\textit{ENERGY SAVINGS} = \textit{INSTALLED LOAD SAVINGS} \times \textit{FLH}$$

where:

CAPACITY = Cooling equipment capacity, expressed in kBtu per hour
EFF_b = Baseline efficiency, expressed in SEER units (Btu per Watt-hour)
EFF_p = Program induced efficiency, expressed in SEER units (Btu per Watt-hour)
FLH = Annual full load hours, expressed in hours per year

The utility calculated equipment capacity and program-induced efficiency based on participant information reported on the rebate application form. The utility used the minimum efficiency level required by federal standards as the baseline efficiency level.

Participant Costs

The utility evaluated participant costs based on a survey of equipment vendors in its service territory. By using regression analysis, the utility expressed equipment costs as a function of change in efficiency and equipment capacity. That is, the utility expressed the vendor survey data in units of dollars per change in SEER per kBtu. The utility arrived at average participant costs by multiplying this value by the average change in SEER and average equipment size.

Equipment Life

The utility assigned equipment life based on manufacturer estimates.

Evaluation Results

Tables 1 through 3 present the evaluation results, including separate results for three participant groups: free riders, net participants, and all participants. Table 1 presents the input values used to calculate load impacts and participant costs. Table 2 presents the evaluation results per participant and Table 3 presents evaluation results for the total program.

For the purpose of this paper, we present the input values in Table 1 as averages across the sample of participants, and then calculate the results in Tables 2 and 3 by applying the engineering formulas to these average values.

Because the engineering formulas involve products and reciprocals, it would be better to apply the engineering formulas to individual participants, and then aggregate results across the participant sample. However, we have applied the former approach because it illustrates the point of the paper more clearly.

Table 1 indicates differences among groups for average equipment capacity and program-induced efficiency. These differences in turn lead to differences among groups in the evaluation results displayed in Tables 2 and 3.

Table 3 also presents a net-to-gross ratio calculated for each evaluation result. Since net participants installed

Table 1. Evaluation Input Variables

	Net Participants	Free Riders	Gross Participants
Equipment Capacity (kBtu)	45.1	41.4	43.6
Equipment Efficiency (SEER)			
Baseline	10.00	10.00	10.00
Program Induced	10.60	10.89	10.72
Increase	0.60	0.89	0.72
Full Load Hours (hours/year)	1,040	1,040	1,040
Incremental Cost ($/SEER/kBtu)	$5.33	$5.33	$5.33
Equipment Life (years)	15	15	15

Table 2. Evaluation Results: Per Participant

	Net Participants	Free Riders	Gross Participants
Installed Load Savings (kW)	.26	.34	.29
Annual Energy Savings (kWh)	265	352	305
Participant Costs ($)	$144	$197	$167

Table 3. Evaluation Results: Total Program

	Net Participants	Free Riders	Gross Participants	Net-to-Gross Ratio
Participants	112	78	190	.59
Installed Load Savings (kW)	28.6	26.4	55.0	.51
Annual Energy Savings (kWh)	29,735	27,447	57,172	.51
Participant Costs ($)	$16,164	$15,328	$31,492	.51

equipment that was larger but less efficient than the equipment installed by free riders, the net-to-gross ratio varies by evaluation result. For example, while 41% of participants are free riders, these free riders reduce energy savings and participant costs by 49%.

Table 4 presents an example of how these program results would typically be captured in a program cost-effectiveness analysis. That is, the table begins with gross results (e.g., gross impacts calculated in Table 3 as the product of gross participants and average impact per gross participant) and applies a net-to-gross ratio (calculated relative to participants) to arrive at net results, While Table 3 indicates net impacts of 29,735 kWh and net participant costs of $16,164, the traditional approach applied in Table 4 results in net impacts of 34,110 kWh and net participant costs of $ $18,751. The results in Table 4 represent increases over the net approach of 13% and 14% respectively.

Table 4. Evaluation Results: Based on Net-to-Gross Ratio

	Gross Results	Net-to-Gross Ratio	Net Results
Participants	190	.59	112
Installed Load Savings (kW)	55.6	.59	32.8
Annual Energy Savings (kWh)	57,864	.59	34,110
Participant Costs ($)	$21,811	.59	$18,751

Discussion

This simple case study illustrates how cost-effectiveness results can be skewed when evaluations include free riders in samples used to calculate average impacts or participant costs. Since free riders do not differ from net participants in a systematic way, this can either increase or decrease the evaluation results.

A number of factors can contribute to differences in evaluation results between net participant and free rider samples. As suggested by the case study, free riders can install equipment of a different size or efficiency than net participants. In addition, free riders can operate on different schedules (i.e., have different full load hours), or contain a different mix of customer types (e.g., industries or building types), or otherwise use equipment in a different manner. When installed measures have useful lives defined based on rated hours (e.g., lamps and ballasts), different operating schedules for free riders and net participants will result in different lifetimes. (While this did not occur in the case study, it would occur for most lighting programs.) In programs that deliver multiple measures, free riders can install a different mix of measures than net participants. In short, there are a number of reasons to believe that free riders can and will be different than net participants. For this reason they should be excluded from evaluation samples whenever possible.

Although the case study presented in this paper relied on a simple impact evaluation approach, other approaches can also accommodate these underlying principals. For example, by drawing evaluation samples solely from net participants, billing analyses, metering analyses, or other engineering approaches can all avoid skewed results.

A problem that could arise in applying these principals lies in the need to assign individual participants as either free riders or net participants. The simple evaluation approach applied in the case' study lent itself to direct assignment of all participants. However, with other approaches this may not be so straightforward.

For example, many evaluations rely on follow-up surveys of participant and nonparticipant samples to assess free ridership. To the extent that evaluations rely on a battery of questions to determine a range of plausible free ridership levels, individual respondents may not be able to be definitively assigned as free riders or net participants. In addition, problems could arise when free ridership surveys cover only a sample of participants.

One approach for solving this problem would be to draw impact evaluation samples solely from the sample for the free-ridership survey. This might require larger survey samples in order to assure valid impact evaluation results.

Another approach would involve selecting free ridership survey samples that are representative not only of the entire program population, but representative for important program subgroups (e.g., equipment efficiency, equipment capacity, operating schedules, measures installed). Again, this might require larger survey samples in order to assure valid results.

Conclusion

Treatment of free riders in many evaluation approaches implicitly assumes that free riders are identical to net participants in terms of load impacts, participant costs, and equipment lifetime. There are a number of reasons to believe that free riders can differ from net participants and evaluation results can easily show this to be the case. For this reason, impact evaluations should attempt to calculate program results based on participant samples drawn solely from net participant populations.

Endnote

1. The Standard Practice defines gross and net savings (and, by extension, gross and net participants and

participant costs) as follows: "Gross energy savings are considered to be the savings in energy and demand seen by the participant at the meter. These are the appropriate program impacts to calculate bill reductions for the Participant Test. Net savings are assumed to be the savings that are attributable to the program. That is, net savings are gross savings minus those changes in energy use and demand that would have happened even in the absence of the program."

Although not defined as a term in the Standard Practice, free riders represent the difference between gross participants and net participants.

Reference

California Public Utilities Commission (CPUC) and California Energy Commission (CEC). *Standard Practice Manual, Economic Analysis of Demand-Side Management Programs.* December 1987.