COST-EFFECTIVENESS ENLIGHTENMENT: WHICH IS THE RIGHT TEST?

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Introduction

Ever since its beginnings, demand-side management (DSM) has evoked arguments concerning the appropriate cost-effectiveness criteria in the selection of programs. After more than a decade, the issue is still being argued in forums ranging from academic journals to regulatory hearing rooms. The argument is generally made on efficiency grounds: *Which test promotes the selection of programs that will result in the least cost provision of energy service?* But the questions that are often ignored here are: *Least cost to whom? Efficiency from which point of view?*

A large portion of the debate pits the advocates of the "no losers" or ratepayer impact measure (RIM) test (a test that looks at the effect of a program on rate levels) against the advocates of the total resource cost (TRC) or all ratepayers test (a cost test that looks at whether a unit of conservation is cheaper than a unit of the operation or the addition of the next power plant).

The arguments have become confused because both parties view the problem too narrowly. Each is only considering efficiency or "least cost" from one point of view. The RIM advocates look at efficiency from the point of view of the utility's customers and their rate levels, especially in consideration of those customers not on the program. The TRC advocates look at efficiency from the point of view of the service territory as a whole (the utility and its ratepayers together) or from the point of view of total resource use. What is missing here is a consideration of equity. Correct DSM decisions cannot be made without reference to both efficiency and equity as goals.

This paper begins with a definition of the commonly used cost-effectiveness tests, and discusses the points of view represented by each in terms of efficiency and their impacts on equity. Next, an example is given demonstrating the implications of program selection under each test for a hypothetical utility. Finally, a methodology for DSM selection is proposed which acknowledges both the efficiency and equity impacts of the programs.

Definition of the Commonly Used Cost-effectiveness Tests

Five main tests are used to measure the cost-effectiveness of demand-side programs in use across the nation. Each represents a different point of view on the efficiency or "least cost" of a DSM program. They go under different names in different parts of the country, but the names used in the ***California Standard Practice*** are:

- The Participant Test
- The Ratepayer Impact Measure Test
- The Total Resource Cost Test
- The Utility Cost Test
- The Societal Test

Each is discussed in turn below.

The Participant Test

The participant test measures the benefits and costs to a customer due to participation in a DSM program. Benefits include reduction in energy bills, incentives, and appliance or equipment costs that are now avoided due to participation in the program. Costs include any increases in energy bills and any out-of-pocket expenses the customer pays to be in the program.

There is not much controversy about this test. It is generally agreed that all programs must pass this test, if only because a program that is not beneficial to customers will not have participants. This test can be seen as a measure of the efficiency of the program to the program participant.

The Ratepayer Impact Measure Test

The ratepayer impact measure (RIM) test is also known as the "no losers test," the "nonparticipant test," and the "impact on rate level test." The RIM test measures what happens to average rate levels due to changes in utility revenues and operating costs caused by the program. In general, if the reduction in revenues due to a decrease in sales caused by the program is greater than the reduction in the costs to the utility, rate levels must go up to cover the deficiency. The benefits considered in this test are

the reduction in utility supply costs and any increase in revenues. The costs are any increases in utility supply costs, revenue loss, program costs paid by the utility, and any incentives paid to the participants. The benefits and costs to this test are also illustrated in Figure 1.

Efficiency in terms of the RIM test is a lowering of rate levels or average costs. In general, changes in rate levels affect all customers. Therefore, at first glance this test can be seen to ensure equity.

The Total Resource Cost Test

The total resource cost (TRC) test is also known as the "all ratepayers test." The TRC test measures the net benefits of a DSM program in terms of total resources expended to meet an energy demand. Total resources here include utility supply costs, plus both the utility program costs and the net incremental costs paid by the participant. As can be seen in Figure 1, the benefits to this test are the reduction in utility supply costs, plus any appliance or equipment costs avoided by the participant due to the program. The costs are any increases in supply costs, plus all of the program costs paid by either the utility or the participant. Incentives and revenue impacts are not included in this test, because they are dollar transfers between the utility and the participants and thus do not affect the total resource expenditure of the whole (the utility plus all ratepayers).

The TRC test measures efficiency in terms of resource expenditures of the utility and its ratepayers as a whole. Since total resource expenditures for energy are considered to drop when a program passes the TRC test, it follows that the total cost of energy services for the average customer also will drop. The total cost of energy services for a customer includes his or her energy bill, plus any related equipment costs. In terms of equity, only customers who can take advantage of the program will experience the drop in their cost of energy services (other than through rate reduction). Nonparticipants will see no change in costs or a change only in their energy bill due to any rate change that might result from the program.

The Utility Cost Test

The utility cost test has also been called the "utility revenue requirements test." The utility cost test measures the net benefit of a program to a utility's total costs. Incentives are included as a cost to the utility, and participants' costs are ignored. As seen in Figure 1, the benefit to this test is the reduction in utility supply costs. The costs are any increases in utility supply costs, the program costs paid by the utility, and any incentives paid to the participants.

The utility cost test measures efficiency in terms of total costs to the utility. Since total costs to the utility drop when a program passes the utility cost test, it follows that the energy bill of the average customer will also drop. In terms of equity, as with the TRC test in the absence of a decrease in rates, only customers who can take advantage of the program will experience the drop in their bill.

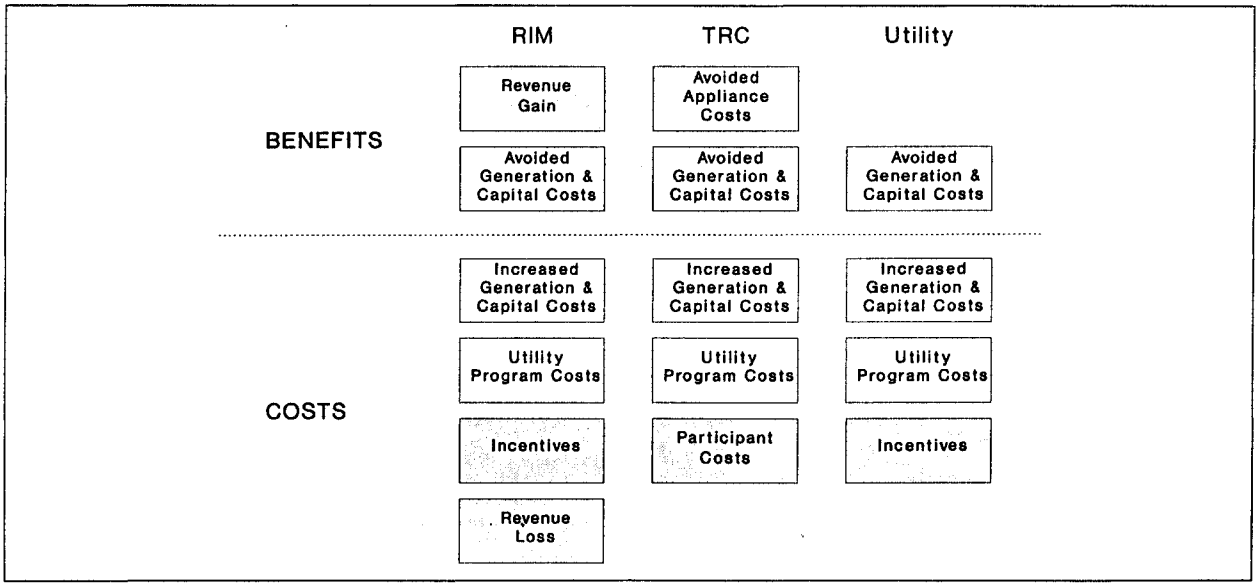

Figure 1. Comparison of Cost-effectiveness Tests

The Societal Test

The societal test attempts to measure the change in total resource costs to society as a whole. In structure, the societal test is similar to the TRC test. The differences lie in trying to quantify the changes in resource costs to society as a whole rather than only to the service territory (the utility and its ratepayers). The benefits and costs of the societal test include those of the TRC test; they add consideration of "externalities" and the use of a societal discount rate.

The societal test measures efficiency in terms of the total resource cost to society. In terms of equity, as with the TRC test in the absence of a decrease in rates, only customers who can take advantage of the program will experience a direct drop in their energy service costs. However, it can be argued that society as a whole benefits from the overall reduction in resource use and experiences the benefits or costs of the "externalities."

An Example

As can be seen from the discussions above, each test measures efficiency from a different point of view. In terms of equity, one test (RIM) ensures that all ratepayers benefit through a reduction in rates, or at least that none are harmed through a rate increase. Three other tests (TRC, utility cost, and societal) measure various benefits to the average customer, but in the absence of a rate decrease, only customers who actually participate experience the direct benefits of the program. The equity argument seems to lie in whether it is better to benefit all customers or the average customer. This would not be much of an argument, except that when rates are higher than marginal costs, which is quite common these days, almost no program can pass the RIM test. Is it equitable to deny DSM programs to customers who want options to lower their costs? The real argument, then, is whether it is better to have no DSM and benefit no one, or to have programs that benefit the average customer.

One point not brought out above is that if all customers participated in a DSM program that passed the TRC test, all customers would experience the drop in their costs of energy services. It would not matter whether rates went up. Their total cost of energy services would still go down. Tables 1 and 2 contain a set of examples illustrating the impacts on customers' bills of a DSM program offered under different circumstances. Table 1 contains an example DSM program offered to all customers and then to one large customer for a utility with marginal costs higher than rates. Table 2 contains the same program, but for a utility with rates higher than marginal costs.

In all of the examples, the hypothetical utility has one large customer with 90% of the load (90,000 kWh per year) and five small customers with a total of 10% of the load (2,000 kWh per year each). The DSM program is assumed to cost $150 and is to reduce energy use 25% for each of the customers on the program. The program costs are all paid by the utility, and there are no incentives or customer costs. (Since there are no incentives or customer costs in the example, the results for the TRC test are identical to those for the utility cost test, and reductions in the cost of energy services equal the reduction in the customer's bill.)

In the example in Table 1, marginal costs are assumed to be 6¢ per kilowatthour and rates are 5¢ per kilowatthour. Marginal costs tend to be higher than rates for utilities that are capacity constrained.

As can be seen in Table 1, when marginal costs are higher than rates, all customers' bills drop in both cases—Case 1, the program offered to all customers; and Case 2, the program offered only to one large customer. The program also passes both the RIM test (benefit-cost ratios of 1.07 and 1.06) and the TRC test (benefit-cost ratios of 10.00 and 9.00). Rate levels drop from 5¢ per kWh to 4.9¢ per kWh. In Case 1, the bill reductions are larger since all customers are experiencing the benefit of both a reduction in rates and a reduction in energy use. In Case 2, the bill reductions are smaller, especially for the small customers, as they are no longer reducing their energy use. The bill reductions for the small customers in Case 2 reflect only the rate decrease.

Table 2 illustrates the impacts of the same program offered at a utility with rates higher than marginal costs—e.g., a utility without a significant capacity constraint. As can be seen, the program no longer passes the RIM test (benefit-cost ratios of 0.76 and 0.75). Rate levels are expected to rise from 6¢ per kWh to 6.5¢ per kWh. Both cases pass the TRC test with benefit-cost ratios of 8.33 and 7.50.

Note that even though rate levels rise in Case 1, all customers' bills go down—significantly. This is because the reduction in each customer's bill due to lowered energy use is greater than the bill increase due to the increase in rates. However, in Case 2, where only the large customer participates, only the bill of the large customer goes down. Here the small customers experience a bill increase due to the program and its rate increase.

In summary, when a program can pass RIM and rates go down, all customers benefit, whether they are on the program or not. When a program does not pass RIM, but does pass the TRC, all customers who are on the program (and the "average" customer) benefit, but those not on

Table 1. Cost-effectiveness of a DSM Program when MC > Rates

Total system load:	100,000 kWh/yr
Large customer	90,000 kWh/yr
Small customers:	10,000 kWh/yr
Each small customer:	2,000 kWh/yr
Load reduction due to the program:	25%
Program cost (no incentives):	$150.00
Marginal Costs Greater than Rates	
Marginal cost:	0.06 $/kWh
Rates:	0.05 $/kWh
Cost-effectiveness results	

	CASE 1 All Customers Participate	CASE 2 Only Large Customers
RIM benefits:	$1,500	$1,350
RIM costs:	$1,400	$1,275
RIM B/C ratio:	1.07	1.06
LRI-RIM ($/kWh):	($0.001)	($0.001)
TRC benefits:	$1,500	$1,350
TRC costs:	$150	$150
TRC B/C ratio:	10.00	9.00
Rate w/RIM recovery:	$0.049	$0.049
Large customer —		
Old bill ($/yr):	$4,500	$4,500
New bill ($/yr):	$3,285	$3,310
Small customer —		
Old bill ($/yr):	$100	$100
New bill ($/yr):	$73	$98

Table 2. Cost-effectiveness of a DSM Program when Rates > MC

Total system load:	100,000kWh/yr
Large customer	90,000kWh/yr
Small customers:	10,000kWh/yr
Each small customer:	2,000kWh/yr
Load reduction due to the program:	25%
Program cost (no incentives):	$150.00
Rates Greater than Marginal Costs	
Marginal Cost:	0.05$/kWh
Rates:	0.06$/kWh
Cost-effectiveness results	

	CASE 1 All Customers Participate	CASE 2 Only Large Customers
RIM benefits:	$1,250	$1,125
RIM costs:	$1,650	$1,500
RIM B/C ratio:	0.76	0.75
LRI-RIM ($/kWh):	$0.005	$0.005
TRC benefits:	$1,250	$1,125
TRC costs:	$150	$150
TRC B/C ratio:	8.33	7.50
Rate w/RIM recovery:	$0.065	$0.065
Large customer —		
Old bill ($/yr):	$5,400	$5,400
New bill ($/yr):	$4,410	$4,377
Small customer —		
Old bill ($/yr):	$120	$120
New bill ($/yr):	$98	$130

the program experience an increase in their bills due to the increase in rates.

The Question: Which Test is the Right Test to Use?

It is proposed that neither test is the right test to be used in isolation. The selection of DSM programs requires consideration of both types of tests, and both goals—efficiency and equity. The following methodology is proposed for the selection of DSM programs. Stated simply:

Step 1: Implement all programs that pass the RIM test.

Step 2: Eliminate all programs that do not pass the TRC test.

Step 3: Evaluate the distributional impacts of the remaining programs.

Of course there are exceptions to this set of steps depending on each utility's situation, and some of these will be discussed below. Also assumed here is that the programs pass the participant test—that they are cost effective (beneficial) to the customers participating in the program. [Note: It can be shown that if a program passes the participant test and the RIM test, it will (with rare exception) pass the TRC test.]

In more detail, this methodology proposes that—barring constraints to the utility not accounted for in standard cost-effectiveness analysis—all programs that pass the RIM test should be implemented. These programs have shown themselves to be cheaper than the supply-side

alternative and have benefits to all customers, whether they are on the program or not through rate reductions.

All programs that do not pass the TRC test can be eliminated, as they have been shown to be more expensive than the supply-side alternative. (This statement assumes that participant costs are included for DSM programs in their comparison to supply-side alternatives.)

The remaining group of programs are in "the gray area." This is where equity becomes important. These are programs that benefit all customers "on average," but rates do rise, and only customers who participate in the program actually experience the benefits of lowered costs of energy services. Customers who do not participate experience bill increases due to the increase in rates. There are two questions to answer in evaluating these programs:

- Will all customers have access to a DSM program that is cost effective and beneficial to them?
- At what point (at what rate impact, at what number of customers, and in what circumstances) is the impact on nonparticipating customers acceptable?

As was shown above, if all customers participate in DSM programs passing the TRC test, even though rates may go up, all customers' costs of energy services will go down.

The second question is a policy decision. If all customers have access to cost-effective DSM programs, but some choose not to join, is the utility responsible for the bill increases they face due to rate increases? Another dimension to consider is whether a rate increase of half a mil to all customers is worth the 200 MW of load relief that DSM will generate for the system?

These questions cannot be answered here. They are decisions each utility must make for itself. In addition, a utility must take into consideration other variables not explicitly accounted for in cost-effectiveness analysis in its choice of DSM programs, such as the timing of the load impacts and the urgency of the load reduction requirement. Some DSM programs will come "on line" faster than others. Budget constraints and regulatory mandate might also affect the decision.

Conclusion

In conclusion, no one test is the correct test to be used in the selection of DSM programs. Each represents a different point of view and has different efficiency and equity considerations that cannot be ignored. The methodology presented provides simple guidelines to enable DSM choices to be made that promote the achievement of both goals.

The words of cost-effectiveness enlightenment are thus: The DSM forest is not best defined by a single cost-effectiveness test tree.