

- FINAL REPORT -

**INDIRECT COSTS AND BENEFITS PILOT STUDY  
OF SDG&E'S COMMERCIAL LIGHTING PROGRAM**

*Submitted to:*

CALIFORNIA DEMAND-SIDE MEASUREMENT  
ADVISORY COMMITTEE (CADMAC)  
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# EXECUTIVE SUMMARY

## INTRODUCTION

This report has been prepared for the California Demand-Side Measurement Advisory Committee (CADMAC) in response to the requirement of California Public Utilities Commission Decision 95-12-054. It presents the results of a pilot study to determine the feasibility, accuracy, and cost of information on indirect costs and benefits. The subject of this pilot study research is San Diego Gas & Electric's (SDG&E's) 1995 Commercial Lighting Program.

### Importance of This Project

As discussed further in this report, the identification and estimation of indirect costs and benefits is *crucial to the future of energy efficiency*. It is essential to:

- **Determine the benefits of programs.** As seen in this report, participants and nonparticipants are aware of, consider, and experience a wide variety of indirect benefits and costs. The net value of these ICBs has a direct impact on the true benefits of present or planned energy efficiency programs.
- **Better program design.** Knowledge of large customer indirect benefits or misperceptions regarding costs allows better targeting of program marketing and better program designs.
- **Market transformation.** Indirect costs that are considered or expected, but not experienced, and indirect benefits that are not considered or expected, but are experienced, are both evidence of information market barriers. These are also sources of significant benefits for market transformation or other energy efficiency promotion efforts.

*One of the most important conclusions of this study* is that it shows we can value the key market effects of a program: the removal of misperceptions and misinformation. The largest benefits of market transformation lie in the elimination of these information-type barriers.

## SUCSESSES OF THIS PROJECT

This study has shown that it is possible to estimate indirect costs and benefits. Even though we did not estimate monetary values for many individual ICBs in this study, we have shown that estimates for certain individual ICBs and for all ICBs, as a whole, are possible with the following results:

- Through focus groups and thoughtful consideration, it is possible to define a set of ICBs that have been considered and experienced by a significant number of participants. A large number of ICBs are experienced by participants.
- Our question system seems to generate reasonable responses regarding the consideration of and the experience of ICBs by participants.
- Even with a small nonparticipant sample size, significant differences were measured between the ICBs considered by participants and nonparticipants.
- Customers' investment criteria were used to show the value of that implied set of indirect costs.
- We demonstrated the calculation of the value of participants' higher costs of funds.
- We demonstrated that it is possible to construct and obtain seemingly reasonable answers to questions regarding the value of a participant's overall ICBs.
- There exists measurable relationships between the likelihood of participants' perceiving higher overall ICB values and particular customer characteristics and experience of ICBs.
- We demonstrated the feasibility of a methodology that can estimate dollar values for ICBs as a whole, and potentially for individual ICBs—contingent valuation.

## PROJECT OBJECTIVE AND OUR PROPOSED PLAN

The purpose of this study was to determine the feasibility, accuracy, and cost of information on the indirect costs and benefits of a commercial lighting retrofit program. Our proposal stated that we planned to do three things in response to this goal:

1. Identify the indirect costs and benefits (ICBs) experienced by participants in the program;
2. Monetize those ICBs that were likely to be directly monetizable; and
3. Employ a form of pricing analysis to determine threshold values for the remaining ICBs.

We proposed to first identify the ICBs because even though the RFP listed at least ten ICBs to consider, there was no guarantee that those were the ICBs these program participants actually experienced. Our proposal also stated that we would not attempt to measure two of the ICBs listed in the RFP: change in building owner awareness of efficient lighting products and changes in the availability of efficient lighting products.

We believed at the time of our proposal that the following ICBs would be the most likely for direct monetization:

- Higher cost of funds;
- Reductions in O&M costs;
- Other direct participant costs such as that of downtime and training; and
- Cost of risk.

Our plans for these monetizations depended on our ability to obtain from participants the key inputs needed—e.g., hours of downtime caused by the lighting retrofit installation.

Finally, since we believe it essential to account for all ICBs, we proposed to obtain an indication from program participants their impression as to the value of the remaining, non-monetizable ICBs. We believe that to only add those ICBs that are easily monetizable to the present “direct” costs and benefits does nothing to improve program evaluation, and may very well worsen the accuracy of results.

## **APPROACH**

### **Focus Groups**

Due to the exploratory nature of the project we began with a set of three focus groups—two with program participants, one with nonparticipants. The main purpose of the focus groups was to identify the indirect costs and benefits (ICBs) experienced by program participants and nonparticipants. The focus groups were also used to determine the best way to obtain the information for the direct monetization of certain ICBs. This information was then used to develop appropriate questions for our telephone survey.

### **Focus Group Results**

The focus groups resulted in the identification of 30 different ICBs. Table ES-1 indicates the relationship between the ICBs identified and those originally suggested in the RFP. As can be seen, the 30 ICBs identified in the focus groups cover the ICBs suggested in the RFP (with the exception of the two stated in the proposal as not to be covered) and add a substantial number of new ones.

The other result of the focus groups was that we determined that our plans for the direct calculation of individual ICBs, other than O&M cost reductions and the higher cost of funds, from secondary data was not possible. We had hoped that certain of the ICBs (such as customer downtime and training costs) could be directly estimated from customer inputs.

### **Telephone Surveys**

The results of the focus groups were used to develop our telephone survey. Our original goal was to complete 70 participant and 70 nonparticipant surveys.

The survey began with a series of questions on customer characteristics that could be used to segment customer responses. The survey then asked participants whether they considered each ICB in their decision making, and then asked to what extent they actually experienced each. The last portion of the participants' survey contained a series of questions intended to give a dollar threshold value for each participants' ICBs.

**Table ES-1  
FOCUS GROUP RESULTS**

ICBs Mentioned in RFP	ICBs Addressed in this Study
Changes in productivity levels of workers from changed lighting levels	Productivity; improved working conditions
Aesthetic appeal of indoor space, effect on visiting clients	<ul style="list-style-type: none"> <li>▪ Improved visual comfort of users and guests</li> <li>▪ Reduced discomfort due to noise and glare</li> <li>▪ Improved appearance of facilities</li> <li>▪ Increased attractiveness of merchandise</li> <li>▪ Occupant or tenant complaints about the new lighting</li> </ul>
Change in building owner awareness of efficient lighting products	Not addressed (stated in the proposal)
Changes in the availability of efficient lighting products	Not addressed (stated in the proposal)
Changes in customer costs of searching for efficient lighting products	Finding trustworthy contractors
Changes in the perceived reliability of the product	<ul style="list-style-type: none"> <li>▪ Reduced equipment failure</li> <li>▪ The technology may not perform as expected</li> </ul>
Changes in the perceived uncertainty in energy savings estimates	<ul style="list-style-type: none"> <li>▪ Reduced lighting maintenance, purchase, and warehousing requirements</li> <li>▪ Need for increased staff maintenance or attention</li> <li>▪ More sophisticated staff may be needed to service and replace equipment</li> </ul>
Changes in maintenance costs	Increased safety or security and reduced vulnerability to lawsuits
Changes in safety or health of building occupants	Increased responsibilities for disposal of hazardous wastes
Environmental impacts	<p style="text-align: center;"><b>Other Indirect Costs or Benefits</b></p> <ul style="list-style-type: none"> <li>▪ Fulfilling management objectives/philosophy</li> <li>▪ Better fit of lighting to user or customer needs</li> <li>▪ Making proposals to upper management</li> <li>▪ Obtaining or setting aside funds</li> <li>▪ Setting aside other organizational needs</li> <li>▪ Staff time for planning renovations or retrofits (including budget development and getting information)</li> <li>▪ Staff time for setting up contracts</li> <li>▪ Staff time for setting up and managing retrofits or renovations</li> <li>▪ Inconvenience during retrofits</li> <li>▪ Cannot use old stock</li> <li>▪ Need to redecorate or rewire</li> <li>▪ Vulnerability to code inspections</li> <li>▪ Need to add task lighting</li> <li>▪ The use of the space may change</li> <li>▪ Energy costs or equipment costs may come down</li> <li>▪ Newer, better equipment may become available</li> </ul>

## **Survey Results**

We completed 70 participant surveys and 26 nonparticipant surveys. The project team in discussions with SDG&E decided to accept 26 surveys as the final total for nonparticipant respondents for two reasons. First, our attempts to obtain the 26 had essentially exhausted our sample of nonparticipants from which to draw. Second, the main value of the nonparticipant survey was in answering questions for future program design and the development of new products—objectives that were dropped from the project. Nonparticipant results are not used in any of the estimated dollar values of ICBs in this report.

When compared to the population of participants as a whole, our sample is very comparable in terms of the business types represented. Also, even though the survey questionnaire was long and complicated, we did seem to get good respondent comprehension and understanding of the key questions. For example, only three respondents out of 70 answered “don’t know” to all the questions regarding ICBs. Also, only four others answered all the ICBs using the most positive response, otherwise, respondents seemed to consider each question separately and answer accordingly.

## **ANALYSIS RESULTS**

### **Customer Consideration and Experience of Indirect Costs and Benefits**

- Overall, the survey results confirm those of the focus groups: Customers do report considering and experiencing indirect costs and benefits when deciding to participate in lighting projects. Each of the ICBs was reported as considered and experienced by a substantial minority (at least 19%) of participants.
- Two indirect costs were reported as experienced significantly more often than average by participants: staff time for planning renovations and retrofits and staff time for setting up and managing retrofits or renovations.
- Two indirect costs were reported as experienced significantly less often than average by participants: the use of the space may change and more sophisticated staff may be needed to service and replace equipment.
- Our attempt to obtain information regarding the relative size of ICBs through a scaling question failed. In all but one case of the 30 ICBs



examined (and that one case is marginal), the distribution of reported experiences is highly bimodal; that is, participants report either that they did not experience the ICB at issue, or they experienced it “a great deal.”

- Correlation analysis of reported experiences indicates a very high degree of relationship among all ICBs. Although the correlations range from highs of 0.8 and 0.9 (when considering the relationships of some costs within logical subgroups) to lows of 0.2 (when considering the relationships of some costs to certain benefits), virtually all are significantly related in the positive direction.
- We found that the likelihood of reporting ICBs experienced at the various levels is directly related to a respondent having the responsibility of monitoring the results of the lighting project.
- Even with a sample size of 26, we were able to find significant differences between participant and nonparticipant consideration of ICBs. The main indirect cost considered more often by nonparticipants was the need to redecorate or rewire. The main indirect benefit considered more often by participants was fulfilling management objectives or philosophy.

### **O&M Cost Reductions**

- Although the RFP for this project lists “changes in maintenance costs” as an ICB to study, these benefits have already been included in the utility’s evaluation of this program. The average proportion of present valued O&M cost reductions compared to net benefits across our sample of 70 participants is 2.3%. This translates into O&M cost savings of \$1,476, which is included in participant average standard net benefits of \$64,174. This result and the other dollar estimates in this study are shown in Table ES-2.
- While O&M savings only make up 2.3% ( $\$1,476 / \$64,174$ ) of net benefits across our sample participants’ measures, these savings make up 23.4% ( $\$20.19 / \$86.21$ ) of net benefits for certain compact fluorescent measures. O&M savings for lighting only come from reductions in the labor and equipment costs of bulb replacement because of longer life (compact fluorescents versus incandescents) or fewer bulbs (delamping).

**Table ES-2  
SUMMARY OF MONETIZATION RESULTS**

Indirect Cost or Benefit Measured	Monetary Estimate as a % of Standard Participant Net Benefits	95% Confidence		Resulting Range of \$ Estimates per Participant Based on Sample Average Participant Net Benefits of \$64,174	Cost of Increased Accuracy**
		Absolute Precision	Relative Precision		
Reduced O&M costs	2.3%*	0.8%	34.8%	\$963 to \$1,989*	\$67,000
Incremental cost of funds	-16.7% to -25.7%	N/A	N/A	-\$10,741 to -\$16,465	\$13,000
Investment criterion (a set of indirect costs)	-82.3%	13.1%	15.9%	-\$44,408 to -\$61,222	\$36,000
Pricing analysis questions (all ICBs) <b>For comparison only</b>	Minimum: -67.7% Maximum -56.4%	Minimum: 7.2% Maximum 8.6%	N/A	Minimum: -\$48,067 to -\$38,825 Maximum: -\$30,675 to -\$41,713	N/A
Contingent valuation	-48.7%	20.0%***	41.1%***	-\$18,418 to -\$44,088	\$110,000

\*Already included in standard calculation of participant net benefits.

\*\*Assumptions are shown at the end of the Executive Summary.

\*\*\*The standard estimates of precision cannot be calculated for contingent valuation results. However, accepted reasonable estimates of precision are possible and these estimates are based on shortened version of those calculations.

- Survey responses validated some of the inputs to the utility O&M savings calculations, hinted that customer estimations of O&M savings may include components not considered in standard calculations, and indicated that customer records may often be available to aid further study of this benefit.

### **Customer Investment Criteria**

- Customers' investment criteria reflect a number of indirect costs at least implicitly considered by customers in their investment decisions. These investment criteria can include customers' cost of funds, various types of risk, management and staff time to evaluate and put the investment in place, and the opportunity cost of capital.
- It is not our intention to determine exactly which indirect costs are incorporated in investment criteria, nor do we recommend that this parameter be considered for further study as a direct estimate of the value of these indirect costs. We do, however, think that the value of the indirect costs implicit in these criteria is of interest at least for comparison purposes.
- Forty-four out of 70 participant respondents stated the type of investment criteria their company used for energy efficiency investments and 33 gave the actual criterion. Note that a five-year payback criterion is equivalent to a 23.9% return on investment criterion for measures with a 10-year life and assuming a 3% escalation rate.
- The average estimated value for the indirect costs implied in customers' investment criteria for our average sample participant is a net cost of \$52,815.

### **Customers' Cost of Funds**

- As mentioned above, a customer's cost of funds is implicitly included in (and is the lower bound for) his or her investment criterion. A customer's cost of funds or cost of capital is technically a weighted average of the customer's cost of debt and cost of equity with the weighting depending on the company's debt to equity ratio.

- We did not attempt to ask customers directly for their cost of funds as that is a number businesses do not willingly divulge; it indicates too much about a company's financial situation. Instead, we surveyed a small number of banks and made some simplifying assumptions to get a reasonable low-end estimate of 10% to 12% for participating customers.
- A customer cost of funds of 10% reduces average participant standard net benefits (calculated with a utility cost of capital-based discount rate of 7%) by \$10,741. A cost of funds of 12% reduces standard net benefits by \$16,465.

### **“Willingness to Pay” Question Analysis**

- The “willingness to pay” (WTP) questions were asked immediately after the questions regarding the consideration and experience of each ICB. We also prefaced these questions by reminding participants of the expected annual savings, incremental equipment costs, and rebate received for their lighting project to ensure that they were as informed as possible in their responses.
- The first question asked whether respondents thought that their companies had experienced positive net benefits from their lighting projects when all ICBs were considered. Across the 57 participants that answered this question, 54 (95%) gave a “likely” answer. Therefore, almost all participants surveyed believe that the net value of their ICBs was positive or a small enough net cost to not entirely offset standard participant net benefits.
- The next questions were aimed at determining how large participants perceived their net benefits to be. One half to 60% of participants sampled and answering these questions reported that their net benefits were large enough to cover the dollar amounts hypothesized as additional costs. Because of the dollar amounts used, we can also say that these respondents indicated that their net benefits were large enough to ensure that their projects were cost-effective to all ratepayers when all ICBs are included.
- We received what seem to be reasonable answers to the WTP questions. We had very few “don't know” answers (13 out of 70), respondents seemed to take the questions seriously and consider each separately, and

responses seemed to vary in expected ways. Finally, the answers given to these questions are consistent with the estimates obtained from customers' investment criteria. The investment criteria estimates showed a tendency to be lower than the WTP answers which is expected since the investment criteria only incorporates certain indirect costs.

- For reference purposes only, the average minimum net value for ICBs across all respondents for which a minimum was available (55 out of 70) is -\$43,446 and the average maximum net value across those with a maximum available (27 out of 70) is -\$36,194.
- A significantly higher proportion of customers who reported experiencing the following indirect benefits also reported it likely that their company experienced large enough net benefits to accommodate the largest dollar value asked: improved visual comfort of users and guests, reduced discomfort due to noise and glare, improved appearance of facilities, and increased safety or security and reduced vulnerability to lawsuits.
- However, it is interesting that the proportions of customers reporting higher net benefits are also higher for 13 out of 20 indirect costs. We believe this result is related to the single factor "all or nothing" nature of reported ICB experience discussed above.
- Accordingly, we investigated and found that those reporting higher net benefits also tended to report experiencing more ICBs. Also, those reporting that they were responsible for monitoring their company's lighting projects also tended to report it more likely that their company experienced high net benefits. However, it is interesting to note that while the *level* of likelihood of higher net benefits is related to monitoring, whether the respondent gave a likely response or not does not seem to be. One explanation may be that these respondents are simply more certain of their answers.
- Respondents who rated their company as being less risk adverse also perceived higher net benefits, as did those who reported having completed additional lighting improvements beyond the program project.

## Contingent Valuation

- Although not our initial purpose, we found that the WTP questions could be used to demonstrate the feasibility of a future contingent valuation (CV) study.
- CV is a well-developed technique that is used by market researchers and economists to place a value on goods or services for which no market-based pricing mechanism exists—e.g., environmental amenities such as clean air. Respondents are asked to provide “yes/no” answers to questions that ask whether or not they are willing to pay a stated price for the good or service in question, called the bid amount.
- A simple CV model was run on our WTP survey question results and the outcome is promising for future CV studies on several accounts.
  - We were lucky in that the dollar amounts used in our WTP questions were of a reasonable order of magnitude to bound a significant number of respondents values.
  - Our simple model with only three explanatory variables shows a high ability for CV to predict WTP: the model predicted likelihood correctly for 69% of the sample.
  - Both the “bid” and “benefits” coefficients are significant and have the right sign even with our small sample size.
  - We had a small coefficient of variation on the sample, allowing smaller future sample sizes; the coefficient of variation on our sample (due to our normalization procedure for the bid variable) was 0.25 while standard estimates assume a coefficient of 0.5
- Our model was estimated for illustrative purposes only. However, recognizing the limitations of this model, we can use its results to estimate a net value for ICBs as a whole of -\$31,253.
- Although well accepted in many circles, there are several significant problems with WTP-type analyses. They include the tendency for WTP to overestimate values, the possibility of getting “gut reactions” rather than well thought out answers, and the acceptability of one respondent

representing ICBs for a company. These problems are not without solutions.

## **RECOMMENDATIONS FOR FURTHER RESEARCH AND INCREASED ACCURACY**

Of the estimates of dollar values for ICBs shown in Table ES-2, we only recommend that future studies focus on two. If only one ICB is to be studied, we recommend that it be customers' cost of funds. Significant effort has already been put into O&M cost reduction estimates and customers' cost of funds assumptions are as certain as the other "direct" costs and benefits regularly included in standard net benefit calculations. If, on the other hand, ICBs are to be truly acknowledged in the energy efficiency industry, we recommend that a full contingent valuation study be implemented.

All cost estimates assume a commercial lighting program.

### **Customer Cost of Funds**

Our recommended study would not be large and would focus on the financial community rather than customers themselves as most businesses consider their cost of funds as confidential information. Our cost estimate of \$13,000 assumes 20 telephone interviews with bankers and financial analysts.

### **Contingent Valuation**

Our minimum recommended contingent valuation study to estimate the net value of ICBs as a whole for participants—i.e., a study to provide results for program evaluation—has several parts each discussed below.

- **Focus groups.** We recommend any future study of ICBs begin with focus groups. Our cost estimate assumes four groups: one group per each of four major business types.
- **Survey design.** We recommend a survey instrument fairly similar to the one used for this study with the following changes/enhancements. The WTP questions should be modified to enable the best responses for CV. Additional questions regarding the ICBs found to be "most important"

would aid in determining the relative of size of ICBs. We also propose follow-up questions immediately following WTP to obtain information on whether the responses are “gut reactions.” Finally, we suggest a short follow-up survey be administered, say, a week after the main survey to see if customers’ perceptions had changed with time, especially after they had a chance to confer with other managers.

- **Sample size.** We estimate a sample of size of 286 participants will be more than adequate to give an across population estimate of the net value of ICBs as a whole.
- Our total cost estimate of \$110,000 for this minimum level CV study includes an estimate for analysis and draft and final reports.

The above study components and cost estimate represent what we believe to be the minimum for a contingent valuation study of commercial lighting. Increasing the sample size will increase the chances of significant by business-type and individual ICB estimates which will be useful in future program design and new product development.

One of the main benefits of market transformation programs is the reduction of information-related market barriers. Contingent valuation provides one of the only ways to directly value the reduction of these barriers. Ideally, customers’ net value of ICBs should be measured before the program and then after measure adoption. Alternatively, if pre-program data are not available, the net value of ICBs for participants could be compared that to nonparticipants’ net value—accounting where possible for self-selection bias.

## **WORTH OF ESTIMATING INDIRECT COSTS AND BENEFITS**

We believe that it is *highly worthwhile* to estimate and take into consideration the net value of ICBs as a whole. The cost of a CV study to estimate this value is within the range of the cost of an impact evaluation for the same program and the dollar value of ICBs is comparable to the dollar value of energy savings.



# 1. INTRODUCTION

This report has been prepared for the California Demand-Side Measurement Advisory Committee (CADMAC) in response to the requirements of California Public Utilities Commission Decision 95-12-054. It presents the results of a pilot study to determine the feasibility, accuracy, and cost of information on indirect costs and benefits. The subject of this pilot study research is San Diego Gas & Electric's (SDG&E's) 1995 Commercial Lighting Program.

The indirect costs and benefits of utility programs were identified in California's 1990 *Energy Efficiency Blueprint* as customers' transaction costs, the cost of risk, and changes in quality of energy services. A more comprehensive list was considered for this study.

Initially, it is likely that this study's purpose was to provide input to the evaluation process for utility energy efficiency programs in California. However, despite its usefulness for this purpose, *the real benefit of this study and the identification and valuation of indirect costs and benefits is for future programs, especially those meant for market transformation.*

## **The Measurement of Indirect Costs and Benefits Is Necessary to Determining the Benefits of Future Energy Efficiency Programs**

The pressures of competition and restructuring make it essential that dollars be spent only where there are real benefits to be gained. It has long been known and acknowledged that although program evaluation (cost-effectiveness) tests include certain of customers' costs and benefits (e.g., incremental equipment costs) they do not contain all the costs and benefits to participating customers. Without the inclusion of all indirect costs and benefits, we do not know the actual net benefits of a program and it is likely that the most beneficial programs and projects will be missed.

## **The Measurement of Indirect Costs and Benefits Is Essential to Better Program Design**

Knowledge of the significant indirect benefits or misperceptions regarding costs allows better targeting of program marketing and better program design. If it is known that a particular indirect cost, say the need to redecorate or rewire, is significantly more common for a particular business type (non-food retail and

groceries) that has not installed efficient lighting, that program's marketing can work to target these customers when they are planning to redecorate or rewire anyway, or work to clear up any possible misunderstandings as to the need for redecoration or rewiring with efficient lighting installations.

### **The Measurement of Indirect Costs and Benefits Is Crucial to Market Transformation Efforts**

Indirect costs that are considered or expected, but not experienced, and indirect benefits that are not considered or expected, but are experienced, are both evidence of information market barriers. They identify where customers have misconceptions regarding efficiency measures that may prevent them from adopting these measures. Overcoming this type of market barrier is the source of some of the most significant benefits for market transformation or other energy efficiency promotion efforts.

### **PERSPECTIVE**

Indirect costs and benefits (ICBs) are not so much indirect as they have been considered difficult to quantify. This is why they have traditionally been left out of the equations used to evaluate energy efficiency programs. These costs and benefits present a quantification challenge for at least three reasons. First, the magnitude of these costs and benefits depends on factors other than those defined by the equipment installed. For example, a number of indirect costs relating to staff time needed for project planning and management are likely to vary more by the customer's organizational structure than by the type of measure installed. Other indirect benefits such as increased productivity from efficient lighting relate more to the use of the building in which the lighting is installed (e.g., office building versus hotel) than to the number and sizes of the fixtures installed.

In contrast, equipment costs and energy savings are both fairly directly related to the equipment installed. This has made these parameters comparatively easy to measure, using equipment-specific information alone. Little was needed regarding specific customer characteristics, information that is more challenging and expensive together.

Second, a number of ICBs are non-market goods. That is, there exists no direct market through which their value can be determined. Instead, we are dependent on an analysis of customers' revealed or stated preferences for valuation. Examples of these

non-market ICBs are various types of risk and quality changes such as improved visual comfort. In contrast, the market establishes the price of equipment and the price of electricity (with the aid of regulation).

Finally, there are a large number of ICBs. Our study identified 30 different ICBs for an efficient lighting program. To apply the same level of effort in estimating each of these ICBs, as is given the estimation of energy and demand savings, would bankrupt energy efficiency. A reasonable compromise would be to only estimate the larger ICBs. However, to only estimate those ICBs that are more directly quantifiable would run the risk of biasing program evaluation results more than they are already due to the exclusion of all ICBs.

Given these characteristics, the estimation of ICBs presents a real challenge. This study, in taking on this challenge, is the first we know of its kind. When reading this report, please keep in mind the magnitude of our task. One way to put this project into perspective is to remember back when the first attempts were made to estimate freeridership. No one knew what to expect as to customers' responses to inquiries regarding their intentions in the absence of the programs. Similarly, we did not know what we would get when we questioned customers on the various ICBs. This study can be seen as a first, exploratory attempt to measure 30 different "freerider-type" parameters.

## **OUR PROPOSED PLAN**

As discussed above, the purpose of this study was to determine the feasibility, accuracy, and cost of information on the indirect costs and benefits of a commercial lighting retrofit program. Our proposal stated that we planned to do three things in response to this goal:

1. Identify the indirect costs and benefits (ICBs) experienced by participants in the program;
2. Monetize those ICBs that were likely to be directly monetizable; and
3. Employ a form of pricing analysis to determine threshold values for the remaining ICBs.

We proposed to first identify the ICBs because even though the RFP listed at least ten ICBs to consider, there was no guarantee that those were the ICBs these program participants actually experienced. Our proposal also stated that we would not attempt

to measure two of the ICBs listed in the RFP: change in building owner awareness of efficient lighting products and changes in the availability of efficient lighting products.

We believed at the time of our proposal that the following ICBs would be the most likely for direct monetization:

- Higher cost of funds;
- Reductions in O&M costs;
- Other direct participant costs such as that of downtime and training; and
- Cost of risk.

Our plans for these monetizations depended on our ability to obtain from participants the key inputs needed—e.g., hours of downtime caused by the lighting retrofit installation.

Finally, since we believe it essential to account for all ICBs, we proposed to obtain an indication from program participants their impression as to the value of the remaining, non-monetizable ICBs. We believe that to only add those ICBs that are easily monetizable to the present “direct” costs and benefits does nothing to improve program evaluation, and may very well worsen the accuracy of results.

Our approach to the project consisted of three steps:

1. A set of focus groups to identify the ICBs experienced and to determine the best way to obtain the information needed for the direct monetization;
2. A telephone survey to gather the information needed; and
3. Analysis of the survey results to monetize the ICBs.

## **ORGANIZATION OF THIS REPORT**

Section 2 of this report presents our approach to the project. It presents our approach to the focus groups, their results, and the implications of these results on the survey. This section also describes the survey design and results. Section 3 presents the analysis performed on the data collected and our monetary estimates of the ICBs quantified. Finally, Section 4 presents our recommendations for further research and estimates of the cost of that research.

## **2. APPROACH**

### **FOCUS GROUPS**

Due to the exploratory nature of the project we began with a set of focus groups. The main purpose of the focus groups was to identify the indirect costs and benefits (ICBs) experienced by program participants and nonparticipants. The focus groups were also used to develop customer-determined descriptions of each ICB and to determine the best way to obtain the information for the direct monetization of certain ICBs. This information was then used to develop appropriate questions for our telephone survey.

#### **Three Focus Groups Were Conducted**

Three focus groups were conducted: two with program participants, one with nonparticipants. We also interviewed an Energy Service Representative who works with the U.S. Military, which received approximately one-fourth of the program funding.

The focus groups began with an open discussion of the role of lighting in customers' businesses, which led to their volunteering ICBs experienced. After their unsolicited list was developed, the facilitator then probed for specific ICBs and information. The full focus group report is contained as Appendix A of this report.

#### **Focus Group Results**

The focus groups resulted in the identification of 30 different ICBs. Table 1 indicates the relationship between the ICBs identified and those originally suggested in the RFP. As can be seen, the 30 ICBs identified in the focus groups cover the ICBs suggested in the RFP (with the exception of the two stated in the proposal as not to be covered) and add a substantial number of new ones.

The other result of the focus groups was that we determined that our plans for the direct calculation of individual ICBs, other than O&M cost reductions and the higher cost of funds, from secondary data was not possible. We had hoped that certain of the ICBs (such as customer downtime and training costs) could be directly estimated from customer inputs.

**Table 1**  
**FOCUS GROUP RESULTS**

ICBs Mentioned in RFP	ICBs Addressed in this Study
Changes in productivity levels of workers from changed lighting levels	Productivity, improved working conditions
Aesthetic appeal of indoor space, effect on visiting clients	<ul style="list-style-type: none"> <li>■ Improved visual comfort of users and guests</li> <li>■ Reduced discomfort due to noise and glare</li> <li>■ Improved appearance of facilities</li> <li>■ Increased attractiveness of merchandise</li> <li>■ Occupant or tenant complaints about the new lighting</li> </ul>
Change in building owner awareness of efficient lighting products	Not addressed (stated in the proposal)
Changes in the availability of efficient lighting products	Not addressed (stated in the proposal)
Changes in customer costs of searching for efficient lighting products	Finding trustworthy contractors
Changes in the perceived reliability of the product	<ul style="list-style-type: none"> <li>■ Reduced equipment failure</li> <li>■ The technology may not perform as expected</li> </ul>
Changes in the perceived uncertainty in energy savings estimates	<ul style="list-style-type: none"> <li>■ Reduced lighting maintenance, purchase, and warehousing requirements</li> <li>■ Need for increased staff maintenance or attention</li> <li>■ More sophisticated staff may be needed to service and replace equipment</li> </ul>
Changes in maintenance costs	Increased safety or security and reduced vulnerability to lawsuits
Changes in safety or health of building occupants	Increased responsibilities for disposal of hazardous wastes
Environmental impacts	<p style="text-align: center;"><b>Other Indirect Costs or Benefits</b></p> <ul style="list-style-type: none"> <li>■ Fulfilling management objectives/philosophy</li> <li>■ Better fit of lighting to user or customer needs</li> <li>■ Making proposals to upper management</li> <li>■ Obtaining or setting aside funds</li> <li>■ Setting aside other organizational needs</li> <li>■ Staff time for planning renovations or retrofits (including budget development and getting information)</li> <li>■ Staff time for setting up contracts</li> <li>■ Staff time for setting up and managing retrofits or renovations</li> <li>■ Inconvenience during retrofits</li> <li>■ Cannot use old stock</li> <li>■ Need to redecorate or rewire</li> <li>■ Vulnerability to code inspections</li> <li>■ Need to add task lighting</li> <li>■ The use of the space may change</li> <li>■ Energy costs or equipment costs may come down</li> <li>■ Newer, better equipment may become available</li> </ul>

Instead we discovered that while customers were aware of and considered numerous ICBs in their decision making, they did not have estimates of, nor the inputs required to directly estimate these ICBs (e.g., records or estimates of time spent managing lighting retrofits) readily available. It is possible that this information could be gathered using extensive on-site inspections and monitoring. However, the goal of this project focused us on *feasible* approaches and we believe that the cost of these on-site approaches would likely greatly exceed the benefits gained. Moreover, we believe the on-site visits themselves would not be welcome by customers. It is one thing to go on site to help customers measure their energy use and savings. This is information of use to them and within the realm of the utility's business. It is quite another thing for the utility to move into customers' management and production procedures.

There were three main types of feedback from the focus group participants that led us to the realization that the inputs needed for the direct monetization of the ICBs proposed was not possible. These are:

1. **They do not monitor ICBs.** For the most part, as stated in the focus group report, customers did not report systematic efforts to identify, review, or monitor ICBs either as part of their decision-making process or as a way for validating their decisions.
2. **There is no reason for them to monitor ICBs.** Customers stated that ICBs are not a concern to senior management so there is no justification to expend the time and effort to monitor them. Instead, they are indirectly acknowledged or used as "tie breakers."
3. **They do not know how to put a direct value on certain ICBs.** Discussants were quite reticent to attach specific values to ICBs. They could come up with indicators, but were unable to provide hard evidence of the presence or magnitude of these ICBs.

Reductions in operation and maintenance (O&M) costs from efficient lighting retrofits was the one ICB that customers did tend to estimate and use in their decision criteria regarding investment. However, it should be noted that we also discovered after the project start that this program's "direct costs" and benefits included reductions in O&M.

## **Implications of the Focus Group Results on Survey Design**

The results of the focus groups caused us to modify our survey design from that originally envisioned. (Note that this was the purpose the focus groups.)

The first obvious effect of the focus group results on the survey design is that we designed the survey around the list of ICBs identified in the focus groups. Each of the ICBs identified through either the open-ended discussions or the direct probing was included in the survey in order to determine the experience of each in the population as a whole.

Second, since the list of ICBs was so long—30 ICBs were identified in the focus groups—and since our original plan of collecting a lot of data for the direct monetization of ICBs was thwarted, we put more effort into our attempt to determine the general order of magnitude of the various ICBs. Knowing the identify of the large ICBs could focus the efforts of future research. We employed four approaches in this attempt:

1. **Scale response to experience level.** We asked a scaling question regarding participants' level of experience with each ICB. The question asked whether customers experienced each ICB "a great deal," "somewhat," "slightly," or "not at all."
2. **Considered versus experienced ICBs.** We asked each participant whether they first considered each ICB in their decision to participate and then whether they actually experienced that ICB. Since participants were for the most part not freeriders, we expected that significantly more costs were considered than experienced and significantly more benefits were not considered than were experienced. If unjustified worries about costs or a lack of awareness of benefits were keeping these customers from installing lighting on their own, these were likely large ICBs.
3. **Nonparticipant versus participant ICB considerations.** Since they did not participate, we expected nonparticipants to consider more or larger costs and fewer or smaller benefits in their decisions regarding efficient lighting than participants.
4. **Open-ended probe for importance.** We also included a question in the survey before the listings of ICBs that asked the customer to state their most important reason for installing efficient lighting.



Third, although the focus group results discouraged our original goal of obtaining direct monetization data for most ICBs, they did indicate hope for information on reductions in O&M costs and for information regarding customers' investment criteria. A customer's investment criterion is an indirect measure of certain of their indirect costs including their cost of funds, risk, and opportunity cost of capital.

We took two main approaches to O&M cost reductions. First, if they indicated that they included these costs in their investment decisions we asked them directly for their dollar estimates. We also asked them a series of questions to determine the existence of records regarding actual O&M (and other) costs and their willingness to make these records available to their utility.

Regarding customers' investment criteria, we first asked them for the investment criterion they used for investments in general, and then asked them for the criterion used for energy efficiency investments.

Finally, again because of our disappointment regarding the direct monetization of a number of ICBs and because of our belief that ICBs should not be included piecemeal based on monetizability, we placed more emphasis on the pricing analysis portion of the survey. We added, where reasonable, three dollar levels to these questions and attempted another test of customers' perceptions of time risk and their cost of money by asking the questions both in an up-front form and in an annual form.

## **TELEPHONE SURVEYS OF PARTICIPANTS AND NONPARTICIPANTS**

The results of the focus groups were used to develop our telephone survey. Our original goal was to complete 70 participant and 70 nonparticipant surveys.

### **Design of the Survey Instrument**

The survey began with a series of questions on customer characteristics that could be used to segment customer responses. The survey then asked participants whether they considered each ICB in their decision making, and then asked to what extent they actually experienced each. For example, participants were asked whether improved visual comfort for their patrons or employees was considered in their decision to install efficient lighting. Then they were asked to what extent did they actually experience improved visual comfort using a scaling question of "not at all," "slightly," "somewhat," and "a great deal."

Differences between the first and second set of questions indicated customers' misperceptions, lack of information, and bounded rationality regarding the ICBs of lighting—e.g., they did not consider (or expect to experience) improved visual comfort, but were now experiencing that benefit. The degree to which participants experienced each ICB was to give a rough indication of its relative size.

Nonparticipants were asked whether the same list of ICBs were part of their decision not to participate. Differences in participants' and nonparticipants' ICBs will indicate the ICBs that could be addressed in program marketing to encourage nonparticipants to participate. Similarities in ICBs may give an indication that those indirect costs (benefits) are higher (lower) for nonparticipating customers than they are for participants.

The last portion of the participants' survey contained a series of questions intended to give a dollar threshold value for each participants' ICBs. Participants were asked to first state whether they believed their company experienced positive net benefits from the installation of efficient lighting when all the costs and benefits discussed had been considered. A "yes" answer here would indicate that the net value of the ICBs was positive or that the net value was not so negative as to totally offset the traditional Participant test net benefits (bill savings plus rebate minus incremental equipment costs).

Participants were next asked whether they believed net benefits would still be positive if their costs turned out to be higher by a certain dollar amount. That is, are net benefits large enough that a certain amount could be subtracted and the remainder still be positive? This question was asked twice: once using an up-front dollar amount and once using an annual amount. The dollar amount was calculated separately for each participant relative to his or her net benefits.<sup>1</sup> A "yes" answer to this question would indicate that participant net benefits including ICBs were larger than the dollar amount asked.

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<sup>1</sup>Since we had no *a priori* information regarding the size of participant ICBs we did two things to determine the dollar amounts to include in the questions. First, we developed the dollar amounts separately for each customer so that customers who installed \$100,000 lighting systems were not asked the same dollar amount than those who had installed \$1,000 systems. Second, again since we had no idea as to even the relative size of the dollar value of ICBs to customers' other net benefits, we decided we would ask a threshold amount. That is, we asked an amount whose answer whether affirmative or negative would provide crucial, *useful* information regarding the net benefits of the program. Therefore, we set the top dollar amount asked for each customer at the amount where the net value (cost) of all ICBs equaled that customer's contribution to the Total Resource Cost (TRC) test net benefits of the program. Thus, customers whose net value of ICBs was higher than this amount added to the TRC-based cost-effectiveness of the program and those with a net value lower than this amount were not themselves cost-effective from this perspective.

The final survey instruments for both program participants and nonparticipants are contained in Appendix B. of this report.

### **Survey Results**

We completed 70 participant surveys and 26 nonparticipant surveys. A total of 435 contacts were attempted to obtain the 70 participant surveys and a total of 801 contacts were attempted to obtain the 26 nonparticipant surveys. Each phone number in the sample was called at least five times and promising numbers were tried more than that before they were rejected.

The project team in discussions with SDG&E decided to accept 26 surveys as the final total for nonparticipant respondents for two reasons. First, our attempts to obtain the 26 had essentially exhausted our sample of nonparticipants from which to draw. At the success rate we were experiencing it would have required two additional samples of 1,000 each to be drawn. Second, the main value of the nonparticipant survey was in answering questions for future program design and the development of new products. These objectives were dropped from the project after our proposal was submitted and before project start. Nonparticipant results have some impact on our attempts to determine the order of magnitude of the ICBs, as discussed above, but they are not used in any of our estimates of the dollar values of ICBs in this report.

When compared to the population of participants as a whole, our sample is very comparable in terms of the business types represented. Also, even though the survey questionnaire was long and complicated, we did seem to get good respondent comprehension and understanding of the key questions. For example, only three respondents out of 70 answered "don't know" to all the questions regarding ICBs. Also, only four others answered all the ICBs using the most positive response, otherwise, respondents seemed to consider each question separately and answer accordingly.

### 3. ANALYSIS RESULTS

This section presents the analyses performed on the survey results. The analyses discussed are:

- Customer consideration and experience of indirect costs and benefits;
- O&M cost reductions;
- Customer investment criteria;
- Customers' cost of funds;
- "Willingness to pay" question analysis; and
- Contingent valuation.

#### **CUSTOMER CONSIDERATION AND EXPERIENCE OF INDIRECT COSTS AND BENEFITS**

In this section we discuss the results of the survey in terms of the indirect costs and benefits considered by participants, our attempts to determine the relative order of magnitude for these costs and benefits, nonparticipants' considerations of ICBs, and customers' responses as the most important influences on their lighting decisions.

#### **Method**

As described earlier, the survey included several sets of questions asking participants about their attention to, and experience with, various costs and benefits associated with their lighting upgrade projects. We asked respondents whether they had considered or experienced each of 20 specific indirect costs and 10 specific indirect benefits that had been drawn from the focus group discussions. As shown in Table 2, the various items seem to fall into several logical groupings.

We first asked the participants whether they considered the items in each grouping. We then asked the degree to which they perceived that their company had experienced each of those particular costs or benefits.<sup>2</sup> We asked each participant about having experienced each cost and benefit, regardless of whether it had been considered. This

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<sup>2</sup>We had discovered in the focus groups that few participants kept records that would allow them to quantify or monetize indirect costs and benefits (e.g., changes in worker productivity). (Indeed, few keep pertinent records of even more easily captured items as O&M cost changes related to lighting changeouts.) Accordingly, we asked only the degree to which each item was experienced.

design allowed us to capture participant reports of having experienced costs and benefits that had not been considered as well as those considered and experienced and those considered but not experienced.

**Table 2**  
**INDIRECT COSTS AND BENEFITS EXPLORED IN THIS STUDY**

Grouping	Indirect Cost or Benefit
Barriers (leading to costs) experienced during project planning or implementation	<ul style="list-style-type: none"> <li>Making proposals to upper or senior management</li> <li>Obtaining or setting aside funds</li> <li>Setting aside other organizational needs</li> <li>Staff time for planning renovations or retrofits</li> <li>Staff time for setting up contracts</li> <li>Finding trustworthy contractors</li> <li>Staff time managing retrofits or renovations</li> <li>Inconvenience during retrofits</li> </ul>
Costs experienced immediately after implementation	<ul style="list-style-type: none"> <li>Occupant or tenant complaints about the new lighting</li> <li>Cannot use old stock</li> <li>Need to redecorate or rewire</li> <li>Vulnerability to code inspections</li> <li>Need to add task lighting</li> </ul>
Threats to payback (risks)	<ul style="list-style-type: none"> <li>The technology may not perform as expected</li> <li>The use of the space may change</li> <li>Energy costs or equipment costs may come down</li> <li>Newer, better equipment may become available</li> </ul>
Threats of unanticipated consequences	<ul style="list-style-type: none"> <li>Need for increased staff maintenance or attention</li> <li>More sophisticated staff may be needed to service and replace</li> <li>Increased responsibilities for disposal of hazardous wastes</li> </ul>
Indirect benefits	<ul style="list-style-type: none"> <li>Reduced lighting maintenance, purchase, and warehousing</li> <li>Reduced equipment failure</li> <li>Improved visual comfort of users and guests</li> <li>Fulfilling management objectives and philosophy</li> <li>Productivity; improved working conditions</li> <li>Better fit of lighting to user or customer needs</li> <li>Reduced discomfort due to noise and glare</li> <li>Improved appearance of facilities</li> <li>Increased attractiveness of merchandise</li> <li>Increased safety or security and reduced vulnerability to lawsuits</li> </ul>

In the remainder of this section, we will first discuss the degree to which participants considered and experienced each of the individual costs and benefits of interest. We will then describe the relationships among the costs and benefits experienced, as reported by participants. We will follow this discussion with a brief comparison of differences between program participants and nonparticipants in reported consideration of ICBs. Next, we will consider the relationship between the perceived costs and benefits and participants' assessments of the net benefits accruing from their lighting upgrade projects. Finally, we will examine some conclusions and implications that flow from these results.

### **ICBs Considered by Program Participants**

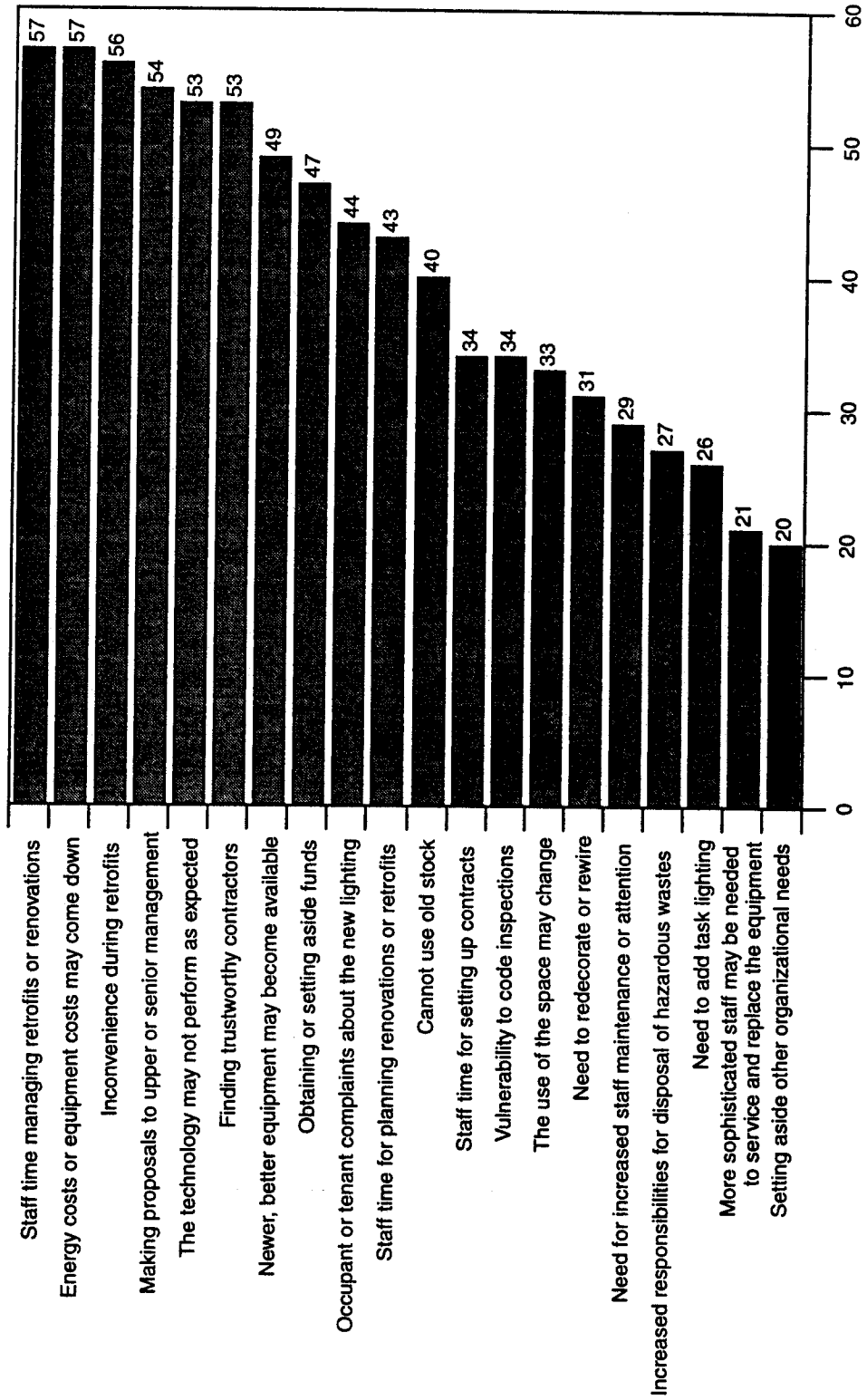
Overall, the survey results confirm those of the focus groups: Customers do report considering indirect costs and benefits when deciding to participate in lighting projects. As shown in Figure 1, each of the indirect costs listed was considered by at least a substantial minority of participants. Scores ranged from a low of 20% (setting aside other organizational needs) to a high of 57% (staff time managing retrofits or renovations). Similarly, as shown in Figure 2, consideration of benefits ranged from a low of 44% (increased safety) to a high of 73% (increased visual comfort of users and guests). It is worth noting that, on average, the reported consideration of ICBs is no greater and no less than the reported consideration of more direct costs and benefits. As shown in Figure 3, between two and three participants in five report considering such factors as the labor costs associated with equipment installation and energy cost savings when deciding to participate in the program.

The consideration of the indirect costs and benefits does not signal that they are actually experienced, of course, nor that they should be included in cost-benefit analyses. However, these considerations are important to understanding the incentives and barriers to customer participation in lighting programs: They signal important nonfinancial barriers that must be overcome in future market-driven efficiency programs and potential promotional points that may be helpful to increasing customer involvement or willingness to pay. We will return to this point after describing the results for perceived experience of the ICBs.

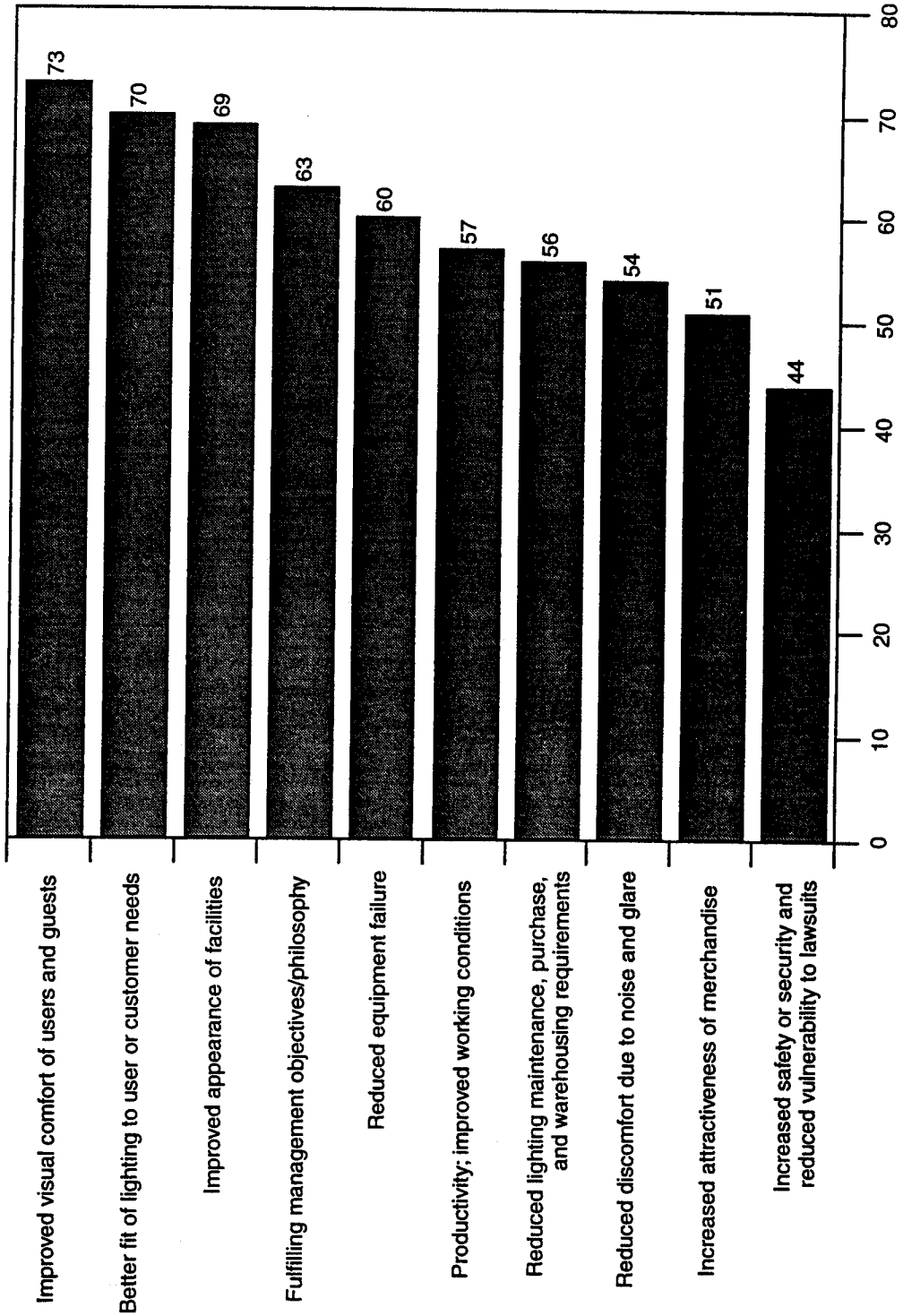
### **ICBs Experienced by Program Participants**

In the case of 19 of the 20 indirect costs considered, a smaller proportion of participants report that they experienced a particular item "a great deal" or

**Figure 1**  
**Percentage of Participants Reporting Consideration of Indirect Costs**

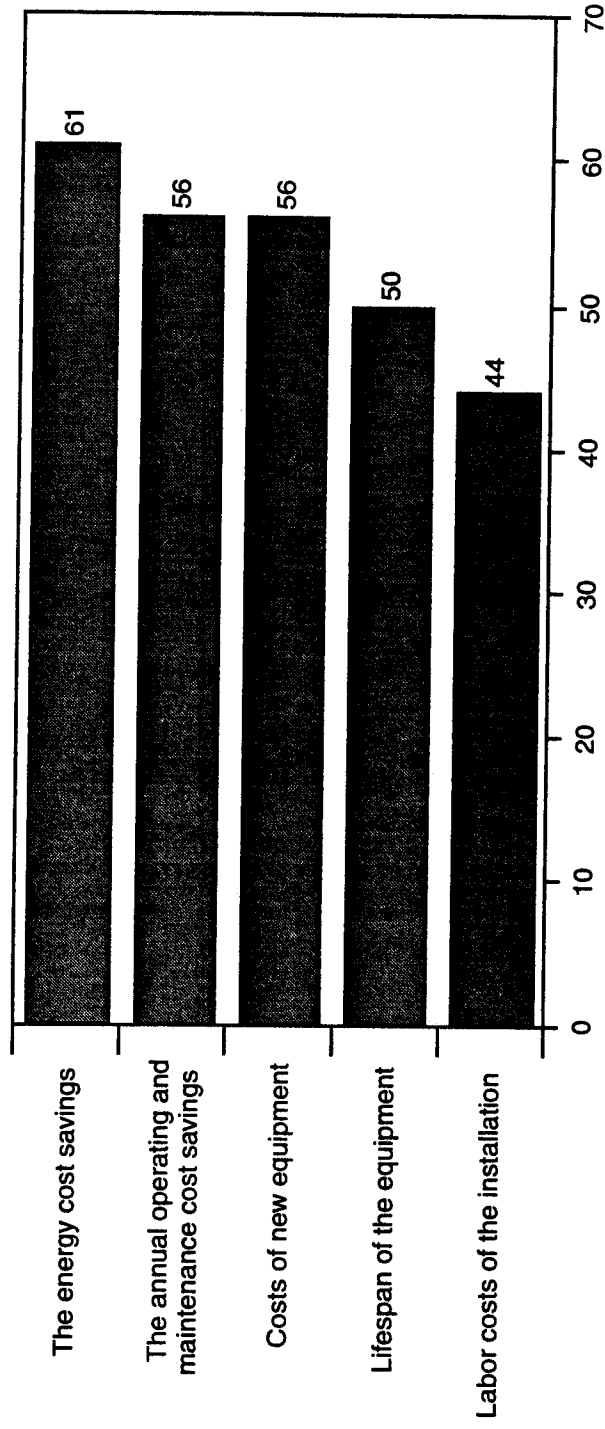


**Figure 2**  
**Percentage of Participants Reporting Consideration of Indirect Benefits**





**Figure 3**  
**Percentage of Participants Reporting Consideration of Direct Costs and Benefits**



“somewhat” than had considered that experience.<sup>3</sup> Nonetheless, approximately one to two respondents in five do report that level of experienced costs. Figure 4 shows the percent of participants that experienced each indirect cost either “a great deal” or “somewhat.” At the high end, 44% of participants say their company experienced the costs of staff time managing retrofits or renovations “a great deal” or “somewhat.” At the low end, 19% report similar levels of costs resulting from changes in the use of the space in which the new equipment was installed.

Interestingly, the reported experience with indirect benefits is both somewhat more frequent and somewhat less variable across the range of items considered. Figure 5 shows the percent of participants that experienced each indirect benefit either “a great deal” or “somewhat.” In each of the ten cases considered, the overall experience reported by participants (at the level of “a great deal” or “somewhat”) is lower than that anticipated; the percentages range from a high of 57% (for fulfilling management objectives) to a low of 40% (for increased safety and for increased attractiveness of merchandise).

### **Relationships Between ICBs Considered and Experienced by Participants**

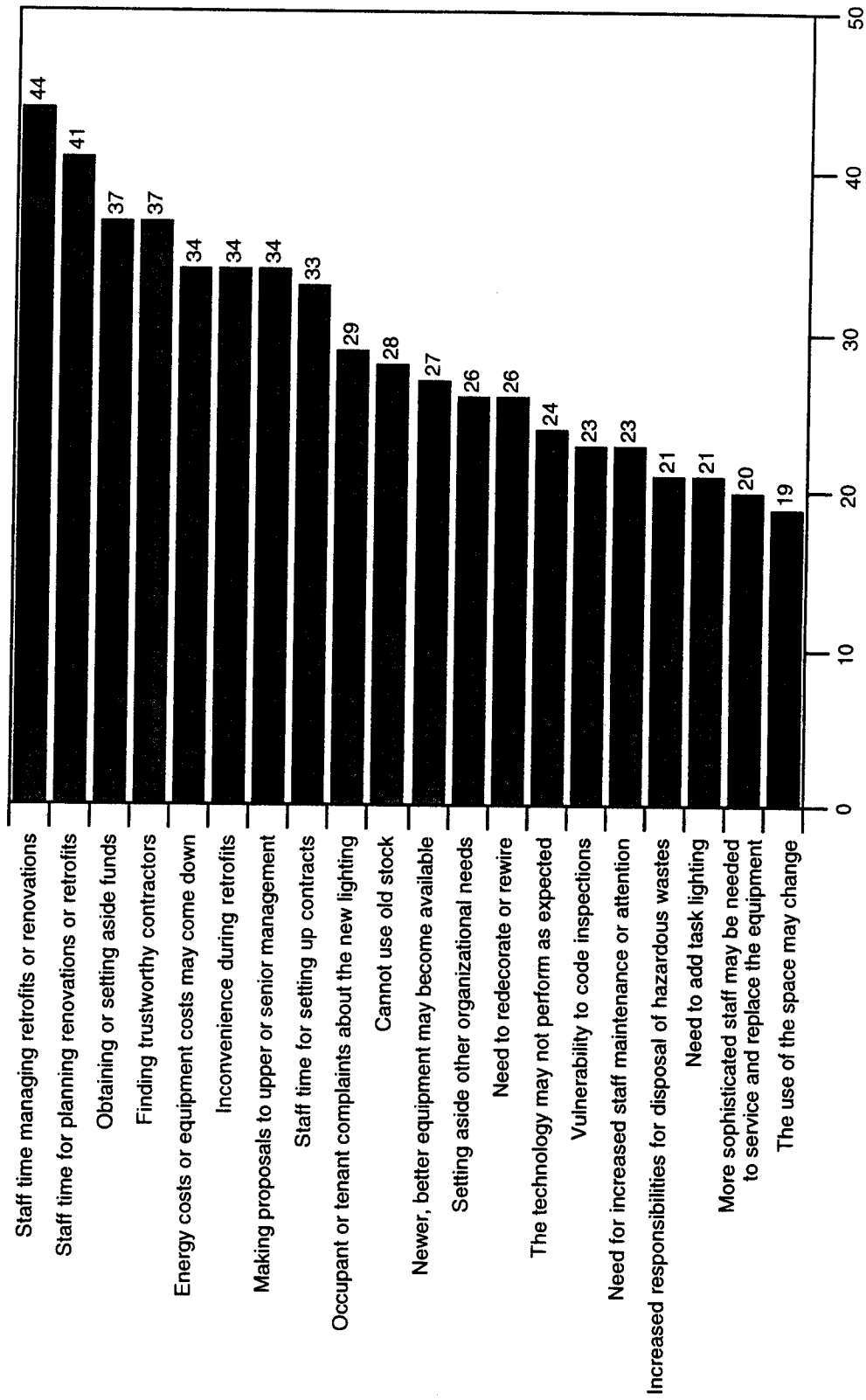
The overall results mask some interesting differences in the responses of individual participants. Tables 3 and 4 recast the results in terms of comparisons between considered and experienced ICBs. For each cost or benefit, the relevant table first shows the percentage of participants who both considered that cost or benefit and reported experiencing it at any level (“a great deal,” “somewhat,” or “slightly”). It then shows the percentage who considered it, but did not report experiencing it at all. (For costs, these constitute what might be labeled “unfounded fears”; for benefits, they might be labeled “disappointments.”) The next column shows either costs or benefits that had not been considered but were reported as experienced at some level. (Such costs might be labeled “pitfalls”; such benefits might be labeled “serendipities.”) The second to last column shows costs or benefits that were neither considered nor reported as experienced at all. The last column shows the “aware” percent—i.e., the percent of participants who either considered and experienced or did not consider and did not experience each ICB.

First, notice that, in general, participants did tend to experience what they considered and not experience what they did not consider. “Aware” percents ranged from 64% to 93% for indirect costs and from 69% to 82% for indirect benefits. It is possible that

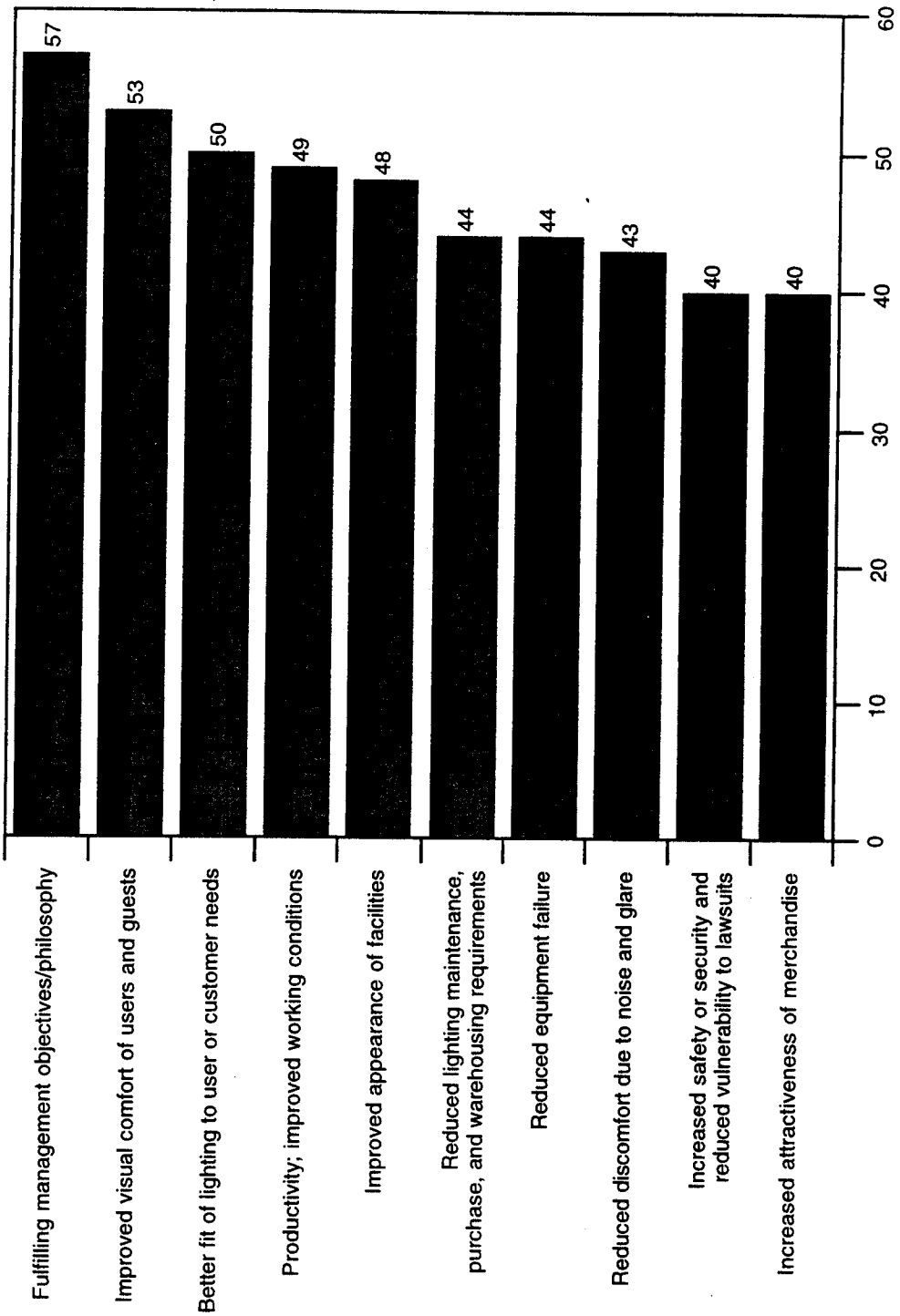
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<sup>3</sup>This overall result is significant ( $p < .05$ ) by a sign test, although few differences for individual items are.

**Figure 4**  
**Percentage of Participants Reporting Experience of Indirect Costs**



**Figure 5**  
**Percentage of Participants Reporting Experience of Indirect Benefits**



**Table 3**  
**REPORTED CONSIDERATION AND EXPERIENCE OF INDIRECT COSTS**

Indirect Costs	Considered		Not Considered		"Aware" Percent
	Experienced	Not Experienced	Experienced	Not Experienced	
Making proposals to upper or senior management	31%	23%	11%	34%	65%
Obtaining or setting aside funds	37%	10%	11%	41%	78%
Setting aside other organizational needs	11%	9%	23%	57%	68%
Staff time for planning renovations or retrofits	34%	9%	21%	36%	70%
Staff time for setting up contracts	26%	9%	20%	46%	72%
Finding trustworthy contractors	43%	10%	7%	40%	83%
Staff time managing retrofits or renovations	47%	10%	13%	30%	77%
Inconvenience during retrofits	39%	17%	10%	34%	73%
Occupant or tenant complaints about the new lighting	24%	20%	16%	40%	64%
Cannot use old stock	26%	14%	9%	51%	77%
Need to redecorate or rewire	21%	10%	7%	61%	82%
Vulnerability to code inspections	17%	17%	7%	59%	76%
Need to add task lighting	21%	4%	6%	69%	90%
The technology may not perform as expected	24%	29%	7%	40%	64%
The use of the space may change	19%	14%	4%	63%	82%
Energy costs or equipment cost may come down	30%	27%	9%	34%	64%
Newer, better equipment may become available	26%	23%	6%	46%	72%
Need for increased staff maintenance or attention	17%	11%	10%	61%	78%
More sophisticated staff may be needed to service or replace	17%	4%	4%	74%	91%
Increased responsibilities for disposal of hazardous wastes	23%	4%	3%	70%	93%

**Table 4**  
**INDIRECT BENEFITS CONSIDERED AND EXPERIENCED**

Indirect Benefits	Considered		Not Considered		"Aware" Percent
	Experienced	Not Experienced	Experienced	Not Experienced	
Reduced lighting maintenance, purchase, and warehousing	40%	16%	16%	29%	69%
Reduced equipment failure	43%	17%	7%	33%	76%
Improved visual comfort of users and guests	53%	20%	4%	23%	76%
Fulfilling management objectives and philosophy	53%	10%	9%	29%	82%
Productivity; improved working conditions	43%	14%	7%	36%	79%
Better fit of lighting to user or customer needs	53%	17%	3%	27%	80%
Reduced discomfort due to noise and glare	43%	11%	7%	39%	82%
Improved appearance of facilities	54%	14%	4%	27%	81%
Increased attractiveness of merchandise	36%	16%	10%	39%	75%
Increased safety or security and reduced vulnerability to lawsuits	33%	11%	13%	43%	76%

this is the result of something like self-fulfilling prophesy—i.e., “I considered this, therefore, it must have happened”—but it is more likely that participants are simply aware of the ICBs of lighting and have realistic perceptions as to their experience of them.

The percentage of participants reporting indirect costs that were considered, but not experienced ranged from 4% to 29%. Five costs appear particularly likely to raise “unfounded fears.” Each of the following potential costs was considered but not experienced by 20% or more of the participants.

- Making proposals to senior management
- Occupant or tenant complaints about the new lighting
- The technology may not perform as expected
- Energy costs or equipment costs may come down
- Newer, better equipment may become available

The percentage of participants reporting indirect benefits that were experienced but not considered, “serendipities,” ranged from 3% to 16%. Both “unfounded fears” and “serendipities” could be considered the “good surprises.”

The percentage of participants reporting indirect costs that were experienced but not considered ranged from 3% to 23%. Again, using a cut-off of 20%, three costs appear particularly likely to be encountered as “pitfalls:”

- Setting aside other organizational needs
- Staff time for planning renovations or retrofits
- Staff time for setting up contracts

Finally, the percentage of participants reporting indirect benefits that were considered but not experienced ranged from 10%–20%. Of these, only one seems particularly likely (i.e., reported by at least 20% of participants) to cause “disappointment.” (Both “pitfalls” and “disappointments” could be considered “bad surprises.”)

- Improved visual comfort of users and guests

Using a somewhat different criterion—the percentage of participants having an unfounded fear differing by 10% or more from the percentage experiencing a pitfall—yields the following additional insights. The following are more often an unfounded fear than a pitfall:

- Making proposals to upper or senior management;
- Vulnerability to code inspections;
- The technology may not perform as expected;
- The use of space may change;
- Energy costs or equipment cost may come down; and
- Newer, better equipment may become available.

Note that the last four bullets are all risks. While it is possible that customers do not report experiencing these risks only because they have not *yet* experienced them, with their year or two of experience it is more likely that their perception of this risk turned out to be higher than actual occurrence.

Using the same criterion, the following indirect costs are more often a pitfall than an unfounded fear:

- Setting aside other organizational needs;
- Staff time for planning renovations and retrofits; and
- Staff time for setting up contracts.

And finally, the following are more often a disappointment than a serendipity:

- Reduced equipment failure;
- Improved visual comfort of users and guests;
- Better fit of lighting to user or customer needs; and
- Improved appearance of facilities.

### **Our Attempt to Determine Order of Magnitude Relative Sizes for ICBs Failed**

As discussed above, we attempted to obtain information on the relative size of ICBs through a scaling question. Participants were asked whether they experienced an ICB “a great deal,” “somewhat,” “slightly,” or “not at all.” The results of the survey indicate that our attempt was not successful.

In all but one case of the thirty ICBs examined (and that one case is marginal), the distribution of reported experiences is highly bimodal; that is, participants report either that they did not experience the ICB at issue, or they experienced it “a great deal.” Relatively few participants report experiencing each of the ICBs at an intermediate level. It is certainly possible that these reports are reflective of reality, but it is more likely that they indicate that participants adopted an “all or nothing” perspective on the experience of ICBs. Thus, not only are we unable at this time to



quantify directly most of the indirect costs and benefits actually experienced, but we appear also unable to quantify the *degree* to which each was experienced.

### **Relationships Among ICBs Reported as Experienced by Program Participants**

One of the purposes of this study was to help develop an instrument for better identifying (and ultimately quantifying) those indirect costs and benefits that affect customer decisions and that should be included in future analyses of net benefits. Accordingly, we were particularly interested in the measurement characteristics of the costs and benefits that emerged from the focus group discussions, including the degree to which they are experienced independently or in definable clusters. (It will be recalled that the indirect costs seem to be categorizable according to the project stage at which they appear. The ICBs might also cluster according to other criteria, such as the degree to which they are equipment-specific—e.g., cannot use old stock; need to add task lighting; newer, better equipment may become available; the technology may not perform as expected; and reduced equipment failure—and those that are user-related—e.g., occupant or tenant complaints about the new lighting; productivity; better fit of lighting to user or customer needs; improved visual comfort of users and guests; and reduced discomfort due to noise and glare.)

As shown above, each of the ICBs listed is considered and is reported as experienced by at least a substantial minority of participants. Moreover, the percentages of respondents who say they considered each or experienced each differ in what appear to be reasonable ways. For example, nearly three participants in four are neither concerned that more efficient lighting equipment will require more sophisticated maintenance staff nor report that they experienced that cost. In contrast, more than one-half report that they both considered and experienced improved visual comfort as a result of their upgrade.

A correlational analysis of reported experiences indicates a very high degree of relationship among all ICBs. Although the correlations range from highs of 0.8 and 0.9 (when considering the relationships of some costs in the same logical subgroups) to lows of 0.2 (when considering the relationships of some costs to certain benefits), virtually all are significantly related in the positive direction ( $p < .05$  that the correlations are greater than 0.0). We are able to force the results to yield multiple

factors,<sup>4</sup> but it appears that a single factor may be a more natural explanation of the results.

The “all or nothing” perspective to level of experience answers discussed above may help explain this result. What is the single factor that, to various degrees, permeates the responses of participants to each of the ICBs examined? We may advance three hypotheses to explain these results. First, it is possible that—at least for the types of lighting projects and the types of customers involved—all of the ICBs do in fact occur together or not at all; if participants experience one of them, they tend to experience them all. Second, the results may be purely an artifact of response biases introduced by the measuring instrument, especially since each group of ICBs was asked in direct proximity to the others. Third, the participants may differ systematically in their attention, and sensitivity, to ICBs: Some respondents tend to monitor and recognize a wide range of ICBs and others are more certain of their occurrence, while others are less aware of the same indicators and outcomes.

It is probably the case that each of the hypotheses discussed is true to some degree. However, we suggest that the most important of these is the third explanation, that respondent sensitivities or attention differ systematically. It seems relatively unlikely that different businesses with different types of lighting will tend to experience various costs and benefits in similar degrees. It also seems unlikely that we would have found the level of differentiation observed among different costs and benefits if the results were largely an artifact of response biases.

Several lines of evidence seem to support the third hypothesis, that some participants are more sensitive to all costs and benefits than are others. First, nearly one-third of all respondents (22 of 70) score at either the absolute minimum (i.e., “not at all”) or the absolute maximum (i.e., “a great deal”) with regard to reported ICB experience.

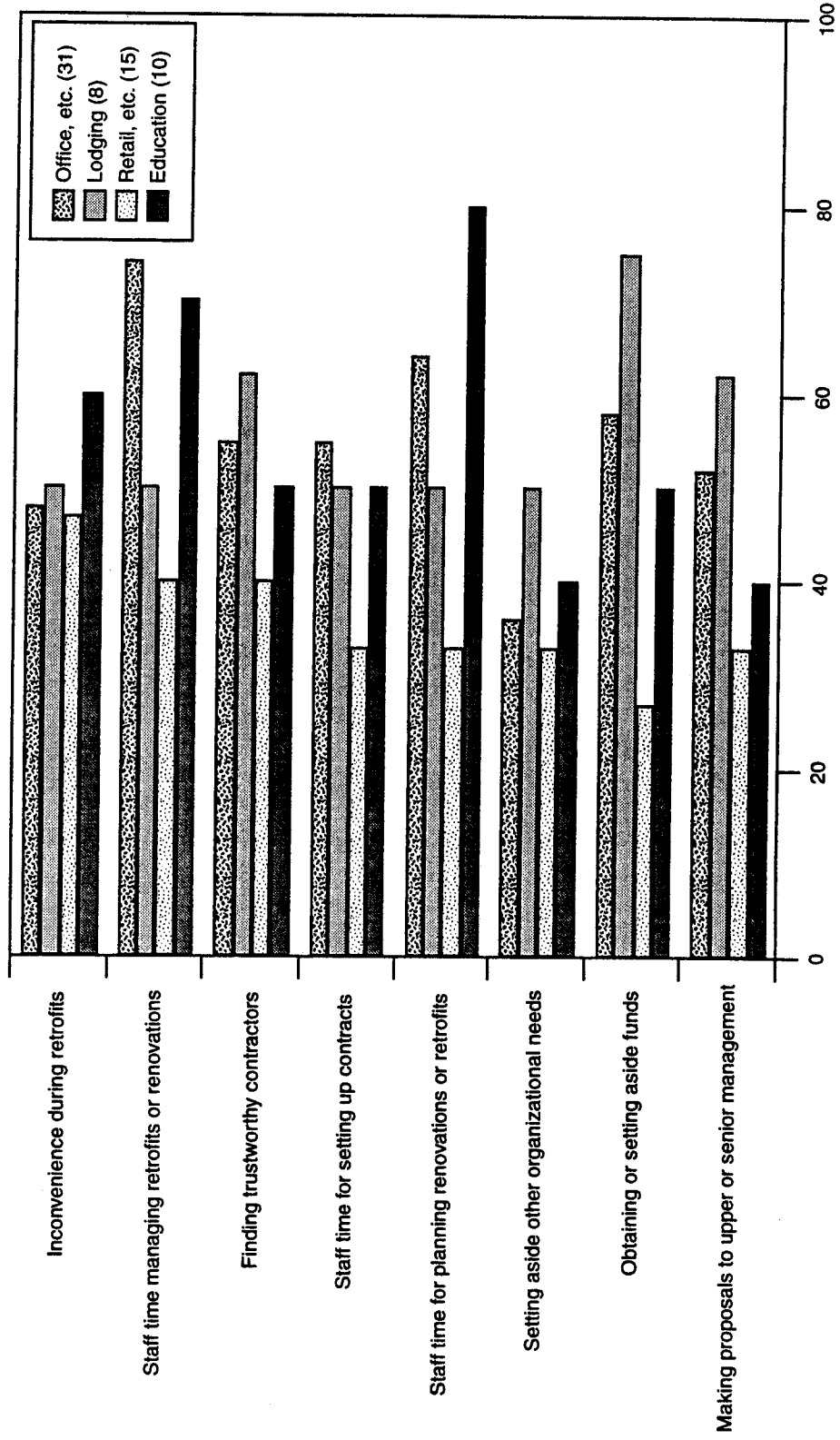
Second, Figures 6, 7, and 8 show reported planning costs, other costs, and benefits, respectively, as a function of participant business type.<sup>5</sup> Although the figures show that participants are clearly responsive to specific ICBs, they also suggest that tendencies toward reporting cost and benefit experiences may differ from one business segment to another, whether because of sensitivity, attention, or reality. For example,

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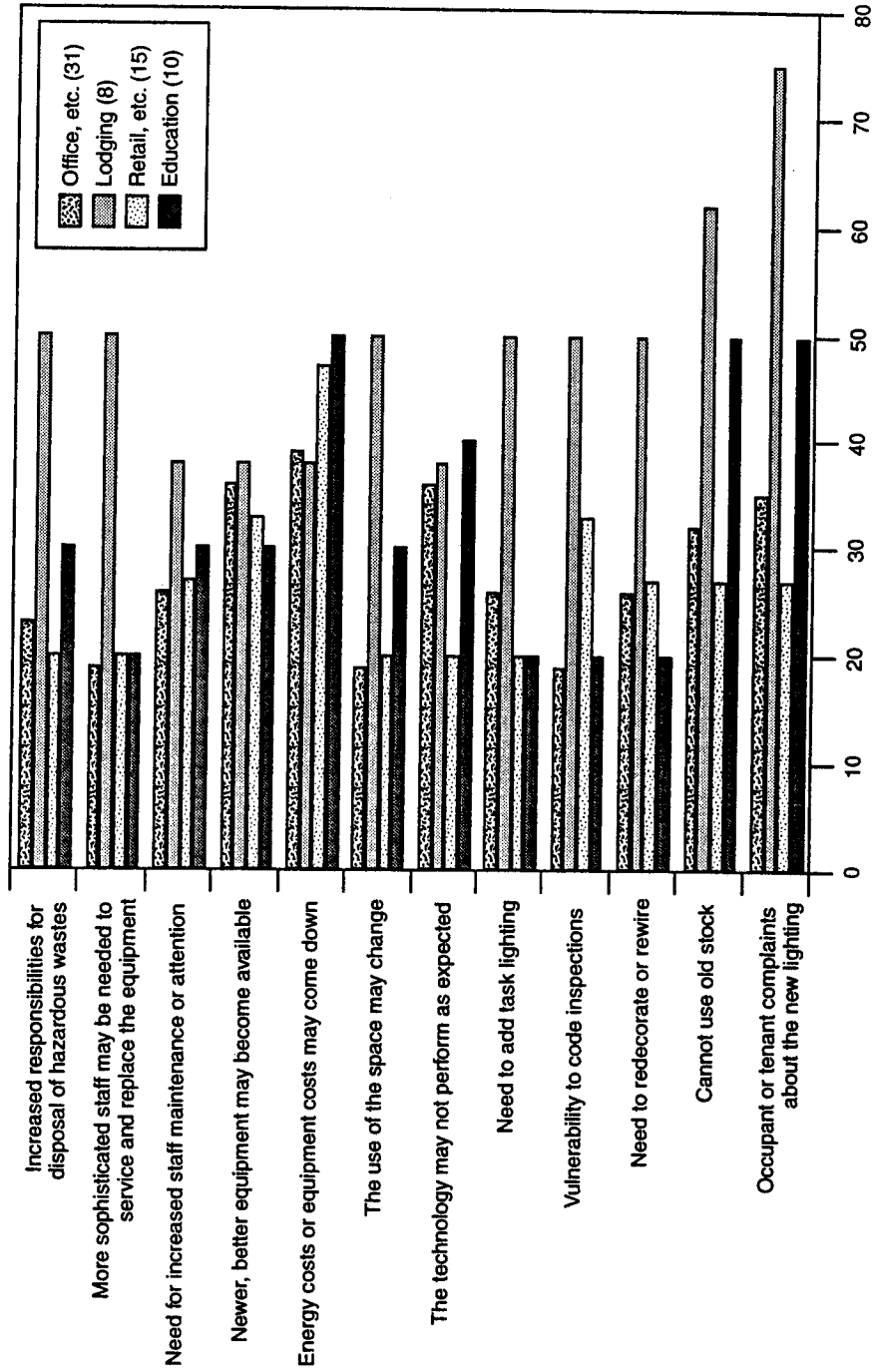
<sup>4</sup>We analyzed the intercorrelations of costs and the intercorrelations of benefits separately. A single factor accounts for 71% of the variance in benefits. Each benefit loads at least 0.76 on that factor. The first unrotated cost factor accounts for 63% of the variance; the first two account for 73% of the variance. Varimax rotation can separate the two factors into one that includes most of the upfront planning costs and one that includes the majority of costs that might be experienced as an aftermath of the project. Additional analysis of the discriminability of these scores would be valuable.

<sup>5</sup>Medical facilities are omitted. Only two were included in the sample.

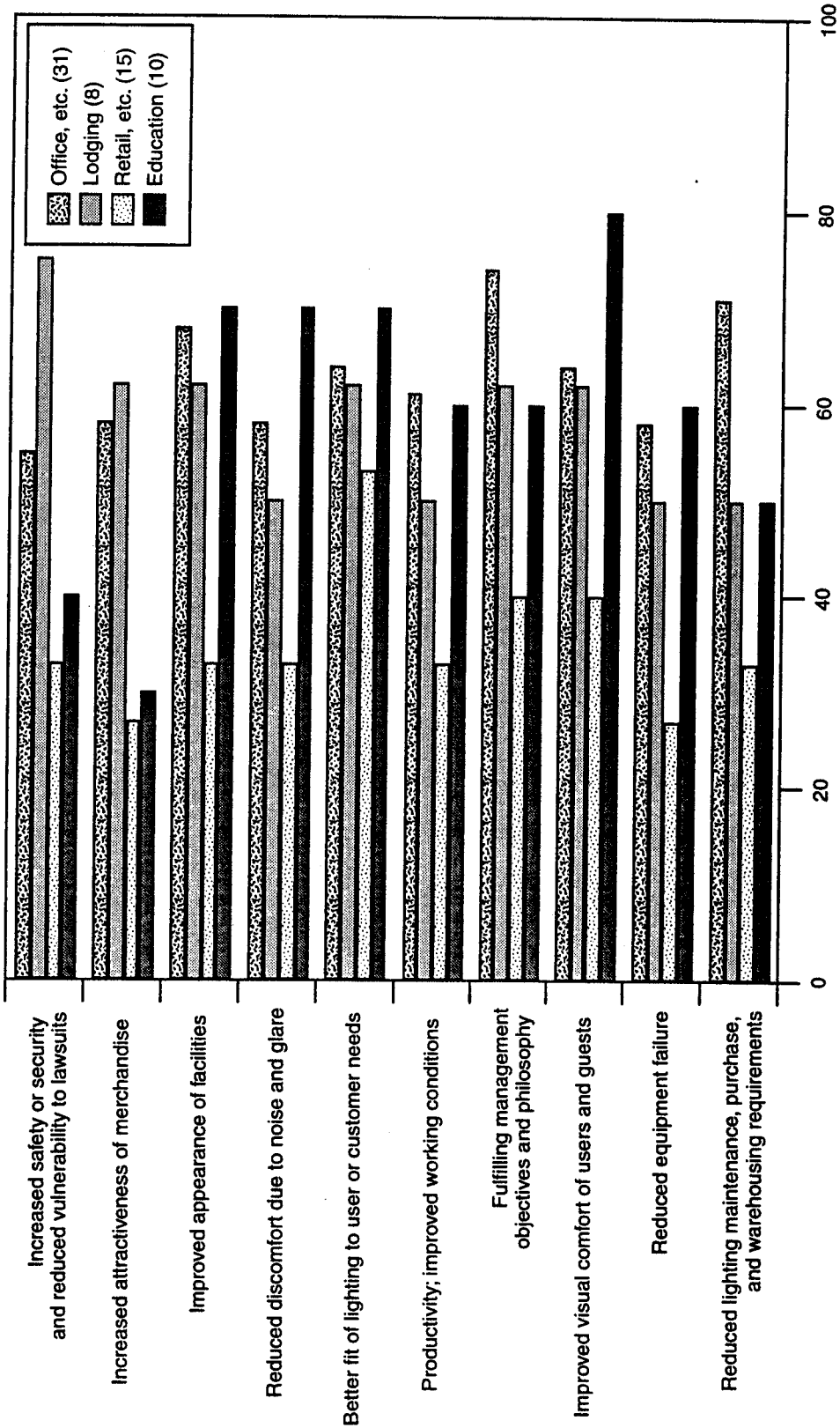
**Figure 6**  
**Planning Indirect Costs Reported as Experienced, By Participant Business Type**



**Figure 7**  
**Other Indirect Costs Reported as Experienced, By Participant Business Type**



**Figure 8**  
**Indirect Benefits Reported as Experienced, By Participant Business Type**



members of the retail segment are consistently less likely than members of other segments to report having experienced *any* of the costs or benefits considered. Conversely, members of the lodging segment are more likely than members of other segments to report experiencing the majority of costs and benefits considered.

Finally, a correlational analysis demonstrates that the likelihood of reporting costs and benefits experienced at the various levels is directly related to having the responsibility of monitoring the results of the lighting upgrade project. Participants who indicated that they were responsible for such monitoring are significantly more likely to report having experienced more costs and benefits than other participants ( $r = 0.56; p < .05$ ).

### **Nonparticipant Survey Results**

We surveyed nonparticipants as well as participants to see if nonparticipant consideration of ICBs would give us any insight into ICBs' effects on the participation decision. For example, if more nonparticipants indicated that they considered a particular indirect cost in their lighting decisions than participants, that may be an indication that indirect cost was larger for them than for participants. It could also indicate that indirect cost was so important to that customer that its likelihood precluded any consideration of participation. On the other hand, if more participants considered a particular indirect benefit that could indicate that that benefit was worth more to them than to nonparticipants, or that that benefit was a main reason for participating.

As discussed above, we completed 26 nonparticipant surveys. Of these 26, three customers gave "don't know" answers to all the ICB questions. Therefore, we eliminated these responses and were left with a nonparticipant database of 23. The small sample size limited the opportunities for analysis of this data. However, we did find some significant differences in the ICBs considered for lighting projects between the two. Significance was established using a standard difference of proportions t-test. The significant differences are discussed below.

Comparisons were made between the total population of participants (70) and nonparticipants (23), and for participating and nonparticipating retail/restaurant/grocery (19 versus 15) and office/commercial business types (31 versus 6). The other business types were not represented (medical) or were only represented by one observation each (education and lodging) in the nonparticipant sample.

### *Indirect Costs*

The following are the indirect costs that were considered by a significantly higher proportion of nonparticipants than participants:

- Need to redecorate or rewire (significant at the 95% level for the total and for the retail/restaurant/grocery business type comparisons);
- Increased responsibilities for disposal of hazardous wastes (significant at the 95% level for the retail/restaurant/grocery business type comparison); and
- Newer, better equipment may become available (significant at the 90% level for the retail/restaurant/grocery business type comparison).

Each of these indirect costs could be either costs that are significantly larger for nonparticipants than participants, or any of these costs could be so important to nonparticipating customers as to be a "deal breaker." That is, the perceived or actual existence of one of these costs could cause a customer to ignore all benefits of efficient lighting.

The following are the indirect costs that were considered by a significantly higher proportion of participants than nonparticipants:

- Need to add task lighting (significant at the 95% level<sup>6</sup> for the office/commercial business type comparison);
- Energy costs or equipment costs may come down (significant at the 95% level for the office/commercial business type comparison and at the 90% level for the total comparison); and
- The technology may not perform as expected (significant at the 90% level for the office/commercial business type comparison).

These results are difficult to interpret, because *a priori* (with the implicit assumption that the "consideration" of a cost is highly related to the belief that one would incur that cost) we would assume that more nonparticipants would have considered costs

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<sup>6</sup>The significance of this difference is questionable since this comparison fails the  $n \cdot p > 5$  test for use of the difference of proportions t-test. No nonparticipant office/commercial customers stated that they considered this indirect cost in their lighting decisions.

than participants. They considered (read: believed they would incur) more costs, and thus, did not participate.

It could be that these costs were considered more often by customers that participated simply because these customers have given more thought to a wider range of the costs and benefits involved in efficient lighting projects. It could also be that these costs were considered by participants and expected to be so small as to be insignificant. Finally, these results lead us to question whether the task lighting participants are considering is actually lighting that they installed as part of their program participation.

### *Indirect Benefits*

The following is the indirect benefit that was considered by a significantly higher proportion of participants than nonparticipants:

- Fulfilling management objectives/philosophy (significant at the 95% level for the total and office/commercial business type comparisons).

This result is not surprising. Those companies that have a management objective or philosophy for cost savings, energy efficiency, or environmental friendliness would, of course, be more likely to participate in an efficient lighting program.

The following are the indirect benefits that were considered by a significantly higher proportion of nonparticipants than participants:

- Improved visual comfort of users and guests (significant at the 95% level for the retail/restaurant/grocery business type comparison);
- Increased attractiveness of merchandise (significant at the 90% level for the retail/restaurant/grocery business type comparison); and
- Increased safety or security and reduced vulnerability to lawsuits (significant at the 90% level for the retail/restaurant/grocery business type comparison).

Again, at first, these results seem difficult to interpret. However, there may be a simple explanation. It is possible that nonparticipating customers considered each of these benefits and decided that they would not experience them (or would only experience them at a minimal level). Or it could be that they decided that they would



likely experience the opposite of the benefit. For example, it is possible that nonparticipants considered improved visual comfort in their lighting decisions, and decided against efficient lighting believing either that they would not experience this benefit or that they would experience a reduction in visual comfort.

### **Results of Open-Ended Probe On “Most Important Reason” for Lighting Project**

As discussed above, we made several attempts through the survey design to determine customers’ relative ranking of ICBs. One of these attempts was an open-ended question regarding the “most important reason why the company decided to proceed with the SDG&E lighting project.” This question was asked before the individual ICBs were discussed.

Of the 70 respondents, the vast majority (48) gave “cost savings” as the answer. Relating specifically to ICBs, two said that the project was “in line with company policy” and two said that appearance or aesthetics was the most important reason. When further asked whether they recalled “any other costs or benefits” considered, three more (out of the 20 who answered this question) said appearance or aesthetics.

These results show that to at least some participants (at least four out of 70) particular ICBs are the most important reason why they participated in the program. Three more volunteered specific indirect benefits as “next level” considerations.

### **O&M COST REDUCTIONS**

Although the RFP for this project lists “changes in maintenance costs” as an ICB to study, SDG&E (and many other utilities) already regularly include O&M savings in their analysis of lighting and other programs—i.e., they regularly include these savings as a “direct” benefit.

The O&M savings for lighting come from the reduction in the need for bulb replacement. Fewer labor hours are needed for installation and replacement equipment costs are avoided for efficient measures with longer bulb lives (i.e., compact fluorescent bulbs versus standard bulbs) or with fewer lamps (i.e., delamping leaves fewer lamps to replace).

Average percent of standard participant net benefits that is present valued O&M savings across the 70 survey respondents according to utility calculations is 2.3%. This translates into O&M cost savings of \$1,476, which is included in the average direct net benefits of the program to these participants of \$64,174.<sup>7</sup> This amount is small because a significant number of participants' measures did not generate O&M savings—i.e., they were not compact fluorescent or delamping measures. While O&M savings only made up 2.3% ( $\$1,476 / \$64,174$ ) of net benefits across all participant measures, these savings make up 23.4% ( $\$20.19 / \$86.21$ ) of net benefits from certain compact fluorescent measures.

Our survey addressed O&M cost reductions through several questions. First, we validated certain of the inputs to utility calculations of O&M savings. For example, responses to our questions regarding hours of operation generally coincide with the hours of operation used in utility analyses.

Second, we asked those respondents who specifically indicated that they consider O&M savings in their decisions to participate what they estimated those savings to be. 39 out of 70 stated that they specifically considered these costs in their decision processes. Of these, 17 gave us estimates of their annual savings. It is interesting that in all cases these estimates greatly exceed those calculated by using utility inputs. It would be interesting to go back to these respondents to determine whether there are elements of O&M cost savings that standard calculations are ignoring.

Finally, we asked a series of questions to determine whether customers kept and would make available "records of the time and materials used to maintain [their] lighting." Thirty-eight of 70 said that they kept this type of record, but less than half of these (18 out of 38) said that they would be willing to make these records available to their utility energy services representative. Most stated cost as the reason. The existence of these records bodes well for future analyses of O&M savings, however, it seems that customers will need to be compensated or otherwise convinced to cooperate in making these available.

## **CUSTOMER INVESTMENT CRITERIA**

As it seemed we would be thwarted from obtaining the specific input data we required to directly monetize a large number of the ICBs, we decided to at least test the

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<sup>7</sup>These dollar amounts, as well as all others calculated in this report, must be considered hypothetical and not the actual dollar costs and benefits of the SDG&E Commercial Lighting Program.

feasibility of obtaining an indirect indicator of indirect costs: customers' investment criteria.

Customers' investment criteria reflect a number of indirect costs at least implicitly considered by customers when considering various investments including energy efficiency. As discussed in the next section, a customers' cost of funds reflects the minimum level for the indirect costs included in the investment criterion. That is, customers' investment criteria must at least be as stringent as their cost of funds or they are wasting their capital—i.e., they would be making less than their money costs.

Investment criteria tend to be more stringent than customers' cost of funds (i.e., require a higher rate of return) because they implicitly contain acknowledgement of other indirect costs. The other indirect costs implicit in a customer's investment criterion include various types of risk, management and staff time for evaluation, decision making, planning and management, and the opportunity cost of capital. That is, the risks of going out of business, of equipment failure, of changing the future use of the space, etc., cause customers to heavily discount future benefits. In addition, management may require a higher return on investment to cover the cost of their and their staff's time to evaluate and put in place the investment. Finally, if the customer has ample investment opportunity at the rate of return implied by their investment criterion choosing to install one investment over another only generates a *net* benefit of the incremental return. That is, if they choose to install energy efficient equipment with a rate of return of 30% instead of another investment with a rate of return of 28% the net benefit of the energy efficiency investment to the customer is only 2%.

It is not our intention here to determine exactly which indirect costs are incorporated in these customers' investment criteria. Instead, we accepted their responses as a reasonable estimate of an undefined set of their indirect costs.

Forty-four out of 70 stated the type of investment criterion their company uses and 33 of these provided the actual criterion. Seven of the 44 stated that their company used a different investment criterion for energy efficiency measures than they did for other investments. In the two cases where the actual criterion was given for both types of investments, one used a more stringent criterion for energy efficiency and one used a less stringent criterion. Table 5 shows the number of each type of criterion and the range of answers given.

**Table 5**  
**RESPONSES TO QUESTIONS REGARDING**  
**CUSTOMERS' INVESTMENT CRITERIA**

	<b>Knew Type of Criterion</b>	<b>Provided Criterion</b>	<b>Range of Answers</b>
Payback	28	25	1-5 years
Minimum rate of return	10	6	10%-100%
Hurdle rate	3	2	16%-45%
Other	3	0	N/A
Totals	44	33	

Table 6 shows the calculation of the indirect costs implicit in the investment criterion for one participant for one measure: a 13-watt compact fluorescent bulb replacing a 60-watt standard incandescent bulb.<sup>8</sup> As can be seen, for a measure with a ten-year life and assuming a 3% escalation rate, an investment criterion of a five-year payback is equivalent to a 23.9% minimum rate of return criterion. For this customer and for this measure, a five-year payback investment criterion implies a value for that set of indirect costs of \$38.55. This is compared to the \$86.21 in net benefits calculated using "direct" costs and benefits. Appendix C contains two additional tables that detail these calculations for all the measures for one participant and for all participants who provided investment criteria.

Based on calculations using the investment criteria given, the average value of the indirect costs implied is \$52,815 for the average of the sample of 70 participants. That is, these customers through their investment criteria value the net benefits of their efficient lighting projects at \$11,359 on average (the \$64,174 average for this sample calculated using "direct" benefits and costs minus \$52,815). The indirect costs implicit in customers' investment criteria are -82.3% (+/- 13.1% absolute or 15.9% relative with 95% confidence) of participant net benefits calculated using standard inputs. (For a listing of the values calculated here compared to those generated by the pricing analysis, see the discussion of the "willingness to pay" question analysis results.)

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<sup>8</sup>Note that our use of a 7% discount rate and a 3% escalation rate reflects our attempt to report reasonable, yet hypothetical results, and is not to be considered reflective of SDG&E's actual assumptions in their evaluation of their Commercial Lighting Program.

**Table 6**  
**Example Calculation of the Indirect Costs Implicit in the Investment Criterion for One Measure**

Measure:	13W CF lamp	Annual Bill Savings:	\$8.71
Up-front Cost:	\$33.19	Annual O&M Savings:	\$2.38
Incentive:	\$25.38	Life in Years:	10
Participant Investment Criterion:	5-Year Payback	Escalation rate:	3%
Implied Discount Rate:	23.85%	Utility Cost of Capital:	7%

Year	Escalated @ 3% & Discounted @ 7%		Simple 5-Year Payback		Escalated @ 3% & Discounted @ 23.85%	
	Bill Savings	O&M Savings	Bill Savings	O&M Savings	Bill Savings	O&M Savings
1	\$8.71	\$2.38	\$8.71	\$2.38	\$8.71	\$2.38
2	\$8.39	\$2.29	\$8.71	\$2.38	\$7.25	\$1.98
3	\$8.07	\$2.21	\$8.71	\$2.38	\$6.03	\$1.65
4	\$7.77	\$2.12	\$8.71	\$2.38	\$5.01	\$1.37
5	\$7.48	\$2.05	\$8.71	\$2.38	\$4.17	\$1.14
6	\$7.20	\$1.97	\$0.00	\$0.00	\$3.47	\$0.95
7	\$6.93	\$1.90	\$0.00	\$0.00	\$2.88	\$0.79
8	\$6.67	\$1.82	\$0.00	\$0.00	\$2.40	\$0.66
9	\$6.42	\$1.76	\$0.00	\$0.00	\$1.99	\$0.55
10	\$6.18	\$1.69	\$0.00	\$0.00	\$1.66	\$0.45
Totals	\$73.83	\$20.19	\$43.56	\$11.91	\$43.56	\$11.91

Net Benefits to Participants Using the Utility's Cost of Capital:  
 $\$86.21 = \$73.83 + \$20.19 + \$25.38 - \$33.19$

Net Benefits to Participants Using Participant's Investment Criterion:  
 $\$47.66 = \$43.56 + \$11.91 + \$25.38 - \$33.19$

Overstatement of Participant Net Benefits (i.e., Value of the Indirect Costs Implicit in the Investment Criterion):  
 $\$38.55 = \$86.21 - \$47.66$

## CUSTOMERS' COST OF FUNDS

As discussed above, a customer's cost of funds is implicitly included in his or her investment criteria. As shown above in Table 6, the standard calculation of the "direct" costs and benefits of this lighting measure used a 7% discount rate. This rate reflects the utility's cost of capital which is the standard discount rate used in the evaluation of energy efficiency programs. However, if the customer's cost of capital is higher, this assumption overvalues participants' benefits.

Discounting acknowledges the fact that a dollar today is not worth the same as a dollar a year from now. Since indirect costs and benefits acknowledge customers' costs and benefits, we should use customers' discount rates to value their benefits.

How much less is a dollar a year from now worth than a dollar today? The future year dollar is worth today some amount equal to or less than the amount you could borrow on that dollar. That is, the value of a dollar a year from now is the size of a loan you could get today that would exactly be paid back by that future dollar. If the cost of funds was 10%, for example, a dollar a year from now is worth just under 91 cents today ( $\$1/(1+0.10)$ ).

If a participant's cost of funds is higher than the utility's, a dollar a year from now is worth less to the participant than to the utility.

A customer's cost of funds or cost of capital is technically a weighted average of the customer's cost of debt (the cost to borrow the funds) and cost of equity (the cost of using internal funds—the lost return on equity). The weighting depends on the debt to equity ratio the firm requires. A customer's cost of funds can be seen as a combination of how the financial community sees the riskiness of lending to this firm and the firm's typical minimum return on equity investments.

We did not attempt to ask customers directly for their cost of funds as that is a number that businesses do not willingly divulge. This is because a company's cost of capital indicates too much about its financial situation. Instead, we surveyed a small number of banks and made some simplifying assumptions in order to make a reasonable estimate of this variable.

It is typical for commercial businesses to have funds available to them at prime to 4 points above prime. The prime rate in 1995 was 8.25%. Thus, the cost of debt to commercial customers could be estimated as 8.25% to 12.25%. It is more likely that small or medium businesses would face prime plus 2 to 4 points. Since a company's

cost of equity is always higher than its cost of debt, we can assume that 10% to 12% provides a reasonable low-end estimate for a participating customer's cost of funds.

Table 7 contains summary information regarding the average benefit and cost components used in the calculation of participant net benefits according to the standard test calculations. These figures are averages across the 70 program participants surveyed.

**Table 7**  
**COMPONENTS OF THE AVERAGE PARTICIPANT'S NET BENEFITS**

Participant Net Benefits	\$64,174
Annual Energy Bill Savings	\$6,484
Annual O&M Savings	\$157
Incremental Equipment Cost	\$13,961
Rebate	\$5,282

Calculating participant net benefits using "direct" benefits and costs and the above estimates of customers' cost of funds reduces the average net benefits of \$64,174 by \$10,741 (for a cost of funds of 10%) to \$16,465 (for a cost of funds of 12%).

### **"WILLINGNESS TO PAY" QUESTION ANALYSIS**

In this section we discuss the analyses performed on participants' responses to the questions asked regarding their perceptions of their companies' net benefits from their respective lighting projects. We report these results in several ways. First, we present the proportions of total participants and of each business type that professed that positive net benefits were likely to each of the questions. Next we discuss the reasonableness of the responses received according to usual response testing criteria and as shown through a comparison with other data. Finally, we discuss the relationship between the ICBs reported, customer characteristics, and likeliness of positive net benefits.

## **Background and Proportions Likely to Perceive Positive Net Benefits**

As discussed above, the last part of the survey was devoted to a set of questions designed to estimate threshold values for participants' ICBs as a whole. We wanted to test the hypothesis that customers could give a reasonable estimate of the net value of their ICBs. But even more so, we believe that until we know the order of magnitude of individual ICBs and can focus on those with the largest impacts, all ICBs should be acknowledged.

The "willingness-to-pay"-type questions were asked immediately after each of the ICBs had been discussed in terms of consideration and experience. We began by reminding participants of their expected annual energy savings, incremental costs, and rebates received to ensure that they were as informed as possible in their responses.

The first question established whether participants believed that their companies experienced positive net benefits from their lighting projects. Participants' responses were recorded as a six-point scale with 1 being "very likely," 2 as "somewhat likely," 3 as "slightly likely," 4 as "slightly unlikely," 5 as "somewhat unlikely," and 6 as "very unlikely." A "likely" answer indicates that all the ICBs experienced by that participant taken as a whole have either a net positive value or a net negative value that is less in absolute value terms than participant net benefits calculated according to the standard test. That is, if a particular participant has net benefits of \$50,000 when bill savings, incremental equipment costs, reductions in O&M, and the rebate are taken into consideration, the net value of all the ICBs experienced by this participant is either positive or is a net cost less than \$50,000.

Across the 70 participants surveyed and the 57 that answered this question, only three gave an "unlikely" answer (see Table 8). Twelve of the 70 indicated that they "did not know," and 54 (95%) gave a "likely" answer.<sup>9</sup> Therefore, almost all participants surveyed believed that the net value of their ICBs was either positive, or if a net cost, less than their net benefits calculated according to a standard participant test.

Whereas, the first question established whether the participant experienced positive net benefits including ICBs, the second and third questions were designed to determine how large those net benefits were.

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<sup>9</sup>The proportion that stated "likely" (0.95) is significantly different than 1.0 at a 90% confidence level.



**Table 8**  
**PROPORTIONS OF PARTICIPANTS THAT PERCEIVED**  
**POSITIVE NET BENEFITS**

	Total Population	Business Type					
		Education	Retail/Rest.	Medical	Lodging	Office/Commercial	
No. In the survey	70	10	19	2	8	31	
No. Answering positive net benefits question (Percent of total population)	57 81.4%	9 90.0%	13 68.4%	1 50.0%	6 75.0%	28 90.3%	
No. With likely net benefits (Percent of those answering)	54 94.7%	7 77.8%	12 92.3%	1 100.0%	6 100.0%	28 100.0%	
No. With unlikely net benefits (Percent of those answering)	3 5.3%	2 22.2%	1 7.7%	0 0.0%	0 0.0%	0 0.0%	
No. Answering the positive net benefits with up-front cost question (Percent of total population)	52 74.3%	10 100.0%	13 68.4%	1 50.0%	6 75.0%	22 71.0%	
No. With likely net benefits after up-front cost removed (Percent of those answering)	25 48.1%	6 60.0%	6 46.2%	0 0.0%	3 50.0%	10 45.5%	
No. With unlikely net benefits after up-front cost removed (Percent of those answering)	27 51.9%	4 40.0%	7 53.8%	1 100.0%	3 50.0%	12 54.5%	
No. Answering the positive net benefits with annual cost question (Percent of total population)	51 72.9%	10 100.0%	13 68.4%	1 50.0%	4 50.0%	23 74.2%	
No. With likely net benefits after annual cost removed (Percent of those answering)	31 60.8%	7 70.0%	6 46.2%	1 100.0	3 75.0%	14 60.9%	
No. With unlikely net benefits after annual cost removed (Percent of those answering)	20 39.2%	3 30.0%	7 53.8%	0 0.0%	1 25.0%	9 39.1%	

The second and third questions asked participants to now consider that their net benefits were reduced by a particular dollar amount. Were net benefits still positive? Both questions were based on the same base dollar amount, but the second asked the question in terms of a one-time cost and the third asked the question in terms of an annual amount. The annual amount was the annualized (at the utility's cost of capital) value of the one-time dollar amount. Half the participants were asked the one-time dollar question first and half were asked the annual question first. Care was taken in the question design to try to get customers to subjectively estimate net benefits, not reconsider whether the project would have been approved with the additional dollar cost.

In some cases these two questions each had two parts, with the first question offering a step toward the final higher dollar amount.<sup>10</sup>

As can be seen in Table 8, 50% to 60% of the participants sampled stated that they believed their companies experienced positive net benefits even when a substantial dollar amount was removed from their total net benefits. Therefore, just over half of participants are aware of experiencing large enough net benefits to ensure that their projects were cost-effective to all ratepayers. The individual participant net benefits according to standard calculations, dollar amounts asked, and responses are shown in Appendix D.

More participants stated that they believed their companies experienced positive net benefits when an annual dollar amount question was asked than for an up-front dollar question (60.8% versus 48.1%). Since participants' discount rates are likely higher than the utility's cost of capital, we would expect that they would perceive the annual question as being a lower total cost.

The differences in the answers to the up-front and annual dollar questions are not statistically significant. Also, the differences in responses across business types are not significant.

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<sup>10</sup>As discussed in the Approach section of this report, we had no *a priori* information regarding the likely net value customers would place on ICBs. Therefore, we chose a value that would vary logically with the order of magnitude variations in customers' net benefits, and that would elicit useful responses even if it were far from customers' actual net value of ICBs. The dollar amount we chose was that value for ICBs as a whole that would change the cost-effectiveness of that participant's project from a Total Resource Cost (TRC) perspective. Therefore, a "likely" answer with regard to positive net benefits with this dollar amount removed would at least indicate that that participant's project passed a TRC test, even if it did not provide an estimate of that participant's net value of ICBs.

## **Respondents Gave Reasonable Answers to the “Willingness to Pay” Questions**

We were pleased with the quality of responses we received to the “willingness-to-pay”-type questions. We had very few refusals to answer—57 out of 70 answered these questions. Respondents seemed to be taking the questions seriously and considering each one separately, and answers seemed to vary in expected ways—e.g., higher dollar amounts were given lower likelihoods of leaving positive net benefits.

Finally, the information generated compared very well to the indirect cost values estimated from the investment criteria. Table 9 shows the comparison of the indirect cost value estimated from the investment criterion to the range values available from the up-front dollar amount “willingness to pay” (WTP) questions where each was available for a customer. Since our WTP questions only gave threshold answers, we only know that customers’ estimates of the net value of ICBs lie above or below the dollar values asked. Since we asked more than one question, however, we were able to obtain ranges rather than just a minimum or maximum for a fair number of respondents (15 out of the 30 customers for which both types of estimates were available).

As can be seen in the table, the investment criterion numbers always fell below the maximum when there was a maximum estimate available (indicated as an “OK” in the last column). The investment criterion estimates also fell below the minimum “willingness to pay” estimate in 20 of 30 cases. These results are as expected. Since the value estimated from the investment criteria only includes indirect costs and the net value from the WTP questions acknowledges all ICBs, we would expect the estimates from the investment criterion to either be equal to each customer’s net value for all ICBs (if that customer did not experience any indirect benefits), or to fall below the net value for all ICBs (indicating that that customer experienced indirect benefits that are not reflected in their investment criterion). It also should be noted, that these results could also be explained by the fact that the main criticism of WTP questions is that respondents tend to overestimate values.

For reference purposes only, we report that the average minimum net value for ICBs across all customers for which a minimum was available (55 out of 70) is  $-\$43,446$  ( $-67.7\%$  of  $\$64,174$ ). The average maximum net value for ICBs across all customers for which a maximum was available (27 out of 70) is  $-\$36,194$  ( $-56.4\%$  of  $\$64,174$ ).

**Table 9  
COMPARISON OF "WILLINGNESS TO PAY" RESPONSES TO  
INDIRECT COST VALUES IMPLICIT IN INVESTMENT CRITERIA**

Reference #	ICB Value Estimated from Investment Criterion	ICB Value Range Estimated from Pricing Analysis Questions		Investment Criterion Estimates Compared to Pricing Analysis Range
		Minimum \$	Maximum \$	
1	(\$409,915)	(\$576,825)	(\$365,099)	OK
2	(\$247,846)	(\$323,781)	(\$142,240)	OK
3	(\$184,466)	(\$146,338)		Below
4	(\$160,774)	(\$88,734)		Below
5	(\$146,969)	(\$141,917)	(\$65,337)	Below
6	(\$79,011)	(\$27,764)		Below
7	(\$77,316)	(\$54,835)		Below
8	(\$75,341)	(\$81,050)		OK
9	(\$51,069)	(\$30,012)		Below
10	(\$25,402)	(\$4,980)		Below
11	(\$22,665)	(\$25,405)	(\$17,133)	OK
12	(\$18,109)	(\$12,014)	(\$8,525)	Below
13	(\$17,964)	(\$9,939)	(\$7,087)	Below
14	(\$17,848)	(\$15,033)	(\$14,477)	Below
15	(\$13,628)	(\$10,452)	(\$4,955)	Below
16	(\$13,444)	(\$6,174)		Below
17	(\$13,054)	(\$6,810)	(\$4,701)	Below
18	(\$10,879)	(\$8,025)	(\$4,491)	Below

Table 9 (continued)

Reference #	ICB Value Estimated from Investment Criterion	ICB Value Range Estimated from Pricing Analysis Questions		Investment Criterion Estimates Compared to Pricing Analysis Range	
		Minimum \$	Maximum \$	Minimum \$	Maximum \$
19	(\$8,562)	(\$3,684)		Below	
20	(\$8,208)	(\$9,723)	(\$6,191)	OK	OK
21	(\$7,887)	(\$5,266)	(\$3,783)	Below	OK
22	(\$7,775)	(\$8,511)		OK	
23	(\$5,768)	(\$8,619)		OK	
24	(\$5,373)	(\$3,139)		Below	
25	(\$5,210)	(\$4,146)		Below	
26	(\$4,674)	(\$4,513)	(\$2,883)	Below	OK
27	(\$2,014)	(\$5,002)	(\$1,600)	OK	OK
28	(\$1,741)	(\$2,561)	(\$1,024)	OK	OK
29	(\$672)	\$32		Below	
30	(\$559)	(\$578)		OK	
Summary Statistics:					
•	Below/Above			20	0
•	OK			10	15
•	Total			30	15

## Relationship Between ICBs Experienced, Customer Characteristics, and “Willingness to Pay” Responses

We had hoped to successfully specify a model which would relate each respondents experience with various ICBs to their perceived net benefits from the WTP questions. This is the reason why we asked respondents their level of likelihood of experiencing net benefits at different levels of dollar amounts removed—i.e., asked whether it was “very likely,” “somewhat likely,” etc. that their company experienced net benefits. This hope was a bit of a far reach as stated likelihood of positive net benefits (i.e., likelihood that the net value of ICBs is above or below a particular amount) is not the same as an estimate of the net value of ICBs or of net benefits including ICBs. Nevertheless, none of the regression models we estimated explained more than 30% of the variance (all adjusted  $R^2$ s were less than 0.30).

We did, however, determine a number of significant relationships between the likelihood of perceiving higher net benefits than the dollar amounts asked and the experience of certain ICBs.

A significantly higher proportion of customers who reported experiencing the following indirect benefits “somewhat” or “a great deal” also reported it likely (“slightly,” “somewhat,” or “very”) that their company experienced positive net benefits ( $p < .10$  for the first one,  $p < .05$  for the rest):<sup>11</sup>

- Improved visual comfort of users and guests
- Reduced discomfort due to noise and glare
- Improved appearance of facilities
- Increased safety or security and reduced vulnerability to lawsuits

These results are as expected—i.e., one would think that indirect benefits would be experienced by more respondents that perceived higher net benefits than those that perceived lower net benefits.

However, it is interesting that the proportions of customers reporting higher net benefits are also higher for 13 out of 20 indirect costs. A significantly higher proportion of customers who reported experiencing the following indirect costs “somewhat” or “a great deal” also reported it likely (“slightly,” “somewhat,” or “very”) that their company experienced positive net benefits ( $p < .05$ ):

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<sup>11</sup>From here on the statement “perceived positive net benefits” should be read as “perceived positive net benefits even when the highest dollar amount asked was removed.” The shorter phrase is used for ease of reading.

- Obtaining or setting aside funds
- Setting aside other organizational needs
- Inconvenience during retrofits
- Occupant or tenant complaints about the new lighting
- Cannot use old stock
- Need to redecorate or rewire
- Vulnerability to code inspections
- Need to add task lighting
- The technology may not perform as expected
- the use of the space may change
- Newer, better equipment may become available
- More sophisticated staff may be needed to service and replace equipment
- Increased responsibility for hazardous wastes

We believe these results are related to the single-factor, “all or nothing” nature of reported experience with ICBs discussed above. Accordingly, we investigated the relationship of overall sensitivity or attention to ICBs (i.e., the number of ICBs reported as experienced) and the perceived likelihood of positive net benefits. The relationship is significantly positive ( $p < .05$ ): The greater the attention or sensitivity to ICBs, the greater the rated likelihood of positive net benefits.<sup>12</sup> In other words, either those participants who are carefully following the effects of their lighting upgrade on their nonfinancial benefits and costs are more likely to agree that they are realizing net benefits from the project or those who are realizing net benefits are more likely to recognize the associated indirect costs and benefits. Furthermore, it would appear that the reported benefit experiences outweigh the reported cost experiences, at least perceptually.

An associated finding is that participants who say that they are responsible for monitoring the costs and benefits of their projects are both more likely to be sensitive or attentive to the ICBs (see above) and more likely to perceive net benefits to their company as a result of the lighting upgrade ( $p < .05$ ). However, it is interesting to note that while the level of likelihood of perceiving net benefits is significantly related to whether a respondent is responsible for monitoring, whether a respondent gives a likely response (defined as “slightly,” “somewhat,” or “very”) to the up-front dollar question or not is not. Almost exactly the same proportion of respondents who monitored their projects gave a “likely” response to the up-front dollar WTP questions as gave an unlikely response. One explanation for this seeming dichotomy is

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<sup>12</sup>In fact, additional analyses using the three separate ICB factors discussed earlier indicate that greater reported experience with overall benefits does generally line up with greater perceived likelihood of positive net benefits ( $p < .05$  in four of the five cases studied).

that monitoring causes a respondent to be more certain of his or her likelihood of positive net benefits for this question.

Finally, we note that participants who rated themselves as less adverse to risk were also more likely to perceive positive net benefits from their lighting project.

Also, participants who perceive that their project is likely to provide positive net benefits to the company tend to be those who also report having completed additional lighting improvements beyond those included in the program studied ( $p < .10$ ). In other words, those who appear satisfied with the program are more likely to be "repeat customers" for efficiency projects. They may also constitute the group whose attitudes and behavior have been altered in a lasting way, and be the group that is most willing to participate in future market-driven programs.

## CONTINGENT VALUATION

Although not our initial purpose, we found that the WTP questions could be used to demonstrate the feasibility of a future contingent valuation (CV) study. CV is a well-developed technique that is used by market researchers and economists to place a value on goods or services for which no market-based pricing mechanism exists. For example, CV has been used to value environmental amenities such as clean air or water, or health benefits, such as reduced cancer risks. It has also been used on many occasions to estimate the value that customers place on electric service reliability.

In a contingent valuation survey, respondents are asked in a very structured way how much they are willing to pay to either avoid certain types of events or have access to some goods or services for which there is no explicit market.

Traditionally, the approach used in contingent valuation has been to directly ask survey respondents to state their exact maximum willingness to pay for the particular non-market good. Because of the difficulty of responding reliably to these types of questions, however, the direct approach has fallen out of favor and is no longer used in high quality applications of the contingent valuation method. Instead, researchers use discrete response techniques where survey respondents are asked to provide "yes/no" responses to questions that ask whether or not the respondent is willing to pay a stated price, known as the *bid amount*. This approach resembles market decision making and is thought to be easier for the respondent to answer reliably. The discrete response approach has been strongly endorsed by the panel on contingent valuation (a panel composed of leading economists, including two Nobel prize



winners, who were assigned the task of evaluating the reliability of the contingent valuation method for use by public agencies, especially for litigation purposes).<sup>13</sup>

The CV approach uses the referendum approach. The referendum approach “bounds” the maximum willingness to pay (WTP) by asking the respondent whether he or she would be willing to pay a specified amount. A “yes” response indicates that the respondent would be willing to pay that amount or more, i.e., it gives a lower bound to the maximum WTP; a “no” response gives an upper bound. The mean WTP can be estimated statistically from the survey responses.

An extension of this approach, and one which is more statistically reliable, is the “double-bounded” technique. Using this technique the survey asks respondents whether they would pay some monetary amount (or bid) to obtain some non-market good or service. A second choice question, whose bid depends on the answer to the first question, is then asked. If the response to the first question is “yes,” then the second bid is an amount greater than the first bid, and if it is “no,” the second bid is an amount smaller.

The superior statistical efficiency of the “double-bounded” approach makes intuitive sense given that the “double-bounded” approach yields more information than the “single-bounded” approach about each respondent’s preferences. We were lucky in this study to have asked questions that resulted in some “double-bounded” responses. (Remember, we had no *a priori* information on the likely size of the net value for ICBs and so were lucky that the dollar values used happened to bound certain participants’ responses.)

### **Specification of the Statistical Model**

In the survey conducted, the program participants were asked whether they thought that the investment would have produced net benefits to their companies had the up-front cost been higher. We assumed that this amount was analogous to a bid in the CV terminology. The answers to the question were assumed to be analogous to their willingness to pay in CV terminology and represent their maximum value of their participation in the program, including all costs and benefits.

The likelihood function requires expressions for the probabilities associated with the two possible responses, yes/no, expressed as follows:

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<sup>13</sup>Arrow, K., R. C. E. Lamer, P. <, R. and H. , 1993, “Report of the Panel on Contingent Valuation,” *Federal Register*, Vol. 58, No. 10.

$$Prob(yes)=f(BID,X)$$

where  $f(\text{Bid},X)$  is specified as some particular function of the bid value and the respondents characteristics,  $X$ . When the functional form is assumed to be logistic, a logit model of the following form is estimated:

$$f(BID,X)=\frac{1}{1+e^{-(\alpha+\beta BID+\gamma X)}}$$

The survey for this project was not designed to produce data for a CV study, more so not for a double-bounded logit approach. However, we worked with the data available and constructed the model below. This model was constructed simply to show the potential use of the CV approach for this project. The results are not intended to be used. They are simply presented here for illustration purposes.

The logit model we estimated took the following form:

$$\log\frac{P_i}{1-P_i} = \alpha + \beta_1 BID + \beta_2 BENEFITS$$

where  $P_i$  is the probability of perception of net benefit (i.e., net benefits greater than the dollar cost amount in the question),  $BID$  is the amount of the up-front cost (normalized to the participant's net benefits), and  $BENEFITS$  are based on reports by participants.

Once the model was estimated, WTP was assessed as follows:

$$WTP = \frac{\log(1+e^{(\alpha+\beta_2 \overline{BENEFITS})})}{-\beta_1}$$

In other words, using the estimated coefficients from the logit model along with the average number of benefits experienced by the participants, the WTP is estimated.

Since the  $BID$  in this analysis was constructed as a ratio of the actual bid to the participant's net benefits excluding ICBs, the resulting WTP was also in the form of a ratio. The estimated model is shown below. The overall accuracy is usually judged by the number of cases predicted accurately. In this case, the model was able to predict

the likelihood of the participants accurately in 69.0% (i.e., the “Concordant” is 69.0%) of the cases.

$$WTP = \frac{\log(1 + e^{(0.4984 + 0.1403 (\overline{BENEFITS}))})}{3.5179}$$

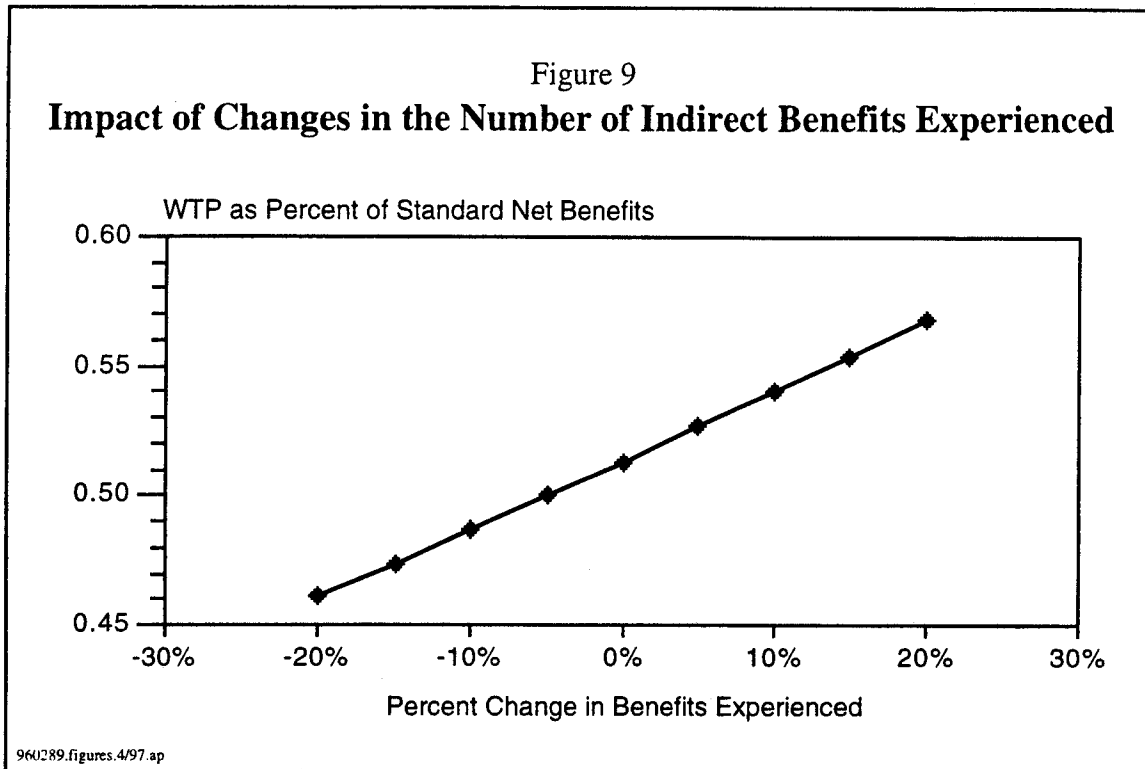
Using the estimated coefficients and the average number of indirect benefits experienced by the participants included in the model estimation, the WTP was estimated at 51.3% of the participants’ net benefits calculated using “direct” costs and benefits. In other words, the net perceived benefit of the combination of indirect and direct benefits and costs is valued at just over 50% of the standard estimate of participants net benefits. For example, if a participant’s net benefits excluding ICBs were \$50,000 and he or she experienced an average number of indirect benefits, net benefits including ICBs is estimated at \$25,500 (\$50,000 \* 0.51). Therefore, the net value of the ICBs themselves is \$25,500 minus \$50,000 or -\$24,500.

Figure 9 shows the impact of changes in the experienced indirect benefits on the WTP. The horizontal axis depicts changes in the number of experienced indirect benefits in 5% increments from the average number experienced in the model sample. The vertical axis shows the impacts of these changes on the WTP (as a ratio of participants net benefits excluding ICBs).

Again the estimated model is presented here for illustrative purposes only. Had the CV approach been the goal of the data collection, some of the questions would have been asked differently.

For example, had we intended on using a double-bounded approach, the respondents would have been engaged in two rounds of questions. In determining WTP, if the first answer is “yes,” the bid is raised, otherwise the bid is lowered. As a result, four sets of answers are possible; “YY,” “YN,” “NY,” and “NN.”

The level of the second bid is contingent upon the first. In cases where respondents fall in the “YN,” and “NY” categories, researchers are able to place the true WTP between the two bids. In the cases where respondent fall in the “YY,” and “NN” categories, the second bid sharpens the single choice interval (raising the lower bound or lowering the upper bound).



Recognizing the limitations of the model, we can use its results to estimate a net value for participants' ICBs as  $-\$31,253$   $((1 - 0.513) * \$64,174; +/- 20.0\%$  absolute or  $41.1\%$  relative for 90% confidence).<sup>14</sup>

The results of this model bode well for a future contingent valuation study to estimate the net value of ICBs. We had four significant successes regarding CV:

1. **We were lucky in that some of our respondents had “double-bounded” responses.** As discussed above, we had no *a priori* information regarding the net value of ICBs. We were lucky in that the dollar values we used in the WTP questions were close enough to some participants' values that our questions bounded their estimates.
2. **The model shows a high ability to predict WTP.** Even with the small number of variables estimated and the small sample size, we were able to

<sup>14</sup>The standard estimates of precision cannot be calculated for contingent valuation results. Instead, accepted reasonable estimates of precision are possible through an involved calculation called “bootstrapping.” These precision levels were calculated using a shortened version of those calculations.

specify a model that is able to predict participants' answers correctly in 69% of the cases.

3. **Both the “bid” and “benefits” coefficients are significant and have the right sign.** Again, despite the small sample size we were able to get more than the intercept coefficient to be significant.
4. **We had a small coefficient of variation on the sample, allowing smaller future sample sizes.** CV studies can require extremely large sample sizes—e.g., 1,000 to 2,000 respondents. This is because there tends to be a large coefficient of variation on the “bid” variable. Since we were able to normalize this variable by dividing it by participant net benefits excluding ICBs, the coefficient of variation for our sample was extremely small: 0.25 compared to a standard assumption of 0.5. This will allow for reasonably-sized sample sizes for future studies.

### **Problems with “Willingness to Pay” Approaches**

While CV and “willingness to pay” look promising for the future estimation of ICBs, these approaches are not without problems. As discussed above, although we did not plan for a CV analysis—we did not have enough information on ICBs to know if it was possible—we were lucky in that we were able to obtain reasonable answers to the WTP questions and were able to estimate a significant CV model. In this section we address three major problems with the use of CV to estimate ICBs and pose possible solutions to those problems.

First, it should be noted that the main criticism of CV analysis is that it is believed to overstate the values estimated. Since CV is often applied to non-market goods, this result is known through its application on market goods. In fact, it has long been acknowledged in market research that customers' stated intentions to buy regularly exceed their actual buying behaviors by more than 50%. One benefit of applying CV to the estimation of ICBs is that there is the possibility for a market test to check the answers received. Customers installing energy efficiency on their own, with the aid of information if misperceptions are expected, will demonstrate their net value of ICBs.

Second, we need to determine whether customers are giving a “gut reaction” response to the WTP questions or well thought out answers. Of course, only well thought out answers are of use, and luckily there are ways to help ensure that these are what are given. In a true, well designed CV study respondents would be either provided with information ahead of time so that they could carefully formulate their answers, or

they would be provided as much information as is reasonable at the time of the survey and then recontacted, say, a week later to see if their response had changed. Follow-up, probing questions are also recommended in either case after the first answer is given to elicit the reasons behind the answer. In a sense, we followed the second of the two approaches presented (although we did not have enough survey time for the follow-up questions), and that is also the recommended approach. This is because if customers are given the information ahead of time, it is still not known whether they thought about it, or just threw the information aside or gave it to a subordinate to calculate.

Finally, we need to consider whether a single respondent can give a reasonable estimate for the ICBs of a business as a whole. In an ideal world, the perceptions of value (and decisions) of the company's owner and main decision maker would exactly represent the net value to society of the ICBs of energy efficiency measures. That is, in an ideal world, where everyone is "all knowing," all benefits and costs to each employee and client of efficient lighting would be known and weighed in the decision to install the lighting. The decision maker would implicitly or explicitly gather and sum the net value to each person impacted by the decision and if the net value was positive, the lighting would be installed, and if it was negative, it would not be installed. In this ideal world, this decision maker would be able to give an accurate estimate for the net value of all ICBs.

However, this ideal world does not exist (and the complications of predicting piecemeal the components of this ideal world illustrate why "letting the market decide" is often a highly attractive option). Decision makers cannot be assumed to be aware of all the impacts of ICBs in their companies. Nor can we assume that any other one type of staff person is either. Some will have a better overall picture than others, especially in a smaller company, but it is often the case that their responsibilities do not cover all areas of impact. For example, a facilities manager will likely know a lot about O&M costs, inventory, staff time for planning and management, and finding contractors. However, they may only receive indirect reports, if any, on facility or merchandise appearance and productivity.

There is no perfect solution to this problem, but several are offered here. One solution to this problem is to obtain estimates from several key people. This approach, however, can cause problems in interpretation—i.e., how are results combined, especially when two people's perceptions are offsetting. Another, possibly more promising, solution is to identify the person most likely to have an overall perspective on ICBs and provide them with information on the likely value of impacts that are not in their area. For example, a facilities manager can be provided with estimates on the value of productivity gains. These estimates combined with an

opportunity for them to go and talk to the staff person who would have a better sense of this indirect benefit would allow that manager to give a better estimate of the net value of all ICBs at his or her facility.

As discussed above, there are significant problems with obtaining customers' perceptions of net value through a "willingness to pay" question format. However, these problems are not insurmountable, and we believe that the benefit derived from being able to assess all ICBs at once greatly outweighs the cost of applying this approach well.

#### **4. SUMMARY AND RECOMMENDATIONS FOR FURTHER RESEARCH**

This study has shown that it is possible to estimate indirect costs and benefits. Even though we did not estimate monetary values for many individual ICBs in this study, we have shown that estimates for certain individual ICBs and for all ICBs, as a whole, are possible with the following results:

- Through focus groups and thoughtful consideration, it is possible to define a set of ICBs that have been considered and experienced by a significant number of participants. A large number of ICBs are experienced by participants.
- Our question system seems to generate reasonable responses regarding the consideration of and the experience of ICBs by participants.
- Even with a small nonparticipant sample size, significant differences were measured between the ICBs considered by participants and nonparticipants.
- Customers' investment criteria were used to show the value of that implied set of indirect costs.
- We demonstrated the calculation of the value of participants' higher costs of funds.
- We demonstrated that it is possible to construct and obtain seemingly reasonable answers to questions regarding the value of a participant's overall ICBs.
- There exists measurable relationships between the likelihood of participants' perceiving higher overall ICB values and particular customer characteristics and experience of ICBs.
- We demonstrated the feasibility of a methodology that can estimate dollar values for ICBs as a whole, and potentially for individual ICBs—contingent valuation.



Table 10 provides a summary of the monetization results for the ICBs considered in this study. This table also presents estimates of the dollar cost of future studies to increase the accuracy of the results presented. The underlying assumptions for these future studies are outlined in the next section, "Recommendations for Further Research and Increased Accuracy."

As discussed above, the identification and estimation of indirect costs and benefits is *crucial to the future of energy efficiency*. It is essential to:

- **Determine the benefits of programs.** As seen in this report, participants and nonparticipants are aware of, consider, and experience a wide variety of indirect benefits and costs. The net value of these ICBs has a direct impact on the true benefits of present or planned energy efficiency programs.
- **Better program design.** Knowledge of large customer indirect benefits or misperceptions regarding costs allows better targeting of program marketing and better program designs.
- **Market transformation.** Indirect costs that are considered or expected, but not experienced, and indirect benefits that are not considered or expected, but are experienced are both evidence of information market barriers. These are also sources of significant benefits for market transformation or other energy efficiency promotion efforts.

## **RECOMMENDATIONS FOR FURTHER RESEARCH AND INCREASED ACCURACY**

This section presents the underlying assumptions for the dollar values shown in Table 10 corresponding to the cost of achieving additional accuracy for each of the ICBs and sets of ICBs discussed. All of these cost estimates assume estimation of ICBs for a commercial lighting program.

Of these estimates, we only recommend that future studies focus on two. If only one ICB is to be studied, we recommend that it be customers' cost of funds. This variable is as "certain" as the other direct costs and benefits, and significant effort has already been put into the estimation and inclusion of O&M reductions. On the other hand, if ICBs are to be truly acknowledged in the energy efficiency industry, we recommend that a full contingent valuation study be done.

**Table 10**  
**SUMMARY OF MONETIZATION RESULTS**

	Monetary Estimate as a % of Standard Participant Net Benefits	95% Confidence		Resulting Range of \$ Estimates per Participant Based on Sample Average Participant Net Benefits of \$64,174	Cost of Increased Accuracy**
		Absolute Precision	Relative Precision		
Indirect Cost or Benefit Measured					
Reduced O&M costs	2.3%*	0.8%	34.8%	\$1,153 to \$2,179*	\$67,000
Incremental cost of funds	-16.7% to -25.7%	N/A	N/A	-\$10,741 to -\$16,465	\$13,000
Investment criterion (a set of indirect costs)	-82.3%	13.1%	15.9%	-\$44,408 to -\$61,222	\$36,000
Pricing analysis questions (all ICBs) <b>For comparison only</b>	Minimum: -67.7% Maximum -56.4%	Minimum: 7.2% Maximum 8.6%	N/A	Minimum: -\$48,067 to -\$38,825 Maximum: -\$30,675 to -\$41,713	N/A
Contingent valuation	-48.7%	20.0%***	41.1%***	-\$18,418 to -\$44,088	\$110,000

\*Already included in standard calculation of participant net benefits.

\*\*Assumptions are shown on the following pages.

\*\*\*The standard estimates of precision cannot be calculated for contingent valuation results. However, accepted reasonable estimates of precision are possible and these estimates are based on shortened version of those calculations.

## **Reduced O&M Costs**

As discussed in this report, SDG&E (and many other utilities) regularly include O&M savings as part of participant benefits in standard calculations. Significant effort has already been expended on the accurate estimation of this benefit. However, there may be room for additional research, especially since the participants that provided us with their O&M savings estimates seemed to perceive significantly higher savings than the standard calculations generate.

If additional study is to be expended on O&M savings, we recommend beginning with detailed telephone interviews by an engineer of a sample of those who gave estimates of O&M savings and of those who did not give any estimate. These interviews would focus on determining the inputs and assumptions these customers are using in their estimates of O&M reductions. Our cost estimate assumes 20 interviews spread across business types and a cash incentive to encourage participation.

The results of these interviews would then be used to develop a survey instrument design that includes an algorithm to pull in expected values for certain variables for each respondent. This survey would be conducted on a sample size of 260 (280 minus the 20 engineer interviews) for a 90% confidence allowing a +/- 10% error margin for O&M savings estimates by four building types. The cost estimate also includes time for the analysis of the survey results and draft and final reports.

Total cost estimate: \$67,000

## **Incremental Cost of Funds**

As discussed above, if only one ICB is to be studied and included in program evaluation, we recommend that it be customers' incremental cost of funds. The size of study required would not be large and data collection would focus on the financial community rather than customers themselves as most businesses would consider their actual cost of funds confidential information.

Our cost estimate assumes 20 telephone interviews with bankers and financial analysts to determine the cost of funds of various business types under various scenarios. Draft and final reports are included.

Total cost estimate: \$13,000

## **Investment Criterion**

As discussed in the report, customers' investment criteria implicitly include their values for several indirect costs, including their cost of funds. If additional accuracy is desired regarding the value of indirect costs implicit in investment criteria, we recommend straightforward survey research.

The survey design should be more straightforward than that discussed below for contingent valuation or above for O&M cost savings in that respondent-specific expected dollar amounts are not expected to be needed. A sample size of 228 is proposed for a 90% confidence allowing a +/- 10% error margin for estimates by four building types. We estimate a smaller sample size per building type to be needed here (57 versus 70 above) as the coefficient of variation of the survey sample (0.46) is lower than the estimate used as the standard for sample size estimation (0.50). Our cost estimate includes analysis of the survey results and draft and final reports.

Cost estimate: \$36,000

## **Contingent Valuation**

As discussed above, if the energy efficiency industry is going to begin to acknowledge ICBs, we recommend that this be the study undertaken: a contingent valuation study to estimate the net value for all ICBs. Our minimum recommended study to estimate the net value of ICBs for participants—i.e., a study to provide results for program evaluation—has several parts, each discussed below. Enhancements to this design, including additional analyses for market transformation purposes, are discussed at the end of this section.

**Focus groups.** We recommend that any future study attempting to identify and estimate the value of ICBs begin with a set of focus groups. The number of groups needed will depend on the technology considered and the customer class. More complicated technologies or technology groups and more diverse customer characteristics would justify a larger number of focus groups, one focus group per major business type. Other studies of commercial lighting would, of course, have the opportunity to build on this study, and thus, not have to start from scratch. But if this study was to be done again for the first time, it would cost approximately \$5,500 per focus group.

**Survey design.** We recommend a survey design that is fairly similar to that developed for this study. Of course, this design would be modified to acknowledge its use for contingent valuation. In particular four main changes would be made. First, the “willingness to pay” questions would be modified to enable a double-bounded approach. That is, the level of the second bid question would depend on the answer to the first.

Second, questions will be added to the survey that allow some additional measure of the relative size of a customer’s “experiencing” various ICBs. This could be as simple as adding a question at the end of each the list of indirect costs and indirect benefits that asked customers to now indicate which three, for example, of the indirect costs they experienced had the largest impact on his or her company. This would help pull respondents out of the “all or nothing” answer pattern discussed above.

The third change would be to ask some follow-up questions immediately after the WTP questions to obtain information relating to whether customers are answering those questions thoughtfully or from “gut reaction.”

Finally, we also recommend that a short follow-up survey be designed to be administered to respondents a week later. The purpose of this survey is to see if customers’ perceptions of the net value of ICBs had changed after they had time to think about their responses and possibly check them with others. This will provide an additional check on “gut reaction” versus well-thought-out responses and will give us some feedback on the ability of one respondent to represent a company.

These changes would not cause a significant increase to the cost of the survey we used in this study. The main survey instrument design would, of course, require an algorithm to pull in expected values for certain variables for each respondent, as did the present survey. If the participant survey was designed from scratch for the first time again, and a short call-back questionnaire developed, it would cost approximately \$13,000.

**Sample size.** Contingent valuation studies tend to require large sample sizes, typically on the order of 1,000 to 2,000 respondents. However, we believe that if we make certain assumptions and restrict the analysis to across population answers, given the results of this study, we could do a reasonable job with a sample size of 286. This estimate is based on the assumptions of a coefficient of variation of the willingness to pay of 1.0 (the sample in this study had a coefficient of 0.25); a 90% confidence level; and allowing a +/- 10% error margin. If the willingness to pay estimates are more heterogeneous resulting in a higher coefficient of variation of 1.5, we could still maintain a sample size of 286 if we allowed a +/- 15% error margin. As with our

illustration in this study, we recommend normalizing the willingness to pay values to standard participant net benefits, therefore it is likely that a coefficient of 1.0 will be sufficient.

This sample size of 286 is for an estimate of the net value of all ICBs as a whole across all business types. A larger sample size (i.e., 286 per business type) would be needed to ensure a separate estimate of the value of ICBs by business type. Also, a significantly larger sample would be needed to ensure the estimation of values for individual ICBs. We recommend a total sample size of 286 for the next study at an approximate cost of \$45,000.

**Analysis and reports.** We assume that the analysis of the survey results and draft and final reports would cost approximately \$30,000.

Total cost estimate (minimum study) : \$110,000

The above study components and cost estimate represent what we believe to be the minimum for a contingent valuation study of commercial lighting. As mentioned, this study design would provide an across-population estimate of the net value of ICBs as a whole. This estimate is appropriate for program evaluation. If we are lucky, we may also get some individual ICB value estimates or ICB estimates by business type which will be useful in future program design and new product development, but the sample size does not guarantee this. Increasing the sample size will increase the chances of significant by business-type and individual ICB estimates.

One of the main benefits of market transformation programs is the reduction of information-related market barriers. Contingent valuation provides one of the only ways to directly value the reduction of these barriers. If a program is the true cause for measure adoption, the net value of a customer's ICBs after adoption should be significantly higher than their perceived net value of ICBs before adoption (and before influence by the program). Ideally, this customer's net value of ICBs should be measured first before the program and then later after measure adoption.

Alternatively, if pre-program data are not available, one could measure the net value of ICBs for participants and compare that to nonparticipants' net value. Of course, this study would have to account where possible for self-selection bias.

In the last section we discussed several problems with "willingness to pay" analyses. Our study design above addresses the "gut reaction" versus well-thought-out answer question and begins to address the question of whether one respondent can represent a company. Additional study components could be added to further test the viability of

a contingent valuation approach. (See the potential solutions presented in the above-referenced section.) We do not recommend these, however, in the above study as we believe that more experience with this approach is needed before the results of more sophisticated tests could be interpreted correctly.

### **IS IT WORTHWHILE TO ESTIMATE ICBS?**

We believe that it is *highly worthwhile* to estimate and take into consideration the net value of all ICBS as a whole.

The cost of a contingent valuation study that can estimate the net value of ICBS as a whole is within the range of the cost of an impact evaluation for the same program. And the dollar value of these ICBS is of comparable size to the dollar value of the energy savings from the impact study.

Not only can a contingent valuation study be used in program evaluation:

- It can give an indication of the relative size of each ICB which is useful for targeting program design—e.g., if staff costs for planning renovations or retrofits is a relatively large indirect cost, program design can incorporate utility help with this task; and
- With the inclusion of a nonparticipant (or alternatively, a time) component, it can indicate the size of the dollar benefits of the removal of awareness/perception market barriers. These barriers are the key source of benefits from market transformation efforts.