PROGRAM PLANNING TO PLEASE ALL OF THE PEOPLE ALL OF THE TIME

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ABSTRACT

Key words: Cost-effectiveness analysis, program design, program evaluation, program planning, demand-side programs.

For a building energy efficiency program to be successful it doesn't need to "please all", but it must be considered beneficial or cost-effective by the decision makers involved. This paper presents and demonstrates a simple analytical tool to aid in demand-side program planning, design, and evaluation.* This tool requires very little time, effort, and data to quickly calculate and recalculate the cost-effectiveness of a potential or existing program from the following points of view: the program participant, the non-participating ratepayers, all ratepayers, utility resource planning, and society. A tool like this is essential for program planning for the following reasons:

1. Sensitivity analysis is easily performed which allows valuable resources to be focused on estimating the program design elements that most strongly affect cost-effectiveness.

2. Any decision is easier with complete information. This tool brings all of the elements of cost-effectiveness together creating a simplifying context for program decisions.

3. Knowledge of the cost-effectiveness of the program and the factors affecting it is invaluable in supporting and justifying a program.

4. Quick calculation allows easy monitoring of regulatory cost-effectiveness criteria, and full support documentation is readily available.

5. Use of this type of tool enables program designers to approach "pleasing all of the people all of the time".

* A microcomputer-based example of this type of tool is available and will be demonstrated during the Summer Study.

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INTRODUCTION

For a building energy efficiency program to be successful it doesn't need to "please all", but it must be considered beneficial or cost-effective by the decision makers involved. The benefits must exceed the costs. The program may be offering or promoting the use of the latest energy efficient technology and equipment and it may offer enticing incentives, but that is not the basis on which the final decision to offer the program will be made. The program must satisfy the goals and objectives of the utility offering it.

This paper discusses energy efficiency technology in terms of its use in utility energy and load management programs. Many utilities and many of their regulatory commissions require cost-effectiveness analysis to support and justify utility programs. This paper presents and demonstrates a simple analytical tool to aid in utility program planning, design, and evaluation. This tool is a software model package that simplifies and brings all of the elements of cost-effectiveness analysis together for the program planner. This allows energy efficiency programs to be designed while ensuring their cost-effectiveness to the utility and regulatory commission(s). Although this tool is aimed at utility use, equipment vendors may also wish to use it to build supporting documentation to sell their technology.

This paper is organized as follows. The first section presents a discussion of possible utility goals which can be met with energy management programs and how these programs are evaluated given these goals. The next section discusses the benefits of using this tool in the design and evaluation of potential and existing programs. We will then walk through the analysis of several variations of a efficient lighting equipment program to demonstrate the use of the cost-effectiveness model. The last section presents our conclusions.

THE ROLE OF ENERGY MANAGEMENT PROGRAMS IN MEETING UTILITY GOALS

Utilities have many possible goals that may be achieved by energy and load management programs. Several possible utility goals are discussed below. With each of these goals is a brief discussion of how a program could achieve this goal and how achievement is measured. Measurement of the goal achievement is discussed in terms of cost-effectiveness analysis from various perspectives.

To enhance the discussion of cost-effectiveness, a quick synopsis of the components of the analysis is given. As can be seen, a variety of information must be brought together to evaluate these programs. The basic components of cost-effectiveness analysis are the following:

- **Generation and Capacity Savings**, which is the dollar value of the reduction in the need for energy generation (usually kilowatt-hours, but can also be therms) and demand capacity (usually in kilowatts). These savings are a reduction to revenue requirements and are the product of:

-- The Marginal Costs of generation and capacity which are calculated from the information in the resource plan and are based on the cost of the next supply unit; and

-- The Energy and Demand Impacts of the program, which affect the system load curve and are a function of:
  a. the impact per participant; and
  b. the participation rate.

- **Revenue Loss**, which is the lost revenue from the reduction in sales and is made up of:

-- The Rate Structure of the class affected by the program; and

-- The Energy and Demand Impacts of the program, as above.

- **Program Costs** which are paid by the utility.

- **Program Costs** which are paid by the participant.

- **Incentives** paid by the utility to the participant.

POSSIBLE UTILITY GOALS

Minimize Revenue Requirements

With a goal to minimize revenue requirements or the total costs of producing energy, a utility would promote programs that caused a net reduction in revenue requirements. That is, the reduction in generation and capacity costs from the reduction in energy use must be greater than the cost of offering the program. These programs would be a "least cost" resource to the utility. A related, but more specific, goal would be to reduce the need for new capacity. The program must cost less than the peak demand savings valued at the marginal cost of demand (the cost of new capacity). This perspective is called the Utility Revenue Requirements Perspective.

Minimize Rates

Since conservation and load management programs affect the demand for energy, the related reduction in generation and capacity costs is accompanied by a reduction in revenue due to the loss of those sales. The revenue loss or reduction from those lost sales may have to be recovered in the form of higher rates. If the generation and capacity savings exceed the combined costs of the revenue loss and the cost of the program, rate levels can be expected to drop. If the generation and capacity savings are less than the revenue loss and the cost of the program, rate levels can be expected to increase. This perspective is called the Impact on Rate Level (or the Non-Participant or No Loser's) Perspective.

Improve Customer Relations

A utility with this goal might wish to achieve it through several means. One might be the offering of programs that will allow participants to reduce their total cost of energy. If the bill reductions from participation on a program, plus any incentives received, exceed the out-of-pocket and other costs to a participant, the program has reduced the total cost of energy to a customer. If a program is voluntary, it is important that this be true. Otherwise there will be no or very few participants on a program, and therefore, no change achieved in energy demand for the utility. This perspective is called the Participant Perspective.

A utility may also want to offer a program that would lower the total cost of energy to a customer even though the program is not beneficial to the utility. A utility may want to do this simply to promote customer satisfaction by offering alternatives to high energy costs.

Ensure Favorable Regulatory Treatment

A utility with this goal wishes to offer programs that satisfy the goals of its regulatory body. Many regulatory commissions promote programs that lower the total cost of energy services to the utility service territory. That is, programs where the generation and capacity savings exceed the sum of the utility's program costs and the costs of the program to the participants. The savings to the service territory exceed the total cost to the territory which makes the program a least cost resource to the service territory. This perspective is the All Ratepayers Perspective.

Regulatory commissions may also adopt perspectives equivalent to those utilities' perspectives discussed above. Commissions may also promote programs that offer a benefit to society as a whole. That is, the reduction in the use of scarce resources as measured by the generation and capacity savings plus any external benefits exceeds the cost of the program to the utility and to the participants, and any other external costs. This is the Society Perspective.

The perspectives for cost-effectiveness analysis as discussed above are based on the cost-benefit methodology formally adopted and as proposed amended by the California Public Utility Commission and the California Energy Commission in their Standard Practice for Cost-Benefit Analysis of Conservation and Load Management Programs, February 1983. Although based on the California methodology, these perspectives are consistent with most of the cost-effectiveness tests used in the nation.

BENEFITS OF USING A COST-EFFECTIVENESS MODEL AS AN ANALYSIS TOOL

As can be seen in the discussion above, many types of information must be brought together in order to evaluate the cost-effectiveness of a program. The information needed can be divided into two main catagories, which we will call program data and system data. Program data includes information most familiar to program planners, designers, and evaluators. This information includes the program participation levels, the changes in energy and demand use or impacts per participant, the incentive paid, the capital, administrative and operating and maintenance costs of the program to the utility, and the capital and operating and maintenance costs to the participant.

System data includes information that describes the utility system characteristics. This information is the marginal cost of capacity and energy for the system and the rate structure for the class of customers affected by the program. The marginal costs are used to value the changes in energy and demand use as generation and capacity savings. The rate structure is used to estimate the revenue loss resulting from the lost sales due to the change in energy and demand use.

Much time and research effort is spent quantifying each of the elements of both the program data and the system data. But all of this information is needed to evaluate the cost-effectiveness of a program. That is why there is a need for some system or method which allows program planners to bring each of these pieces of information together and determine the effect on the cost-effectiveness of their programs. If planners want to develop successful programs, ones that will be implemented as well as achieve their intended impact, they must know how these elements interact and determine the cost-effectiveness of their programs.

In response to this perceived need a simple analytical tool can be helpful. One example is **DSPlanner**, which was developed by BHC in conjunction with utility clients. This tool is an easy to use software model package that brings together the required program data and system data and calculates the cost-effectiveness of a potential or existing program from each of the perspectives of analysis discussed above.

The analysis performed in this paper utilizes this package. The intent is to demonstrate the need for this type of tool and is not to promote this particular software.

Efficiency of the Design Process

By using a tool that brings all of the elements of cost-effectiveness analysis together program design and analysis can proceed more efficiently. Even though the quantification of each of the information elements may be difficult, in most cases a general order of magnitude or range is known. This information can be entered into the model and a "first cut" analysis performed.

Although the estimates used for each value may not be acceptable as final numbers to utility and regulatory decision-makers, the results of analysis using this type of data are valuable. For example, one of the elements that is particularly difficult to quantify is the energy and demand impacts that result from a customer's participation in the program. Although these impacts are utility-specific, general ranges for the impacts are known from similar programs at other utilities. If nearby utilities are achieving demand reductions of 0.5 to 2.0 kilowatts per residential customer for a weatherization program, before expending extensive time and funds determining whether the value is 1.25 or 1.5 for your utility, it could be very valuable to determine if the program is cost-effective at 0.5 kW. If it is, then any additional savings will simply strengthen the cost-effectiveness determination. If it is not, it may be valuable to determine at what level of savings the program is cost-effective. If the program is not cost-effective even with savings of 2.5 kW, it most likely will not be implemented at your utility in any case.

Sensitivity Analysis

Similar sensitivity analysis can be performed for other elements of program design. A valuable input to the determination of the appropriate incentive (if any) to pay for a program is the maximum amount that could be paid and have the program remain cost-effective. This is easily determined from the results of the model.

Participation rates are also difficult to predict. They depend on many factors, including the marketing and advertising assumed and the incentive offered. This tool allows a quick analysis of the impact on a program's cost-effectiveness of achieving only half the participation assumed, achieving full participation later in the program than assumed, or if twice the number of customers sign up.

This type of sensitivity analysis is invaluable for program planners. It allows time and effort to be focused on quantifying the elements that most affect the successful implementation of a program.

Quick Analysis of the Effect of System Changes

Analysis of program merits can also be quickly performed if the utility's system characteristics change. As new resource plans are adopted with resulting new sets of marginal costs, programs can be reevaluated to determine if they are still beneficial given the new system characteristics. Also as rates and rate structures change, program cost-effectiveness is affected. Full documentation of the effect of the changes is easily obtainable from the model.

Full Information

When a program planner has at his fingertips the ability to determine the impact of a change in any of the inputs to cost-effectiveness analysis, he has access to a wealth of information about his program. Any decisions are easier with complete information, and this tool enables decision making to be as simple as possible. The resulting impact on a program's cost-effectiveness can be determined instantaneously from almost any combination of assumptions proposed.

When it comes time to justify a program to upper management or to the regulatory commission or ratepayers, the information available from this type of model is invaluable. Not only is detailed output for each perspective available for the program proposed, but it is easily available for variations of the program used to justify the final program. Possible questions or comments concerning a proposed program can be anticipated and answers easily prepared in advance.

EXAMPLE OF THE USE OF THE COST-EFFECTIVENESS MODEL

In order to demonstrate the use of this type of analytical tool, this section of the paper will walk through the analysis of several variations of a program which a utility might consider to promote the adoption of new, energy efficient lighting technologies. The program is promoting four types of measures to commercial buildings. These are:

- Change standard 4 foot fluorescent lamps to more efficient lamps;
- Change standard 8 foot fluorescent lamps to more efficient lamps;
- Install occupancy sensors; and
- Replace both lamps and ballast with efficient lamps and solid state ballast.

System Data

We are assuming that the utility is a summer peaking utility with the marginal cost structure shown in Table I. The commercial rate structure is also shown in Table I. The demand charges are shown for the entire period, thus, the $27.72 summer on-peak demand charge is the monthly charge of $4.62 times six months.

Program Data

It is assumed that the average commercial customer would have peak savings of 38.4 kilowatts and a total annual energy savings of 150,667 kilowatt-hours. These savings have been allocated to summer and winter seasons and peak and off-peak periods as shown in Table I. The assumed timing of the impacts is important for the correct valuation of the savings. We are also assuming that the life of the equipment is 3 years. Occupancy sensors will last longer but their impact is a small portion of the total impact of the program.

We are assuming a four year program with a total of 300 large commercial customers participating in the program. Fifty are assumed to join in the first year, 75 in the second year, 100 in the third and 75 in the fourth year.

The utility's program costs are assumed to be $70,000 a year for the four years of the program. This cost is to cover advertising, promotion, and the staff costs to administer the program. The cost to the participant is assumed to be $27,900 to cover the purchase and installation of the energy efficient equipment.

For this first program we are assuming that no incentive will be paid to the participants. The belief is that the reduction in their electric bills will be the incentive.

RESULTS

These are all reasonable assumptions for a program. All of this information can be entered into the model in under 10 minutes. As can be seen in Table II, the cost-effectiveness from a Utility Revenue Requirements perspective is very strong. The utility sees a reduction in its revenue requirements or its total costs of producing electricity of $9.9 million, from the reduced need for generation and capacity, at a cost of $266,800. Sounds like a great investment. This program is definitely cheaper to the utility than the generation and capacity plant alternatives and is therefore a "least cost" alternative to the utility when compared to the supply alternatives. This analysis would have to be compared to that for other programs to indicate if this program is the "least cost" alternative.

The participant doesn't fare as well. The present value of their bill reductions is $7 million, but the total cost of the equipment is $7.9 million. The program has a net cost of $0.9 million to the participants and a benefit-cost ratio below one of 0.88. The utility may not get any participants on this program with these figures. This analysis shows that energy efficient lighting is not cost-effective to commercial customers under present rates and these assumptions.

The program as it stands will lower rate levels as seen in the Impact on Rate Level perspective. The $9.9 million in generation and capacity savings more than covers the sum of the utility's program costs and the revenue loss of $7.2 million. This leaves a net benefit of $2.7 million to lower rates. The rate reduction can be estimated by dividing the net benefit of $2.7 million by total sales. If total sales were 300 gigawatt-hours, the estimated rate reduction would be about $.01 per kilowatt-hour.

Finally, from an All Ratepayers perspective the benefits to the ratepayers of the generation and capacity savings of $9.9 million more than offset the total costs of the program of the sum of the utility and participant program costs. The positive net benefit of $1.7 million and the benefit-cost ratio of 1.21 indicate that this program is a "least cost" alternative to the service territory or to all ratepayers when compared to the generation and capacity alternative represented in the marginal costs.

ANALYSIS OF THE RESULTS

To sum up this analysis, the program looks good to the utility revenue requirements, to all ratepayers, and to the rate levels, but it doesn't look good to the participants. Since the analysis is based on an assumption of 300 participants, without a cost-effective participant perspective this assumption falls to zero and the analysis is moot.

Before throwing the whole thing out, let us look at what can be done to improve the program to the participant. We need to increase their benefits or reduce their costs. If we believe the assumed cost of the equipment is reasonable, we cannot reduce their costs. To increase their benefits, we would need to increase their bill reductions through increasing their rates (not likely), increase the energy and demand reductions (let us say these were reasonable numbers to begin with) or offer an incentive.

How large does this incentive need to be? We need an incentive large enough to cover the net cost of the program to the participant. This is easily estimated from the results in Table II. The net cost to the participant perspective is $940,000. If we divide this number by the number of participants (300) we get an incentive of approximately $3,100 per participant. This incentive of $3,100 per participant will cover the net cost of the program to the participants and cause the benefits of the program to approximately equal the costs.

How large could this incentive be? The largest incentive that could be paid without increasing rate levels can be estimated from the net benefit to the Impact on Rate Level perspective. Incentives are a cost to this perspective. Therefore, if we take the net benefits of $2.7 million and pay it out as incentive to the 300 participants, the incentive could be as much as $9,000. With two quick calculations we have determined a range for the incentive. The lower end of $3,100 is the least that can be paid and have the program be feasible to participants and the higher amount of $9,000 is the most that could be paid and not increase rates.

NEW PROGRAM ASSUMPTIONS

Assume that this is a utility that doesn't necessarily require programs to lower rates, but favors programs that are not going to raise rate levels. Given this assumption, we analyzed the program assuming an incentive of $9,000 was paid to each participant. Essentially the utility is rebating nearly one third of the equipment cost ($9,000 incentive/$27,900 equipment cost). The rest of the program assumptions remain the same as in the first analysis. The results of this program are in Table III.

The benefits and costs to the Utility Revenue Requirements and the All Ratepayers perspectives remain the same. This is because incentives are in most cases considered rate reductions and not part of the revenue requirements, and therefore, are not part of utility program costs. Incentives are considered to be transfer payments or shifts in revenue collection.

As expected the Participant perspective looks good. The benefits from the program have increased due to the incentive from $7 million to $9.5 million. The costs remain the same at $7.9 million and the net benefits are now positive at $1.6 million for a benefit-cost ratio of 1.20. The positive net benefits and the assumption of a 3 year equipment life indicate that the payback period is less than 3 years. This is now an attractive program to commercial customers.

The benefits from the Impact on Rate Level perspective remain the same at $9.9 million and the costs increase to $9.8 million for a small net benefit of $108,810 and a benefit-cost ratio near one. This indicates that rate levels will not be affected by this program.

Now this is a highly feasible program. It looks good from all of the perspectives and is made up from a reasonable set of assumptions. Now the fine tuning can begin. Will we really get those impacts? What happens if we get less? We know from our analysis that achieving impacts greater than those assumed only can strengthen the cost-effectiveness from all perspectives.

Of course, our analysis above went from no incentive to a $9,000 incentive with no change in participation rates. There is a strong relationship between participation and incentives that must be considered. Further analysis might entail estimating the participation level appropriate for the assumption of a $9,000 incentive and recalculating the model to see how the new participation assumption affects cost-effectiveness. Participation is also influenced by marketing. The relationship between the utility's program costs and participation might be checked.

The bottom line is that in approximately 20 minutes worth of data entry, model calculation, a quick estimation on the calculator and recalculation of the model, we now know quite a bit about the feasibility of this program and can focus our efforts on fine tuning the key variables.

ANALYSIS FOR A CHANGE IN THE RESOURCE PLAN

Now, what happens if the resource plan of the utility changes, or similarly, this program is considered at another utility with a different resource plan. Under this new resource plan, the utility is in more of a surplus situation. The new marginal costs are presented in Table IV. There is surplus capacity off-peak, so the marginal costs of capacity are zero for those periods. The on-peak capacity can be met with a larger percent of cheaper capacity which lowers the marginal costs during the on-peak periods.

The marginal energy is also being met with a higher percent of cheaper generation which lowers the marginal costs of energy.

What happens to the same program under these new marginal costs? The results of this analysis are in Table V. As can be seen, the costs to each perspective remain the same. Also the benefits to the participants remain the same. The change in the marginal costs do not affect them. The only element that changes is the generation and capacity savings, which are the benefits to the Utility Revenue Requirements, the Impact on Rate Level and the All Ratepayer perspectives.

The Utility Revenue Requirements perspective still looks strong with a net benefit of $6.7 million (down from $9.9 million) and a benefit-cost ratio of 25.19. The program is still a great investment from this perspective and remains substantially cheaper than the supply alternative.

The results for the Impact on Rate Level perspective indicate that this program will now increase rates to the tune of $3.1 million in additional revenue that must be collected (net cost). Lowering the incentive to $3,100 would lessen the increase in rates (by lowering the net cost to approximately $1.3 million -- $9,000 minus $3,100 times 300 subtracted from $3.1 million), but would not keep rate levels from increasing.

The All Ratepayers perspective indicates that the program is no longer a "least cost" alternative to the service territory. The generation and capacity savings of $6.7 million do not cover the combined costs to the utility and to the participants of $8.2 million.

This analysis illuminates two points. First, that the cost-effectiveness of a program can change dramatically with a change in the utility's system characteristics. A change in the resource plan causing a change in the marginal costs affects the cost-effectiveness of a program. Changes in rates can also change cost-effectiveness from the Impact on Rate Level and the Participant perspective. Program planners will have to justify their programs under the new system assumptions. With this analysis tool the effect of changes in the system can be calculated quickly and the analysis of anticipated changes allows for pre-planning.

The second point is that the same program will not always work for all utilities. It is well known that program impacts change from utility to utility, but the different marginal costs and rates at each utility also affect the feasibility of the same program.

CONCLUSIONS

Use of this type of tool enables program designers to approach "pleasing all of the people all of the time." Sensitivity analysis is easily performed with the model, which allows valuable resources to be focused on estimating the program design elements that most strongly affect cost-effectiveness. Also, any decision is easier with complete information. This tool brings all of the elements of cost-effectiveness together creating a simplifying context program decisions. Knowledge of the cost-effectiveness of the program and the factors affecting it is invaluable in supporting and justifying a program. And finally, the quick calculation allows easy monitoring of regulatory cost-effectiveness criteria, and full support documentation is readily available.

Table I: Assumed marginal costs, rates and energy and demand reductions for the commercial energy efficient lighting program example.

	Marginal Costs		Commercial Rates		Program Impacts	
	Capacity	Energy	Demand	Energy	kW Demand	kWh Energy
Summer On-Peak	$37.09	$.058	$27.72	$.046	38.4	25,613
Summer Off-Peak	$ 5.35	$.048	$ 0.00	$.046	16.8	48,213
Winter On-Peak	$25.32	$.064	$21.60	$.046	25.1	10,547
Winter Off-Peak	$ 2.29	$.064	$ 0.00	$.046	20.8	64,787
Total						150,667

Table II: Cost-effectiveness analysis of the commercial energy efficient lighting program example - no incentive.

Perspective	Program Benefit	Program Cost	Net Benefit	Benefit-Cost Ratio
Utility Revenue Req.	$ 9,925,837	$ 266,800	$9,659,037	37.20
Participant	$ 6,991,729	$7,931,344	($ 939,615)	0.88
Impact on Rate Level	$ 9,925,837	$7,092,864	$2,667,308	1.37
All Ratepayers	$ 9,925,837	$8,198,144	$1,727,693	1.21

Table III: Cost-effectiveness analysis of the commercial energy efficient lighting program example - $10,000 incentive.

Perspective	Program Benefit	Program Cost	Net Benefit	Benefit-Cost Ratio
Utility Revenue Req.	$ 9,925,837	$ 266,800	$9,659,037	37.20
Participant	$ 9,550,227	$7,931,344	$1,618,883	1.20
Impact on Rate Level	$ 9,925,837	$9,817,027	$ 108,810	1.01
All Ratepayers	$ 9,925,837	$8,198,144	$1,727,693	1.21

Table IV: Assumed change in marginal costs due to a new utility resource plan commercial energy efficient lighting program example.

	Old Marginal Costs		New Marginal Costs	
	Capacity	Energy	Capacity	Energy
Summer On-Peak	$37.09	$.058	$24.00	$.040
Summer Off-Peak	$ 5.35	$.048	$ 0.00	$.035
Winter On-Peak	$25.32	$.064	$12.00	$.045
Winter Off-Peak	$ 2.29	$.064	$ 0.00	$.045

Table V: Cost-effectiveness analysis of the commercial energy efficient lighting program example -- $10,000 incentive - new marginal costs.

Perspective	Program Benefit	Program Cost	Net Benefit	Benefit-Cost Ratio
Utility Revenue Req.	$ 6,720,445	$ 266,800	$6,453,645	24.19
Participant	$ 9,550,227	$7,931,344	$1,618,883	1.20
Impact on Rate Level	$ 6,720,445	$9,817,027	($3,096,582)	0.68
All Ratepayers	$ 6,720,445	$8,198,144	($1,477,699)	0.82