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APPLYING DSM EVALUATION RESULTS TO UTILITY PLANNING

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Abstract

This paper describes the results of a study to assess the application of DSM evaluation results to utility forecasting and planning. The paper has three objectives: (1) identify forecasting and planning applications of evaluation studies, (2) identify major obstacles and problems associated with applying evaluation results to forecasting and planning, and (3) suggest approaches to address the major problems. The paper summarizes results from interviews with utilities, regulators, and consultants to determine how the utility industry currently applies evaluation results in forecasting and planning. The paper also includes results from a detailed case study of Sacramento Municipal Utility District (SMUD) and Southern California Edison Company (SCE), two utilities with large DSM programs and active evaluation efforts.

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Introduction

Utilities and their customers have invested more than $9 billion in demand-side management (DSM) programs over the past five years. DSM regulatory reforms initiated since 1989 tied program cost recovery, lost revenue recovery, and incentive awards to program performance. With DSM measurement and evaluation as the primary means to verify program impacts, DSM programs have been subjected to more systematic study over this period than any other. Evaluations can also be used to produce results relevant to utility forecasting and planning. Applying evaluation results may be especially important for utilities with substantial current and future commitments to demand-side customer service.

This paper describes the results of a study to assess the application of DSM evaluation results to utility forecasting and planning (Ref. 1). The paper has three objectives: (1) identify forecasting and planning applications of evaluation studies, (2) identify major obstacles and problems associated with applying evaluation results to forecasting and planning, and (3) suggest approaches to address the major problems. The paper summarizes results from interviews with utilities, regulators, and consultants to determine how the utility industry currently applies evaluation results in forecasting and planning. The paper also includes results from a detailed case study of Sacramento Municipal Utility District (SMUD) and Southern California Edison Company (SCE), two utilities with large DSM programs and active evaluation efforts.

Forecasting and Planning Applications of Evaluation Studies

A utility's need for evaluation answers to forecasting questions depends on its planning approach, the available planning tools, and the utility's emphasis on DSM. Our assessment focused on utilities with an integrated approach to planning. These utilities tend to use detailed planning tools, including end-use or technology-choice forecasting models and cost-effectiveness analysis of individual DSM measures.

Our interviews and case study indicate that utilities with detailed forecasting and planning models have a tremendous need for data to develop or verify key assumptions and to verify intermediate and final results of forecasts. In broad terms, these needs include understanding and quantifying the full range of benefits and costs of DSM programs. More specifically, these data needs include baseline energy use characteristics, first-year program or measure energy and peak impacts, savings persistence, program or measure load shape impacts, measure life estimates, measure saturations, measure costs, market penetration, distribution of appliance characteristics, net-to-gross ratios, and other program costs and benefits.

Forecasters identified several additional problems evaluations can help resolve. These problems constitute a joint forecasting and evaluation research agenda. The outstanding problems include estimating the effects of DSM programs targeted at a specific fuel on other fuels, detecting and estimating spillover effects from DSM programs, and understanding the customer decision-making process associated with technology adoption. The last problem contains two related problems—understanding customer adoption of mutually exclusive or interactive DSM measures and estimating payback requirements for different market segments.

Obstacles and Problems Applying Evaluation Results

Because DSM evaluations are not typically designed to meet the needs of forecasters and planners, applying evaluation results to forecasting and planning is rarely straightforward. The four issues of particular concern to forecasters and planners are evaluation availability, evaluation quality, reconciliation and application.

Evaluation Availability

The initial issue is to identify the available evaluation studies that may be suitable for use in planning. Forecasters and planners cannot use studies unknown to them. Thus, the evaluation availability issue is an information problem, which can be exacerbated by locating evaluation, forecasting, and planning functions in different parts of an organization. Organizational structure and information flow are key to addressing evaluation availability.

At SMUD, DSM program operation, evaluation, and program planning (which includes short-run DSM forecasting) groups are located in the Customer Service Division. Demand forecasting, long-run DSM forecasting, and resource planning groups are found in the Planning Division. SMUD attempts to facilitate information flow within and between these groups by assembling an integrated planning database (Ref. 2). In addition, the individual responsible for this database is now in the long-run DSM forecasting group, but was formerly in the DSM program planning group. Thus, this individual is aware of the data needs, models, and objectives of program planners and DSM forecasters.

At SCE, DSM forecasting, program planning and management, and evaluation groups are contained in the Energy Efficiency Division. DSM forecast applications, demand forecasting, and resource planning groups are found in the System Planning Division. These divisions are located in different cities. SCE's response to the communication issue is to appoint an individual from the DSM evaluation group to coordinate between evaluators, program managers, demand forecasters, and DSM forecasters. This coordination includes holding interoffice work sessions as key products, such as demand forecasts, are assembled. The resource planners at SCE rely on the demand and DSM forecasters to ensure that assumptions supporting the forecasts are reliable, defensible, and based on the best available data.

A new evaluation availability issue may arise in response to competitive pressures in the utility industry. DSM program evaluators have traditionally shared evaluation results and lessons learned in professional journals and conferences and through informal contacts and exchanges within the evaluation community. Utility evaluators and their consultants may be less willing to share their progress and results widely, particularly if competition for retail customers becomes widespread. These developments may impede progress on evaluation methods and the incorporation of evaluation results in forecasting and planning.

Evaluation Quality

Assessing evaluation quality is important for forecasting and planning applications, yet judging the quality of evaluations is difficult. Evaluation teams draw on many disciplines, including statistics, economics, sociology, engineering, and computer science; our interviews and case study revealed that comprehensive evaluation reviews require use of all these disciplines. These reviews typically focus on the following elements of an evaluation:

- general treatment of sampling issues;
- clarity and detail of methodological discussion, including model specification and attention to self-

selection bias;

- clarity of discussion of results, interpretation of findings, and conclusions drawn;
- use of alternate methods or sensitivity analyses to derive recommended impact estimate; and
- reputation of contractor.

In addition to these quality indicators, forecasters must assess the evaluation's relevance to the forecasting issue in question and consider whether the study sample is representative of the population of interest to planners. The utility's careful review of the proposed study design and draft study results can improve the quality and applicability of any evaluation study. In designing impact evaluations, forecasting, planning, and evaluation staff at SMUD work together to reach agreement on study methods before the evaluation proceeds. SMUD also uses a structured review process for draft process evaluation results to ensure that factual errors are corrected and to build internal staff recognition of program issues and actions needed to address these issues.

Reconciliation Issues

Reconciliation issues center on determining whether evaluation results can be used for forecasting and planning. In this discussion, to use an evaluation is to directly apply its results. We identify two types of reconciliation issues, which we call plausibility and transferability.

<u>Plausibility</u>. Plausible evaluation results must be believable and derived by credible and logical methods. Assessing the plausibility of an evaluation result involves subjective judgement, but this judgement need not be arbitrary. In many cases, evaluation results can be assessed by viewing them from several perspectives. We list four perspectives below.

- Does including the result in the demand forecast make any elements of the demand forecast less plausible? One way to answer this question is to see how the result changes the demand forecast at the sector and end-use levels. For example, does including results from a commercial high-efficiency space conditioning program change the kilowatt-hours per square foot for the commercial sector in ways that are unreasonable?

- How does the result compare with separate estimates used to support the demand forecast? The forecast may already include performance characteristics of different technologies, such as air conditioners with different energy efficiency ratings. Forecasters can make use of this information to assess program evaluation results.

- Is the evaluation result the product of more than a single evaluation approach? Evaluators often take more than one approach to assessing large DSM programs. For example, an evaluation of a nonresidential retrofit rebate program used engineering analysis of metered data, statistical analysis of billing data, and decision and survey analysis of customer decision data (Ref. 3). The utility compared results from these different approaches and also applied statistical techniques, where appropriate, to integrate estimates from studies that used different approaches before publishing final results for this program. In addition, when different evaluation approaches yield similar results, analysts will have greater confidence in their assessment of program performance.

- Is the result consistent with results from similar programs at other utilities? Interutility comparisons of

DSM evaluation results are often difficult for many reasons. Differences in program measures, incentive levels, customer characteristics, the regional economy, geography, climate, and the built environment can confound interutility comparisons. Of course, the greater the similarity between utilities and their DSM programs the more relevant are comparisons between their evaluation results.

Plausibility is also related to evaluation quality. Much of an evaluation can be of high quality and yet the evaluation can still contain results that are not plausible.

Even with plausible study results, the next question is to decide whether the results *should* be used to update cost or benefit estimates in a resource plan. If the study results are plausible, the impacts of historical year programs should be revised when the initial program estimates and evaluation results differ. What is not clear, however, is when to use the results from a study of impacts from an historical program year to depict the characteristics of future programs. This consideration illustrates our second reconciliation issue, which we call transferability.

Transferability. The transfer of evaluation results can take place over time and location. As Figure 1 illustrates, the transfer over time can occur for two types of program participants. For the first set of participants (Program 1 Cohort) the evaluation may be used to estimate the probable future energy and demand savings that will be achieved. This is the persistence effect for that particular cohort. For the second set of participants (Program 2 Cohort), the evaluation may be used to estimate the probable energy and demand savings by these future participants in a program. The key question in transferability is to determine whether the characteristics of the program evaluated (including its participants) and its context (such as energy prices and economic conditions) are sufficiently similar to the intended application to make the transfer defensible.

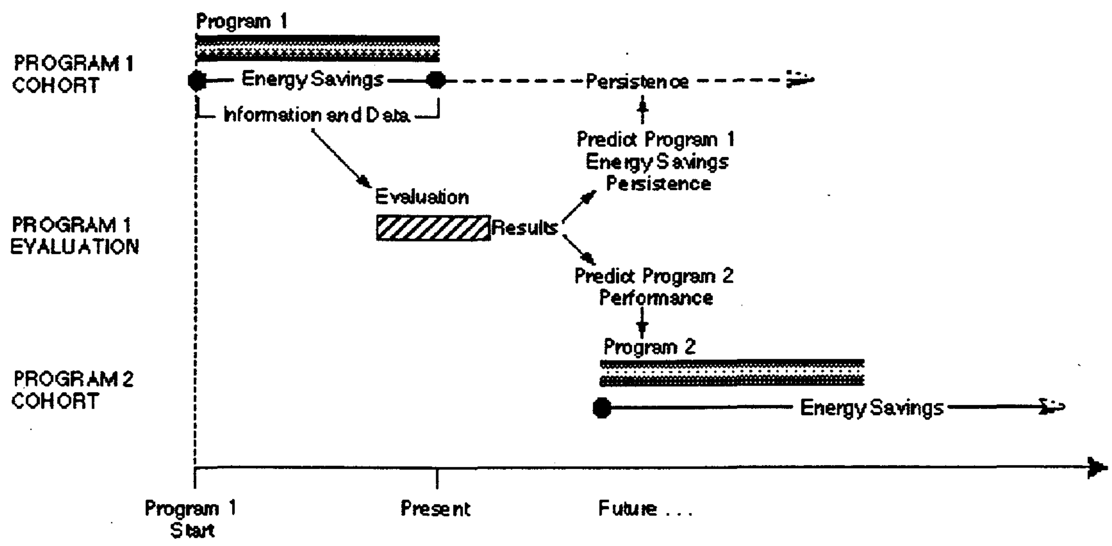

Figure 1. Evaluation results can be used to forecast the long-term savings from historical and future DSM programs.

Transfer over time usually involves a single utility wanting to apply evaluation results from an historical program to revise its long-run forecast for a similar program operating in the future. Transferring evaluation results across locations, from one utility to another, raises issues similar to transferring results across time. The issues are more difficult to resolve, however, because different utilities are more likely to face different economic conditions, market different programs, and use different forecasting methods. Yet to make the transfer meaningful, care must be taken to ensure that the programs are comparable and that the DSM forecasts in question are comparable to the historical programs evaluated. The following discussion on applications issues addresses these concerns more completely.

Application Issues

Application issues arise when analysts actually translate evaluation results to planning inputs. Thus, application issues are closely tied to the decisions analysts reach as they reconcile evaluation results with forecasting assumptions, models, and results.

Forecasters must first decide whether evaluation results will be applied to forecasts of savings from historical programs or future programs. This decision is critical because of the temporal distinction illustrated in Figure 1. The results may be used to revise the savings impacts for program participants during the period covered by the evaluation, for these same participants in the future (the persistence effect), and for future participants in this or similar programs.

Common Issues. Despite this important distinction, we find common issues in the application of evaluation results to historical program and future program forecasts. For example, both applications require *energy savings impacts at the appropriate level of detail* for the forecasting model. Technology-choice models will require much more detail than evaluations generally provide. One solution to this mismatch is to aggregate individual technologies in the forecasting model, such as 4-ton air conditioners with seasonal energy efficiency ratios of 12.0, to more general categories, such as high-efficiency air conditioners. End-use forecasting models, on the other hand, may require less detail than is available from the evaluation. The evaluation may have energy impact estimates for residential high-efficiency air conditioners, but the end-use model may include air conditioners in the broader category of cooling equipment, which also will include heat pumps and evaporative coolers.

Applications to historical and future programs also require *load shape impacts at the appropriate level of detail* for the forecasting model. This issue is particularly important for measures that affect the timing, and not just the level, of demand. Examples of such measures include space conditioning controls (such as set-back thermostats), occupancy sensors for indoor lighting, and adjustable speed drives for motors. Unfortunately, most evaluation studies focus more heavily on estimating energy savings than on estimating load impacts. Even when evaluators attempt to assess load impacts, studies tend to concentrate on demand reductions at a specific time—usually system peak—rather than on demand reductions over the day or week. As a result, forecasters frequently assume that the load shape impacts of measures correspond to the load shapes of the affected end uses or technologies. Addressing this question will require evaluators to devote more attention to the effects of key measures on load shapes. Relying on better measurement alone will not result in rapid progress, however, due to the high cost of metering studies. Forecasters also need to focus on developing improved techniques to estimate load shape impacts from available data. These techniques include improved thermal modeling of shell measures and estimation methods that combine metered data with these simulations (Ref. 4).

Another important issue shared by historical and future forecasts is *matching units of savings* between forecasting models and evaluation results. At the DSM program level, evaluations typically express energy impacts in annual kilowatt-hours or kilowatt-hours per square foot of affected floor space. Forecasters face difficult translation problems when their models do not support similar units. For example, SCE attempted to compare its 1994 forecast of lighting savings from its Energy Management Hardware Rebate Program with the impact evaluation for the 1990 program year. SCE was thwarted because the forecast estimates lighting savings in kilowatts while the evaluation estimates savings in kilowatt-hours (Ref. 5). Equating these units is not possible without additional information, such as the measures's load shape or hours of operation.

Matching the level of analysis is also an important concern. Evaluations and forecasts can be designed at the program, end use, measure, or technology level. An evaluation result at the program level may be difficult to translate to the technology level.

Historical program and future program forecasts must also be concerned with *questions of measure life, savings persistence, and changes in net-to-gross ratios* over time. Some states are approaching the measure life and savings persistence questions with long-term, joint-utility-sponsored studies coordinated by regulatory staff. How net-to-gross ratios change over time remains an important forecasting question, but the DSM community has not yet achieved consensus on the feasibility or usefulness of resolving this question.

A major concern for forecasters is *consistency between the characteristics of baseline energy use and the savings impacts in the evaluation and the forecast*. Unless the baseline efficiency levels of buildings or equipment from the evaluation are consistent with the baseline efficiency levels used in the forecast, the forecasters must attempt to translate the evaluation results. Forecasters must determine whether the baseline assumptions, for example, in the evaluation about hours of equipment operation, connected load, and weather are consistent with those used to characterize the baseline in the forecast.

<u>Issues Unique to Forecasts of Future Program Savings</u>. Historical and future program forecasts differ in at least four important ways. First, *future program forecasts must reflect the penetration of existing and new DSM technologies over time*. The penetration of DSM technologies can increase the overall baseline efficiency of the market (Ref. 6). The challenge for forecasters is to model these changes in baseline efficiency because this is the reference for forecasting savings from future DSM programs.

Second, *future program forecasts must be sensitive to total DSM measure costs* (which include utility and participant costs) and conditions that affect program cost-effectiveness over time. Changes in the following three conditions, for example, will influence cost-effectiveness assessments: utility costs as market segments become more highly saturated or as utility marketing skills improve; technology costs as innovative products are introduced to the marketplace and as designs that were once leading-edge become the norm; and electricity prices.

Third, *forecasters must consider how the characteristics of program participants and external conditions may change* from the evaluation period to the forecast period. Participants in a new program may differ from those who participate when the program is more mature. For example, later participants may operate equipment differently than early participants (affecting hours of operation, for example) or may be less likely to change equipment size or capacity as part of the installation decision.

Finally, *forecasters must consider how to include possible changes in program design, perhaps undertaken in response to the evaluation of an historical program, in future program forecasts*. If an evaluation indicates program performance is not up to expectation, the utility will either eliminate or modify the program. In this case, a direct application of evaluation results to the forecast is not appropriate. Instead, program designers, evaluators, and forecasters must work together to identify the probable change in design and assess the effects of the revision on program performance. In the absence of good information about the effect of revisions on performance, predicting this effect will involve considerable judgement.

Addressing Application Issues

Regulations in some states partially address these application issues by attempting to establish common terminology and definitions for DSM programs and their cost and benefit elements or by developing resource planning protocols that should lead to more uniform and effective reporting of evaluation study results (Refs. 7, 8).

Utilities are also attempting to apply evaluation results to forecasting and planning. SCE began a data integration project in 1993 to address many of the application issues just discussed (Ref. 9). The project's objectives are to successfully integrate data from evaluation studies and forecasting by establishing procedures that formally link four elements of DSM analysis: (1) simulation models used to assess space conditioning measures in buildings, (2) guidelines used by SCE's field personnel to calculate gross measure impacts with customer-specific data, (3) results of evaluation studies that provide estimates of gross and net measure impacts, and (4) short-run and long-run DSM and demand forecasts.

SCE also developed an approach to include the results of its evaluation studies into its DSM forecasting model, results of which support program planning, demand forecasting, and resource planning. Below are the seven steps SCE proposed to identify and resolve inconsistencies between its 1990 program evaluation results and DSM forecasts (Ref. 10).

1. Perform rigorous comparisons of evaluation results with program performance forecasts. Only select measures for this comparison that the evaluation and forecast define comparably or that can be aggregated to reach a common level of detail. Accurately link measures in the forecast with measures in the evaluation. Measure impacts must be expressed or converted to comparable units. Comparisons must be made using the same assumptions about the characteristics of participants, including building types and customer types. Analysts have attempted to perform such comparisons using evaluation results from SCE's 1990 DSM programs and SCE's forecast for 1994 programs (Refs. 5, 11).
2. For measure impacts depending on billing or conditional demand analyses, reestimate statistical models if necessary using units consistent with the units used in forecasting. For example, if the statistical analysis is based on simple installation counts of high-efficiency air conditioners, the models should be reestimated after the installation counts are labeled by tons of air conditioning. Statistical relationships can then be estimated for groups comparable to efficiency levels found in the forecast.
3. Reexamine predicted unit energy savings estimates by program. Attempt to identify differences in average customer characteristics between programs. Compare customer characteristics of program participants that install identical measures under different programs.
4. Reexamine predicted unit energy savings estimates for customized rebate programs. Determine the characteristics of custom installations and compare with characteristics assumed in the DSM forecast, especially with regard to average rebate size, average energy and demand savings, and average customer investment.
5. Identify the most important components of each engineering calculation of a savings estimate for both the evaluation and the forecast. A space conditioning calculation, for example, will contain the following components: baseline thermal characteristics of the building shell, baseline efficiency of the conditioning equipment, operating hours, and engineering algorithms and calculation procedures. The ADM Associates study begins to take this and the following step for selected measures (Ref. 11).
6. Compare between the evaluation and the forecast the engineering calculation components identified above. Identify components with substantial differences for further analysis.
7. Compare net-to-gross ratios from the DSM forecast to the appropriate program year covered by the

evaluation. The effects of forecasted changes in economic conditions, energy prices, or program design may invalidate comparisons with earlier or later program years.

Many of these tasks require a detailed understanding of the customer characteristics represented in both the evaluation results and the forecast results. Explaining why results may be similar or different is more important than identifying similarities and differences. A consultant working to reconcile SCE's non-residential evaluation studies with SCE's 1994 DSM forecast noted that

> . . . the single most important lesson learned in this initial reconciliation process is the value of collecting information on customer characteristics that matches the information used in the engineering estimates. Adding this criterion to Edison's next round of statistical studies should allow the source of differences between the statistical and . . . engineering estimates to be identified. This modification would provide the basis for specific improvements in the engineering estimates (Ref. 5, p. P-3).

In its review and use of process evaluations, SMUD applies a procedure that may also be transferable to other evaluation study applications. Draft evaluation reports are first reviewed by internal stakeholders, including program managers and planners. A primary objective of this review stage is to identify and correct factual errors in the draft report and reach internal agreement on the study's fundamental results. Management then charges a staff member with the responsibility of applying the results and recommendations from the final report. This individual must establish an action plan and a schedule for addressing the study's findings. The action plan identifies the steps needed to address the fundamental issues raised in the process evaluation, gives appropriate parts of the company the responsibility to take these steps, and defines a clear schedule for completing each step. A similar process could be developed and applied to the review of other evaluation studies, particularly impact evaluations.

SMUD has already developed a DSM planning database, as we noted earlier, which was produced through the interoffice efforts of demand forecasting, program planning, and resource planning staff. SMUD intends the database to be an evolving document that reflects new data from existing programs, evaluation study results, and the development and testing of new DSM measures. The database is the utility's primary source of data for cost-effectiveness analysis of measures and programs, annual and cumulative measure savings, and forecasts of future measure and program savings. The development and use of a single database to support demand forecasting, DSM forecasting, program planning, and resource planning is an important and essential step to achieve consistency between these activities. While evaluation results still must be reconciled with this database, reconciliation to a single integrated database is obviously simpler than striving for consistency with independent databases for demand forecasting, DSM forecasting, and program planning.

Evaluation results will continue to have broad applicability to assess the reasonableness of forecast results. For example, plausible evaluation results can be used to assess the reasonableness of a forecast's starting point, where historical data give way to forecast results. A DSM forecast will either assume or estimate a program's net-to-gross ratio. In either case, if the historical and future DSM programs and market conditions are similar, then the net-to-gross ratio in the first year of the forecast should be close to the evaluation result from a recent program year.

Applying evaluation results to forecasts will eventually be facilitated by developing statistical models of energy savings. These models can be developed from data on the important determinants of energy savings already collected in evaluations. In some cases, evaluations may need to be augmented to collect additional customer data relevant to energy savings. These data can then be used to construct a cross-sectional model of energy savings linking energy savings to physical variables such as building floor space, equipment stock, and efficiency; economic variables such as fuel prices, income, or sales; and behavioral variables such as occupancy schedules and thermostat settings. With forecasts of future changes in these variables, the model can then be used to estimate the future savings for both current and future program participants.

In summary, for historical programs, forecasters should use evaluation results when possible to revise forecast assumptions. The exceptions are for cases where the evaluation is seriously flawed or the evaluation results confirm the forecast's underlying engineering analysis and participation rate. In the latter case, including evaluation results may require substantial effort with little or no improvement in the forecast. For future programs, the argument for when evaluation results should be applied is not as clear. An important consideration for forecasters is to determine whether the underlying engineering analysis has improved in response to earlier testing and fieldwork.

Conclusions and Recommendations

Our results indicate that utilities with detailed forecasting and planning models have a tremendous need for data to develop or verify key assumptions and to verify intermediate and final forecast results. In addition, forecasters identified several outstanding problems evaluation studies could help address. Examples of direct applications of evaluation results, however, are not common. We identified four major problems with applying evaluation results: evaluation availability, evaluation quality, reconciliation, and application.

Reconciliation and application issues are the most difficult to address and explain why direct applications of evaluation results are not common. We recommend four approaches to address the consistency problems raised during reconciliation and application. First, develop rigorous analytical comparisons for like measures in evaluations and forecasts. Second, as part of the evaluation, collect data on the key elements of the engineering calculations that support the forecast. Third, use a two-step evaluation review and application process. Finally, develop and use an integrated database for DSM analysis.

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