EVALUATION PROCEDURES AS PART OF PROGRAM PLANNING

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ABSTRACT

Utility sponsored programs in the past were primarily marketing efforts. Levels of participation provided an accurate measure of their success. However, after the emergence of energy conservation programs, volume of participation alone, was no longer a reliable indicator of success. Conservation programs encounter many conflicting forces. Using less of a product often requires a conscientious, sustained effort. Extraneous influences such as weather, pricing, etc. also mask the performance of these programs. Thus many early attempts at evaluating conservation programs were based on little more than best guesses hidden behind that friendly but overworked facade - "the engineering estimate."

Accurately evaluating a myriad of conservation programs, each with specific goals, requires an integration of evaluation procedures into the planning phase of a project. This paper presents a method in which evaluation procedures evolve as a natural consequence of planning.

INTRODUCTION

The purpose of evaluating programs of any type, including energy conservation, is to determine if the benefits of the program are worth the cost. The concepts of program benefits and costs are general in nature and highly susceptible to errors in judgement. Because of this, many if not most utility companies and regulatory agencies have valid, sophisticated methodologies to handle this part of the evaluation. Yet, for all the sophistication, there appears a lack of consistency in the results. In the opinion of these authors, this inconsistency is primarily a result of poor quality input data. This, we feel, is not due to a lack of effort nor intelligence on the part of those providing the data. (They is us!) Unfortunately, thoughts of evaluation often occur only after a program has been implemented. This makes it difficult, sometimes impossible, to obtain the information needed for an accurate analysis. This ultimately results in evaluations based more on assumptions and estimates than on measurable results. We feel a pre-defined evaluation methodology is the best way of ensuring an accurate program analysis.

The intent of this paper is twofold. First, to introduce the methodology used by these authors when starting an evaluation, and to show that it can be a valuable part of conservation program planning. Since we encourage statistical methods, and since the biggest asset or stumbling block is the records you work with, a few comments about records would not be amiss. Thus, the second part of this paper discusses those records you are likely to have and those you would like to have.

EVALUATION PROCEDURES

As Part Of Program Planning

One initial function of planning should be a justification of the program. A major part of this justification is usually based on an initial estimate of the program's impact. The first step in evaluation planning, as practiced by these authors, is precisely this initial estimate of the program impact. Thus at this very early point in the process, program planning and evaluation planning are the same. By capitalizing on this, program planners can avail themselves of an excellent source of information on which to base decisions. The need for an estimated program impact, if viewed from a program evaluator's perspective, will provide, at a minimum, information such as:

1. The estimated program impact on a seasonal basis. This can be important for utility load considerations.
2. An accurate determination of which parts of a "package" are likely to be effective, and which are not. This information provides program planners a great deal of latitude for program optimization, with supporting justifications.
3. Evaluative variables that are directly measureable and those which may be obtained, or inferred indirectly.
4. Identification of quantities that are most likely to provide measurable results of the program's performance.
5. The type of analysis necessary to accurately evaluate the program.
6. Information needed from program participants, helpful in defining supporting personnel requirements and operating budgets.

All of the above information is required when developing evaluation procedures for specific programs. It is also valuable information for program planning. As a bonus for evaluators, if statistical analysis is the selected technique, a very good estimate of the required sample size can readily be calculated at this point.

Methodology

Identify Participants. The first step is to identify the segment of the population eligible for participation in the program. This segment is then subdivided into unique subgroups. By unique subgroups, we mean those identifiable segments whose annual energy usage profile is similar to each other, yet distinctly different from the remainder of the population. Table 1 lists a few typical examples. It is not intended to be complete, merely illustrative.

Table 1. Typical Population Subgroups

Population Type	Identifiable Subgroup
Residential	Total Electric Homes Mixed Fuel Homes
Commercial	Office Buildings Hospitals Convenience Stores

It is important to realize that the subgroups must be identifiable in terms of the energy usage parameter that will be available. For example, an electric utility may only have monthly billing history. From this billing history, it is possible to identify reasonably accurately, the two residential subgroups listed in Table 1. However, it would not be possible to break the group down further.

Estimate Seasonal Energy Distribution. Next we need to define distinct weather seasons and allocate a percentage of the annual energy to each season. If spring and fall have similar weather characteristics, they may be combined as a single unique season.

The purpose is to isolate weather related impacts. In principal, it is possible to distribute the energy usage by month rather than season. However, in practice, the additional time and effort required exceeds the value of any extra information gained. The problem with short periods of time is one of relating weather data to the specific dates when the energy was used. If you are limited to utility billing records (a common situation), meters are seldom read on the first of each month, nor are all of the meters normally read on the same day. Thus a June bill for one participant may reflect energy used between mid-May and mid-June, while the June consumption of a second participant may have occurred between mid-June and mid-July. Attempting to adjust billing data to accurately reflect similar weather conditions is not a small task.

This problem also occurs in our seasonal breakdown. However, by defining seasons in terms of distinctive weather, the effect of different read dates is negligible. In fact, no effort should be made to match energy usage and weather, for example, by using the May billing of one participant and the June billing of another to represent the "actual" June consumption. There are two reasons this error is minor on a seasonal basis. First, because it only occurs at the boundary of the time period, the longer the time period the less the impact. Secondly, because the weather dependent parameter (i.e. degree-hours, degree-days, average temperature, etc.) is minimal at the boundaries of distinct weather seasons.

Figure 1. illustrates a typical seasonal distribution for a mixed fuel home in a southern climate, with energy usage information limited to electrical billing history.

Figure 1. Seasonal Energy Distribution: Mixed Fuel Home

Annual Energy = 100%

Winter Energy = 18% | Spring/Fall Energy = 23% | Summer Energy = 59%

The seasons as depicted in Figure 1 were defined as follows. Winter, the three months of December, January, and February. Summer, the five months of June, July, August, September, and October. The spring/fall season, the remaining four months of March, April, May and November.

The percentages shown reflect the seasonal proportion of the annual energy usage. These percentages should be known or available from any utility company. However, if the distribution is unknown, reasonably accurate estimates are good enough. The percentages shown in Figure 1 are not those of any specific utility company. They were estimated by assuming equal usage each month of the year (base load usage). The five summer months were then assumed to have air conditioning usage equal to the base load. This results in seventeen (17) basic units of usage, distributed among the three seasons. Thus the winter received 3/17 or 18%, the summer 10/17 or 59% and the spring/fall season 4/17 or 23%. The assumptions need to be characteristic of the region, but kept simple and to a minimum number; the results are usually surprisingly accurate.

Identify the Product Impact. We now need to identify for each product or service in the program, the specific point of impact on the energy usage. Include whether the impact is direct or indirect. Table 2 illustrates a few typical examples of this.

Table 2. Examples of Identifying Specific Points of Impact.

Item	Type of Impact on Energy	Location of Impact
Air Conditioner	Direct	All air conditioning energy usage is directly affected by this change.
Ceiling Insulation	Indirect	The direct impact is on heat transferred through the ceiling due to a temperature differential. There is an indirect impact on heating and air conditioning systems proportional to the decrease in the ceiling heat transfer.

Isolate the Impact of the Product. At this time, we have identified each subgroup of the population that will participate in the program. We have a reasonable estimate of how they use energy, and we know where each component of the program affects our measurable energy parameters.

Now, for each subgroup, each season, and each product/service in the program, we need to further refine the energy distribution. The intent is to isolate each specific point of impact. Figure 2 illustrates this procedure for ceiling insulation in mixed fuel homes. The season illustrated is the previously defined summer, and the measurable energy parameter is the electric billing history.

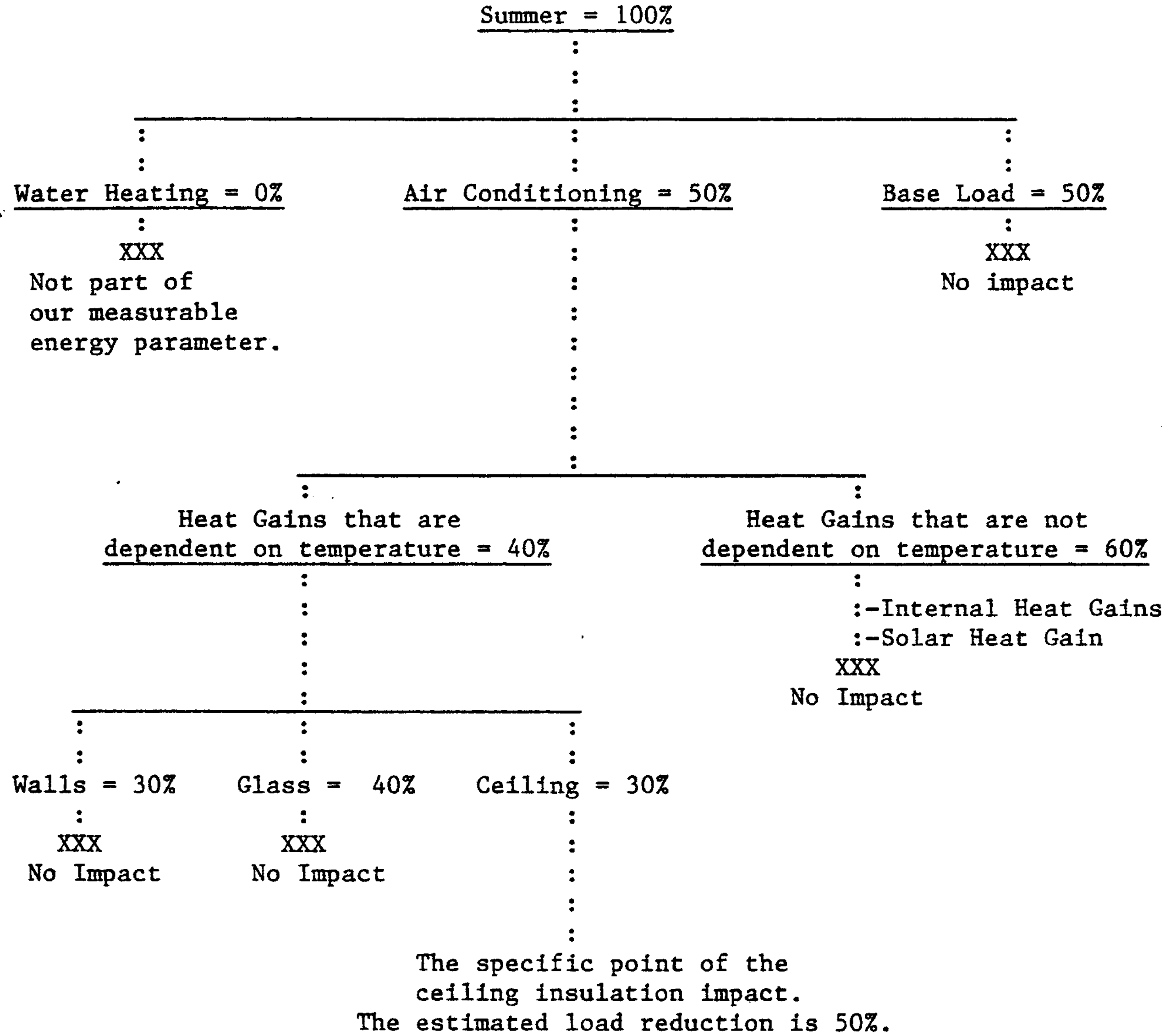
The "summer = 100%" line in Figure 2 should be read as "we are going to divide up all of the energy used during the summer." The summer usage is then split into three broad categories: water heating, air conditioning, and base load. This first level will consist exclusively of items which physically use the energy we measure. The specific items are arbitrary, but must represent the total measured energy. The previous identification of specific points of impact is very helpful when deciding how to allocate the usage.

Since our example is a mixed fuel home, and our energy measurement is the electric bill, the energy used to heat water will not be included in our data. Thus the water heating item need not have been listed. The remaining two items are each allocated one-half the summer total. This is consistent with a previous estimate (see the discussion following Figure 1). Since ceiling insulation has no bearing on our base load usage, we can terminate further investigation of that component.

From Table 2, we note that the direct impact of ceiling insulation is on heat transferred as a result of a temperature difference. Thus a logical split of the air conditioning load would be into those loads which are temperature dependent, and those that are not. At this point we need an estimate of how much of the air conditioning load can be attributed to each of these components. A form used for sizing homes for air conditioning can be valuable for this estimate. Merely dividing the load equally among the options can also be used.

Since the specific point of impact is the ceiling portion of the temperature dependent load, one additional breakdown is required. This load can be divided among walls, glass areas, and ceiling. Since ceiling insulation has no effect on heat movement through walls nor glass areas, these can be eliminated from further consideration. This leaves but one avenue open, and it is the point of direct impact of the ceiling insulation. We have now isolated the point of direct impact.

Figure 2. Example of Isolating Points of Impact



Estimate the Impact of the Program. What remains is to reassemble our previous work and compile it into useful information. This is summarized in Table 3.

We note that both the annual and summer energy usage are directly measurable, while the other two variables require inferences. In the mixed fuel home in our example, its reasonable to define the air conditioning energy usage as the difference between that used during the summer and that used during the winter, (note that winter was not included in our examples). The temperature-dependent air conditioning load can reasonably be assumed as measurable by the air conditioning usage per unit of weather, generally degree-hours or degree-days.

Table 3. Impact of Ceiling Insulation

Point of Impact	Estimated Impact	Measured by
Ceiling heat gain	=50%	not measurable
Temperature dependent air conditioning load	50% x 30% =15%	Change in summer-winter differential per unit weather.
Air conditioning energy usage.	50% x 30% x 40% = 6%	Change in summer-winter differential.
Summer energy usage	50% x 30% x 40% x 50% = 3%	Change in measured energy usage.
Annual energy usage	50% x 30% x 40% x 50% x 59% = 1.8%	Change in measured energy usage.

While the actual program impact will be influenced, as noted earlier, by many factors, a shift in energy usage if it occurs, can normally still be detected. As an example of this, Table 4 contains excerpts of a product evaluation. The specific product is not important to our example.

Table 4. Excerpts from a Product Evaluation

Point of Impact	Estimated Impact	Measured Impact
Annual KWH	2%	.8%
Summer KWH	4%	1.7%
Air Conditioning KWH	8%	2.6%
Air Conditioning KWH per degree-hour	17%	17%

Note the difference in the estimated impact and the measured impact of the first three items. This difference was totally explainable in terms of a change in the weather.

RECORD KEEPING FOR STATISTICAL ANALYSIS

Statistical methods can be an extremely accurate method for program evaluation. However no method of analysis is any better than the data it's based on. While we all like to focus on topics such as program evaluation and planning, we need to remember that good record keeping procedures are essential to the success of any program. Hence, a few thoughts on record keeping.

Common Record Forms

At times a program may have no records. This situation can arise when relying on information from sources, such as contractors, builders, or maintenance personnel. If this occurs, it is usually associated with "routine maintenance" type of programs.

The mere existence of records does not guarantee the information necessary for an accurate evaluation. These records at a minimum should be easily retrievable, include date of participation and contain correct address or other information which can be used to retrieve billing history. Paper and microfiche files have two drawbacks. First, the data cannot be easily reorganized, and second, the information is often difficult to match with that contained on any automated record keeping systems. Therefore, additional time will be required for organizing any data maintained in such static files.

Automated records often present a unique set of problems for the evaluator. Data maintained on one computer system is not always transferrable to another system. For example, program records may be stored on a minicomputer while the billing history is contained in a customer data base on a main-frame computer. Matching them may require manual entry of one data set from one computer onto the other. Hence, time must be allocated for developing procedures and computer programs for data transfer before program evaluation can begin. This data transfer step may not be necessary if program participation is indicated on the customer billing record.

A utility may also have unique record keeping systems for each of its conservation programs. This situation can evolve when separate departments or individuals are responsible for administering each conservation program. For example, records may be only summaries by month in one program and by quarter in another. Generally, comprehensive records can be expected for programs utilizing incentives, cash rebates or coupons.

Ideal Record Keeping

An ideal form for conservation records would be a unique data base with access to a customer's billing history. The desired information per participant includes:

1. Which conservation programs the customer has participated in.
2. The date of each participation.
3. What specific conservation measures were implemented under each program.
4. The specifics on mechanical equipment removed or added as a result of or occurring after participation in a program.
5. Any changes in operating schedules due to or occurring after program participation

Utilities will normally collect information on items 1, 2, and and part of 4 (the equipment they help subsidize). Information under items 3 and 5 may be collected when necessary by polling a sample of participants. A standard format in the conservation data base will decrease statistical software development time and allow for greater software transferability between programs.

An all inclusive conservation data base should provide insight into which groups tend to participate in which types of programs. Such information would be helpful when planning future programs. A "cross-over" effect, when a participating customer learns about and enrolls in another program, may be detectable with this type of data base. It may also reveal a "spill over" effect; where a customer having participated in a program tells a neighbor who then uses the information to save energy. Having identified program participants, we can thus readily determine nonparticipants. Nonparticipants are an important control group having experienced the same weather and rate hikes as participants. Nonparticipants are also a likely target for conservation program promotions.

The effort to create such a conservation data base requires substantial development and maintenance time, and data entry must be kept current.

Closing Comments

Regulatory agencies are now providing an incentive to standardize conservation records by requiring program evaluations. In response, utilities should develop a standard conservation data base if they have not already done so. While this will require significant development time, the advantage for the utility company is reduced analysis time on future programs.

Once a standard program data base is available, all future program data should also be stored there. Program participation forms can be revised to match the data base layout, thus easing data entry. Planned evaluation efforts should accurately define the type of program information desired for a standard data base.

This conservation data base will provide a standard data structure for program analysis. Measured program effectiveness then serves as feedback for future program planning.

SUMMARY

We feel that planning a program without including a method of evaluation is incomplete planning. Evaluative methods utilized during the planning phase of a project not only provide a wealth of information for planners, but also provides benefits for program managers and evaluators. Program managers benefit in areas such as having well defined program goals, established record collection and maintenance procedures, and by a rapid evaluation of programs. For evaluators, inclusion at the planning stage allows the opportunity for input from all concerned parties to be incorporated into an agreed upon methodology. This can eliminate potential conflicts in areas as legitimacy of method, data collection procedures/parameters, and measurable variables.

We also encourage the development and use of a standard methodology for evaluating the results of energy conservation programs. We realize the impossibility of a single method being relevant in all cases. But, it should be possible to outline standard, evaluative procedures which would be appropriate to most programs. This would allow comparisons of similar programs in different sections of the country, nearly an impossible task today. Such comparisons would be useful for optimizing programs for each area. Results from one utility can serve as a base to be adjusted by another utility considering similar programs. Our hats are off to the staff of the Texas Public Utilities Commission. They have recognized this potential and are pursuing the possibilities.