GROSS AND NET SAVINGS ANALYSIS FOR UNIQUE PROJECTS

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Introduction

Trends in utility DSM programs include increasing emphasis on programs for large customers or large projects, and a shift toward financing and information in place of rebates. Evaluation of such programs, including both determination of true gross savings and assessment of free ridership can be difficult.

This paper describes a method of assessing gross savings and free ridership for large, customized projects where simple multiple-choice surveys may be inappropriate. The basis of the method is a combination of document review, site-specific data collection, and scripted interview. A key feature of the method is that the same engineer who reviews documents and site data to determine gross savings also conducts the decision analysis interview. The method has been applied with good results for several programs, including finance and information/only programs.

The emphasis of the paper is on the estimation of net savings accounting for free ridership. Data collection and analysis to develop gross savings estimates is an essential component of developing net savings, but is not addressed in detail here.

In the remainder of this introduction, we review the difficulties with assessing large and custom projects, and describe how the Decision Analysis methodology presented addresses these problems. We also describe some of the contexts in which the methodology has been applied. We then present more details on the structure of the Decision Analysis script and its interpretation. We conclude with some of our experiences in implementing these methods.

Difficulties with Assessing Large and Custom Projects

Assessing savings for large and custom projects is complicated for several reasons. First, each project must be assessed individually, rather than applying a standard formula to a large group of projects as is typical of prescriptive measures. Second, at large sites there are often a variety of changes implemented at around the same time as the measure of interest; care must be taken to identify what changes are part of the measure and which are separate, and to define the operating conditions and non-measure baseline to be used to define gross savings. Third, the alternatives of what could have or would have taken place in the absence of the program are not always clear-cut, and need to be determined case by case. Asking meaningful questions about what took place, how the decision was made, and what else might have been done requires a detailed understanding of the project undertaken. Finally, there are often multiple decision makers whose views need to be considered in assessing free ridership.

Overview of Decision Analysis Methodology

Key features of the decision analysis methodology are the following.

- The Decision Analysis Script is administered by an engineer who is responsible for data collection and/or analysis to determine gross savings. This individual can focus questions on the specific equipment and circumstances of the project, and has the training and information necessary to probe with appropriate follow-up questions.
- The script identifies the financial decision maker who had to approve the project as well as those responsible for the technical decision. Determination of what would have been implemented in the absence of the program is based not just on what an operator or engineer would have recommended, but also on what investment would have been approved.
- The Script is administered in the context of asking technical questions about the measure installation. This context improves the respondents' willingness to discuss the project and ability to recall details. The "piggyback" approach also keeps the incremental time required for the free rider data collection down to a few minutes per project.

Applications of the Method

The Decision Analysis Script has been applied, with some variations, in impact evaluations for several utilities. The programs and projects evaluated have included

- commercial and industrial custom rebate programs in the Midwest, Mountain states, and West Coast
- a very large rebate for a single large industrial customer
- a commercial/industrial financing and information program.

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The time frame of the analysis has varied depending on the regulatory context. In some cases, the focus has been on determining first-year savings. In others, life cycle savings are estimated. In the latter case, the methodology accounts for deferred free ridership, by explicitly identifying the probable timing of equipment changes that would have taken place.

Structure of Decision Analysis Methodology

The Decision Analysis Methodology consists of a Decision Analysis Script and a set of interpretation tools. The script and tools are described below.

The Decision Analysis Script

As discussed above, the Decision Analysis Script is administered by a verification engineer responsible for collecting data either onsite or by phone to support the gross savings analysis. This individual is necessarily familiar with the details of the project. In many cases, the same individual is responsible for conducting the gross savings analysis.

The Decision Analysis data collection script consists of a series of questions designed to isolate the motivation for, and the timing of, installation of energy conservation equipment. To increase the probability that unbiased and accurate decision related data are collected, the questions are designed:

1) to help the customer separate their current thoughts about the project from their decision process at the time of program participation;
2) to prevent the customer from giving defensive or manipulated answers;
3) to identify and justify apparent inconsistencies in respondent's answers;
4) to ensure responses are obtained from a financial decision maker (Question 1) or that such a person's opinion is at least taken into account (Question 5j); and
5) to provide additional insight about the project decision-making, current satisfaction, and possible free driver effects.

Experience indicates that biased answers are likely to be obtained if surveyors simply ask participants if they would have undertaken similar equipment installations in the program's absence. One reason for this is that respondents tend to answer as if the question were "if you had it to do over again, would you do the same project, even if you couldn't get financing or had not received information?" Customers who are happy with their projects will tend to reply in the affirmative. Another reason is that if this is the only question asked, the respondent may recognize the purpose of the question, and give the answer they think will have the desired effect on the program. An additional concern is that, while the main contact might have wanted to pursue the project even without utility involvement the investment might not actually have been approved under these conditions.

The Script has five main parts

1. Identification of decisionmakers and their roles in the decision process.
2. Customer satisfaction with the equipment and with the utility
3. Plans for future implementation of similar measures, and the effect of this project and of future incentives on those plans
4. Customer experience prior to participation, including
   --prior installations of this type of measure or technoogy
   --timing and content of the utility's contribution to the project plans
5. Effect of the utility's contribution (rebate, financing, or information) at the time the decision was made to implement this project.

The responses to Section 5 are the basis of the free ridership assessment for each project. The first four sections are designed to help ensure that the responses obtained in Section 5 are accurate. In the first section, we ensure that an assertion that a measure would have been installed anyway is based not simply on what an operator or engineer would have wanted, but also on what would have been approved by a financial authority. The second and third sections help separate the question we want answered at the end, "What would you otherwise have done at that time?" from the more natural question "What would you do in the future given what you know now?" To keep this distinction clear, we first ask the latter question, explicitly.

Giving the customers a chance to express the thoughts that are of more immediate concern to them—how satisfied they are with the equipment and what they might do in the future—makes it easier to make it clear that this is not the information we're looking for in the next series of questions. In the fourth section, we turn from asking about future plans to asking about the path that led up to the current project.

The final section probes what type of equipment would have been installed in the absence of the utility's contribution, in what amounts, and on what time frame. In addition, respondents are asked to explain why they believe this is what would have occurred. At this point, responses that are inconsistent with responses to the previous four sections are probed for clarification, and/or corroboration by another decisionmaker. Explicit consistency checks and probe instructions are included in the script.

Interpretation Tools

Table 1 shows an example of an interpretation matrix used for assigning free ridership on the basis of the survey responses. This type of matrix would be used for a program focused on first-year savings. If the responses indicate that no portion of the project would have been installed in the absence of the program, the project is credited fully to the program (free ridership = 0). If the responses indicate that the entire project would have been installed within the year even without the program, pure free ridership is assigned. For responses indicating that a smaller quantity or lower efficiency equipment would have been installed, the savings for that reduced project is determined, as a fraction of the actual project gross savings; one minus that fraction is the free ridership for the project.

Table 1 does not include all possible combinations of responses to the question sequences. The table shows only those sets of responses that are consistent and classifiable. If the responses are inconsistent, probing continues until a consistent picture is obtained. For example, if the respondent indicates at 5b that the same equipment would have been installed within the year without the program, but then at 5e concludes that the project would not have been approved, the 5b response is changed to "no."

Accounting for Deferred Free Ridership

In cases where life cycle benefits must be explicitly accounted for in the free rider analysis, the time-line of installations that would have occurred in the absence of the program is key. Figure 1 shows an example of a Non-Participation Activity Timeline. This chart shows the trajectory of gross savings over time, as a percentage of the project's total gross savings. The verifying engineer constructs this timeline on the basis of the responses given to Section 5 of the Decision Analysis Script. On the form, the engineer summarizes the type of equipment that would be installed, the schedule of the installation, and the reasons for believing that this equipment installation would occur on this timeline.

Data need to be collected in this format only if the participant reports that the *timing* of energy conservation equipment installation was directly altered by the program. This approach to the treatment of deferred free ridership is capable of treating cases where respondents believe that there is some quantifiable probability that all of the equipment would have been installed as of a certain year *y*.

An example illustrates two bases for constructing a Non-Participation Activity Timeline from respondents' projections. A hotel replaces 1000 60 W incandescent bulbs with 1000 compact fluorescent bulbs, with a rebate, or after receiving information or financing from the utility. The hotel's representative may speculate about (hypothetical) non-participation activity in at least two different ways:

1. "If the utility hadn't been involved, I'm quite sure we would have installed the efficient bulbs anyway, but not right away. There's a 25% chance we would have done it by the end of the year, a 75% chance we would have done it by the end of the following year, and a 90% chance we would have done it by the end of the next year."
2. "If the utility hadn't been involved, I'm quite sure we would have installed (most of) the efficient bulbs anyway, but not right away. We would have installed 250 bulbs this year, 500 bulbs the following year, and 150 bulbs the next year. 100 of the bulbs wouldn't have been installed, because the utility was responsible for identifying those as likely replacement candidates."

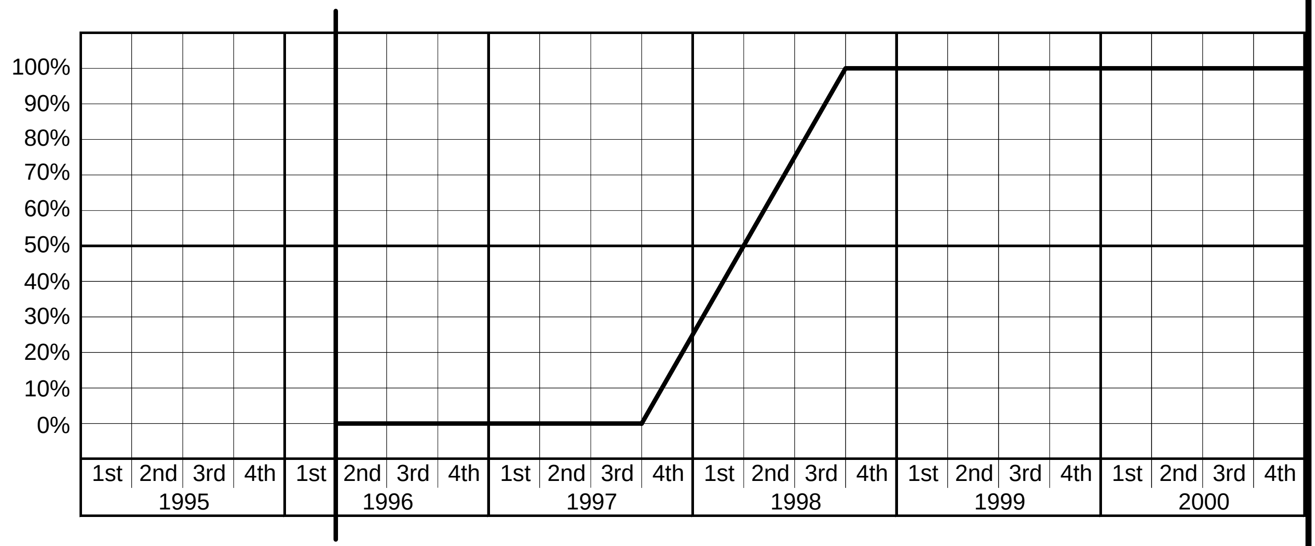
Table 1

Decision Analysis Script Section 5 Interpretation

What would have happened without the program								
Would do the same			Would do something different					
5b Installed same amount and type within 1 year?	5d Why believe this?	5e Would be approved?	5f Would have installed something?	5g/h equipment type efficiency?	5j/k quantity (as fraction of actual)	5l Would be approved?	Free Ridership Calculation	Free Ridership
No			No				Full Credit to Program	0
			Yes	No	1	Yes	from tracking system	Fraction
			Yes	No	Fraction<1	Yes	from tracking system, 5h, and 5k	Fraction
			Yes	Yes	Fraction< 1	Yes	from 5k	Fraction
			Yes	Yes	Don't Know	Yes	Assume 5k fraction equal to 0.5	0.5
Yes	Reason	Yes					Pure Free Rider	1

Figure 1
Non-Participation Activity Timeline

Customer: Hotel X
Date: Feb. 2, 1996
Surveyor: KMS



Efficient Equipment that would have been installed without WP&L involvement: 1000-15 Watt Compact Fluorescent Bulb
Baseline at Install. Date: 1000-60 Watt Incandescent Bulb

Description of Non-Participation Activity: Had the financing not been available, Hotel X would have waited 18 months before doing anything. At that time, CFB would have been installed on a normal replacement schedule. It would have taken one year before all the incandescent bulbs were replaced.

Reason for believing Non-Participation Activity would have occurred as described above: Hotel X's conventional credit line is currently tied up with construction of a new hotel. No funds are available for energy efficiency. However, the hotel has a new energy efficiency policy that was expected to ensure that CFB were installed when the funds became available.

In both these cases, the Nonparticipant Timeline would show the project at zero completion at the beginning, 25% complete at the end of one year, 75% complete at the end of two years, and 90% complete at the end of three years. A linear increase in per cent complete would be assumed between these points.

The difference between the total gross savings from the project and the nonparticipant savings trajectory is the net savings trajectory. From this trajectory, the net present value of incremental costs and incremental savings attributable to the program can be calculated.

Projecting what would have occurred over what future timeline is necessarily somewhat speculative on the part of the respondent. The orientation of the script is to provide a structure for probing with the respondent what specific decisions had been made and what policies, practices, and attitudes made a particular course of action likely, including the timing of when measures would have been installed.

Assessing Participant Spillover

Section 3 of the Decision Analysis Script asks about future measure implementation resulting from experience with the current project. The primary intent of this question sequence is to separate the respondent's future plans from their experience at the time of the decision for the current project. However, these questions can also provide the basis for assessment of participant spillover or free drivership.

The simplest use of the information from the Future Plans questions is to identify customers who have implemented additional measures or are likely to do so. For some non-incentive programs, credit is given to the program whenever a customer is verified to have implemented measures as a result of program information or financing. Customers who indicate that they have undertaken measures in addition to those currently being investigated will be counted in future program savings when those additional measures are entered into the tracking system and verified by the same methods.

Thus, in an information program with this type of tracking and verification, there is no separate “spillover” effect. However, it is useful to identify the potential additional measures, so that the utility customer representatives can follow up to document the measures and claim program savings. Table 2 shows the interpretation matrix used to identify customers with likely additional measures to be credited to the program in the future.

Many non-incentive programs will track only those projects that have been explicitly recommended by the utility. For these programs, as for a rebate program, spillover projects will not be credited to the program by routine verification at the time the project is completed. As a result, to credit the program for these measures, the evaluation must go beyond identifying likely spillover projects, to assigning gross savings levels and program attribution factors We have developed additional questions for Section 3 of the Script that can be used to quantify the savings from these measures.

Where the spillover involves implementing more of the same type of measure, the savings calculation is straightforward. If the spillover claim involves different types of measures, the savings calculation would necessarily be more uncertain. The attribution of the measure to the original program activity would also be harder to defend.

Claims for spillover credit will be easiest to defend if they are made only on the basis of completed installations. Thus, if the evaluation identified a large number of potential spillover projects in progress, a follow-up study might be required to verify the measures actually installed and associated gross savings. This work might be done in conjunction with the evaluation of a later program year. However, the decision-making information collected during the initial evaluation, when the spillover activity was in the planning or early implementation phase, would be a key component of documenting the attribution to the program.

Estimating Program Savings

The net savings S_{Ni} for each site i is determined by applying the free ridership FR_i determined from the Decision Analysis Script to the verified gross savings S_{Gi} determined by the associated engineering analysis. That is

$$S_{Ni} = (1 - FR_i)S_{Gi}.$$

If participant spillover is being claimed as part of net savings, a corresponding spillover multiplier is also included.

This procedure gives solid information on both gross and net` savings from efficiency measures in an individual project. This method is particularly useful in a context where analysis is required of individual, unique customers, and has been applied for such a case.

More commonly, even with custom programs, it is not practical to analyze each project individually. Instead, there may be a basic level of review for all projects, followed by detailed data collection and analysis for a sample. Even where a detailed assessment is attempted for all projects, there will always be some nonrespondents. It is therefore necessary to extend the results from the studied sample to the total set of program participants.

Table 2
Interpretation of Decision Analysis Script Section 3

Additional Efficiency Measures to be Installed because of this Project					
3a Expected?	**3b Within 1 year?**	**3c Type of Measure**	**3d How project affected decision**	**3e What would otherwise have been done?**	**Spillover Likelihood**
					0.0
No					0.0
	Unlikely				0.0
	Don't Know				0.0
		Don't Know			0.0
			Don't Know		0.0
				Don't Know	0.0
Yes	50/50 Chance	Not "Don't know"	Not "Don't know"	Not "Don't know"	0.5
Yes	Very Likely	Not "Don't know"	Not "Don't know"	Not "Don't know"	0.8
Yes	Certain	Not "Don't know"	Not "Don't know"	Not "Don't know"	1.0

Our general approach to developing the estimate of total program savings is to use ratio expansion. In the simplest form of the method, we have

$$S_{NP} = (\Sigma_{i\varepsilon A} S_{Ni} / \Sigma_{i\varepsilon A} S_{Ti}) \Sigma_{i\varepsilon P} S_{Ti}$$

where

S_{NP} = total program net savings
S_{Ni} = net savings for project i
S_{Ti} = tracking estimate of savings for project i
A denotes the analyzed sample
P denotes the set of all participants.

Where a stratified sample is used, the corresponding stratified ratio estimators are used in place of the simple ratio estimator.

In cases where one or two projects account for a large proportion of the tracking estimate of savings, the use of the simple ratio estimator is problematic. Essentially, the ratio method will apply to all the sites the free ridership determined for the dominating project or projects. In such cases, it may be more reasonable to treat the very large projects as stand-alone analyses, and use the ratio expansion method to estimate total savings for the more homogeneous smaller projects. Another alternative is simply to calculate the average free ridership on a per-project basis, and apply this average to the projects that were not individually analyzed.

Experience with the Decision Analysis Methodology

As discussed above, the methods described here have been applied in evaluations of several different programs in different parts of the country. The methods continue to be refined, but on the whole have performed well.

Perspectives from Field Staff

Engineers implementing the method sometimes have difficulty at first with administering subjective questions and making quantitative assessments based on these responses. In addition, the question sequences are somewhat complex and can be awkward initially. However, after working with the tools for several projects, the field staff develop a sense of what information they are trying to develop and how to probe for this information in each situation. Those who are already familiar with the concepts of impact evaluations are generally able to get comfortable with the tool more quickly. Those who have completed several projects with the tool report that they feel very confident of the information they have developed.

This method is particularly well suited to cases where efficient and baseline technology *types* differ substantially. Examples include compact fluorescent lamps replacing incandescent lamps, or an evaporative condenser being installed in lieu of an air-cooled condenser. It is more difficult to quantify free ridership effects reliably when efficient and baseline technology types are similar. Examples of these types of measures include high-efficiency chillers and high-efficiency motors. In these cases, efficiency levels may vary continuously over a wide range for a single technology type.

As with any interview-based data collection method, there is a need to be sensitive to the relationship between survey length and respondent cooperation. Respondents react best when questions are posed within the context of a conversation. With this method, there are opportunities to make the data collection activity more conversational in nature. The ability to do this successfully comes with experience and familiarity with technologies and projects. Interjection of probing questions and identification of potential inconsistencies are both means of enhancing the conversational aspect of data collection. It is important to take advantage of all such opportunities.

Decision analysis data have been collected during on-site verification visits conducted prior to issuance of incentive checks, and during telephone conversations taking place after participants have received a rebate check. The onsite approach benefits from the ability to incorporate non-verbal communication into development of probing questions and subjective judgment of the reliability of responses. This approach also may reduce the number of customer contacts required, thus streamlining implementation and evaluation activities, and decreasing the risk of unduly burdening participants. However, collection of these data prior to rebate payment is sometimes made more difficult by participant concerns about the relationship between survey responses and incentive payment. Participants have a tendency to think that issuance of the check may be contingent upon responses. It is important to make it clear prior to collection of the data that issuance of the check will not be contingent upon responses.

Collection of data over the phone after a participant has received a check benefits from a reduction of participant's concerns about the relationship between responses and receipt of incentive monies. Data collection expenses may be increased, however, if multiple contacts are required to complete verification and evaluation data collection activities. Our experience has been that completeness and reliability of decision analysis data is maximized when these data are collected after the participant has received the incentive payment.

Analysis of a Single Large Industrial Project

The method was utilized in the evaluation of a project in a large industrial facility. Rebated measures included high-efficiency lighting, and an Energy Management System (EMS) used to control lighting and HVAC equipment. Separate free ridership analyses were done for lighting and EMS equipment, and interactions between these technologies were accounted for in calculations of both gross and net impacts.

The free ridership for lighting was determined to be 0.5. Half of the efficient lighting installed through the program would have been installed at the time of the evaluation if the customer had not participated in the program. While efficient lighting systems had been used by the customer in the past, such use was not consistent or systematic.

The free ridership for the EMS portion of the project was determined to be 0.0. The program was determined to be responsible for 100 percent of both impacts and incremental costs associated with installation of the EMS system. The customer reported that it had no previous experience with EMS systems similar to the one for which a rebate was received. The respondent suggested that there wasn't "one chance in fifty" that the EMS would have been installed in the absence of the program.

Analysis of Custom Lighting Projects

The method was utilized in the evaluation of a custom lighting program offered by a utility in the mountain states. While a variety of technologies were incented, a substantial majority of the program activity consisted of installation of electronic ballasts and T8 lamps in lieu of magnetic ballasts and T12 lamps. The majority of these installations were new construction or major remodel projects. In this context, deferred free ridership was not a significant contributor to overall program free ridership. Decision analysis data collected during scripted interviews revealed several interesting patterns.

1. For the majority of participants judged to be pure free riders, the primary basis for this judgment was that their equipment selection was dictated by a corporate efficiency policy.
2. Participants undertaking larger projects appeared to have a greater likelihood of having a corporate energy efficiency policy than participants undertaking smaller projects.
3. Consistent with points 1 and 2, larger projects appeared to have a greater likelihood of being pure free riders than did smaller projects.

Early in the data collection process, we found that existence of corporate energy efficiency policies appeared to be the most important factor responsible for free ridership in this program. Questions on the timing and basis for the corporate policy were then added to the interview script to facilitate more detailed characterization of factors contributing to market transformation and resulting program free ridership.

The overall free ridership rate for the program was estimated to be 49 percent. The detailed decision-making data collection and analysis gave strong support to the result.

Conclusions

The Decision Analysis Script is very effective for assessing free ridership in a variety of contexts. Versions of the method have been implemented with good results for both rebate and nonincentive programs, for individual major projects and for custom programs, to address both free ridership and participant spillover.

Several factors can help improve the quality of the information developed by this method.

- The script should be administered by an engineer who is familiar not only with the project under study, but also with the decisionmaking issues being probed by the questions.
- The script works more smoothly once the administering engineer becomes familiar with its structure, and can shape specific questions quickly.
- As with any tool designed to reconstruct a decision process, the method is more effective if implemented within a short time of the decision.

For projects requiring customized analysis to determine gross energy savings, a corresponding customized, but structured approach is necessary to address free ridership. Because the Decision Analysis Script is implemented in the context of data collection to support engineering analysis, the script yields highly credible, detailed information on complex projects at a low cost.