ONTARIO ENERGY BOARD

IN THE MATTER OF the Ontario Energy Board Act, 1998, S.O. 1998, c. 15, (Schedule B);

AND IN THE MATTER OF an application by Enbridge Gas Distribution Inc. seeking approval of certain demand side management input assumptions for the 2008 program year

REPLY SUBMISSIONS OF ENBRIDGE GAS DISTRIBUTION INC.

Introduction

1. This Reply responds to the submissions made by the following intervenors in this application:

   Canadian Manufacturers Exporters ("CME")
   Consumers Council of Canada ("CCC")
   Energy Probe
   Green Energy Coalition ("GEC")
   Industrial Gas Users Association ("IGUA")
   School Energy Coalition ("SEC")
   Vulnerable Energy Consumers Coalition ("VECC")

2. To the extent possible, Enbridge Gas Distribution Inc. ("EGDI" or the "Company") will respond at the outset of this Reply to issues which are common to some intervenors. The Reply will then deal with program specific issues raised by intervenors.

Nature of Application

3. This is not the first proceeding of this nature before the Ontario Energy Board ("OEB" or the "Board"). Input assumptions have been approved in respect of both demand side management ("DSM") programs undertaken by the gas utilities, and conservation and demand management ("CDM") programs undertaken by the electric utilities. The process which has been followed in the

past is not dissimilar from the process that the Board is following in this application.

4. In respect of proceedings before the Natural Gas DSM Generic Issues proceeding (EB-2006-0021) (the "DSM Generic Proceeding"), the Company would file its input assumptions as part of its annual rate case. The Company did not on an annual basis file all of the detailed reports generated in the various jurisdictions upon which it relied. Relevant reports and data were referenced in the Company's filing, and ultimately Board approvals were received on the basis of such filings.

5. This practice continued into the DSM Generic Proceeding such that during Phases II and III of that proceeding, the Company filed its proposed input assumptions, again referencing the reports and data in support of the proposed assumptions. Indeed, in the Settlement Proposal involving completely settled issues, parties specifically noted that in respect of the agreed upon list of input assumptions "best efforts have been made to identify all of the evidence which supports the values contained in the list of input assumptions in the Substantiation Documentation appended to this Settlement Proposal as Appendix "B".[1] Each of the reports and data supporting the input assumptions which were the subject of this Settlement Proposal, identified in the footnotes of Appendix B, were not filed in evidence. The Board ultimately granted its approval.

6. During Phase III of the DSM Generic Proceeding, several intervenors expressed concerns with the new input assumptions contained in the multi-year DSM plans filed by the gas Utilities. Again, the Utilities referenced supporting studies and data for the purposes of these new input assumptions. As noted by the Board in its Decision and Order in respect of Phase III of the Generic Proceeding, Enbridge responded to the intervenors' concerns noting "that the detail and

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[1] EB-2006-0021, Phase II, Ex. K13.1, p. 4 of 4, 4th para.

format of the assumptions for new programs in its proposed plan is similar to that provided in earlier applications, including Phase II of this proceeding."[2] The Board's Decision and Order also noted Enbridge's response to intervenor criticisms to the effect that "as per the Phase I Decision, the updating process for input assumptions is to be centralized within Board Staff."[3] The Board then went on to make its findings, stated specifically:

> The Board agrees with Enbridge that the updating process for input assumptions is to be centralized within Board Staff. In the Phase I decision the Board stated as follows:
>
> The completely settled issue 3.1 stipulates that the input assumptions will be updated on a regular basis during the plan period as part of each utility's ongoing evaluation and audit process. The Board has the ultimate authority to review and approve any changes. It appears to the Board that unless there is joint utility participation, the updates may occur at different times. This would not be efficient and would burden the regulatory process needlessly. The Board therefore concludes that the updating process should be centralized within Board Staff, at least for this first generation of multi-year DSM plans. The Board anticipates that the recommendations that come from the evaluation and audit committee would, in effect, be the substance of the comments process to be employed for the updating of the list and values of the input assumptions. Any suggested updates to the input assumptions guide arising from the evaluation and audit process should be filed with the Board within one month of the end of the annual audit and evaluation. The suggested updates will be considered by the Board, and the guide will be updated if the Board decides it is necessary. Further Procedural Orders may be issued regarding updates to the guide.[4]

7. To the knowledge of EGDI, the same process has been followed by Union Gas up to and including the proceeding which is the companion to this application, being EB-2008-0385. Union has referenced, but not formally filed, supporting documentation substituting its input assumptions. It is noteworthy that the pre-

[2] EB-2006-0021, Decision and Order, Phase III, p. 7
[3] Ditto, p. 7
[4] Ditto, pp. 7-8

filed evidence for this application is virtually identical to the pre-filed evidence filed by Union Gas in EB-2008-0385.

8. Similarly, during the development of the TRC Guide for CDM Programs to be undertaken by electric local distribution companies, the record did not include a formal "filing" by any party of all of the reports and data supporting the various input assumptions ultimately accepted by the Board for use by electric utilities.

9. The process has once again been followed by the Ontario Power Authority ("OPA") apparently under the similar belief that it would not be helpful to the Board to file thousands of pages of reports in support of an application to approve input assumptions. This is not to suggest that an interested party should not have the right to request copies and make submissions in respect of such reports. However, there have been only minimal requests for copies of supporting reports and documents in past proceedings.

10. There are sound and compelling reasons for this practice in addition to the savings in terms of organizing and collating a massive filing, not to mention the savings in terms of the volume of paper avoided. To a large extent, the studies and data which are referenced in the Utilities' filings refer to reports, the authors of which have been commissioned by an entity in another jurisdiction reviewing programs undertaken outside of Ontario. It would be most impracticable, time consuming, and costly to follow a process which requires that the authors of such reports (often who reside in the United States) to submit to a discovery process in Ontario. It is submitted that it is completely within the jurisdiction of the Board to accept and rely upon, for the purposes of approving input assumptions, the reports and data referenced by the Utilities in their filings. Accordingly, this has been the process which the Board and Utilities have followed.

11. The practice of referencing substantiating reports does not mean that interested parties do not have an opportunity to review and comment upon salient reports and data. The Company submits that no intervenor has been prejudiced by this

practice. It cannot be stated that intervenors, through the EAC, have been denied an opportunity to review and comment upon relevant reports and data underlying this application. Indeed, in respect of the report which appears to have given rise to the issue of greatest prominence – the Summit Blue Consulting, LLC report: *Custom Projects Attribution Study*, October 31, 2008 (the "Summit Blue Report") – it is important to note that intervenors, through the EAC, were involved and agreed to the terms of reference for the engagement of Summit Blue, and the EAC reviewed and commented upon early drafts of the report beginning in the summer of 2008.[5]

12. As previously noted, the Board determined in the DSM Generic Proceeding that the updating of input assumptions would be centralized with Board Staff. Consistent with this, the Company has provided copies of requested reports, including a copy of the Summit Blue report, to Board Staff and its expert consultant, Navigant. A copy of this report was also provided to all members of the Consultative on October 31, 2008. A copy is also attached to this submission.

13. In summary, Summit Blue was retained pursuant to terms of reference agreed upon between EGDI and the members of the EAC. Summit Blue undertook its research and worked independently, and the results of its work were shared with members of the EAC and the Consultative. Aspects of Summit Blue's findings were specifically raised within the Consultative, in particular the inclusion of spillover for the purposes of calculating the LRAM variance account. EGDI advised the EAC earlier of its intent to update assumptions for spillover. Its filing in this application specifically references the Summit Blue Report in respect of relevant input assumptions.

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[5] EGDI's 2007 DSM Audit Summary Report (EXB, T5, S1, page 11) notes that "the EAC reviewed the Summit Blue Draft Report for Custom Project Freeridership Spillover. The EAC acknowledged that spillover was included in the studied terms referenced…"

14. Accordingly, it is simply inconsistent with past practice to treat the Summit Blue Report as being unique in comparison to the prior reports EGDI, Union, and others have referenced in their input assumptions filings. To argue that the Board should not entertain the within application because the Summit Blue report was not formally filed with EGDI's list of proposed input assumptions disregards past practice and is a blatant attempt to make procedure reign over substance.

Timing Issues

15. GEC, CME and IGUA argue, in effect, that the DSM Generic Proceeding Decision in some way sets a prerequisite before a gas utility may bring forward an application for changes to input assumptions. GEC appears to imply, at paragraph 3 of its submission, that absent agreement and recommendation to the Board from the EAC, the Company's proposals in respect of updating its input assumptions must be denied. CME seems to take the same position that EAC agreement is a prerequisite to an application for approval.[6] IGUA appears to take the position that absent agreement on an input assumption with the EAC, the process for updating input assumptions centralized through Board Staff should not be available, but instead should be "brought before the Board on a full and tested record", which EGDI interprets to mean a proceeding significantly more involved that the input updating process envisioned by the Board.

16. Nowhere in the DSM Generic Proceeding Decision can language be found which prohibits the Utilities from seeking approval for updated input assumptions because no agreement has been reached with the EAC, or because members of the EAC or other intervenors feel that there has been insufficient consultation. The fact is that instances will arise where no amount of consultation will result in a settlement.

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[6] CME states, at page 1, that the EAC has not agreed that spillover should be included in EGDI's 2008 input assumptions. It then goes on to state, at page 3, that in CME's submission, where an input assumption, such as spillover, which does not proceed with the consent of either the EAC or the Consultative, the "proper manner" that EGDI should conduct itself is to forgo bringing forth an application for approval.

17. The DSM Generic Proceeding Decision, at Issue 3.1, requires gas utilities to base input assumptions on research utilizing the "best available data" to review and update assumptions on a regular basis during the plan period. Issue 3.3 then goes on to require utilities to manage DSM programs with regard to "the best available information and to react through changes to program design, implementation and/or mix, to material changes and base data as soon as is feasible".[7] In respect of spillover, currently, the best available data is the Summit Blue report. It confirms that spillover is a real and measurable phenomenon. It clearly affects program design and implementation in that with the assistance of spillover, programs which previously were not considered cost effective may become cost effective and therefore eligible to be undertaken.

18. If gas utilities are prevented from seeking approval to update input assumptions based upon the best available information until the EAC has agreed to the proposed update or is satisfied with the level of consultation, the result could be complete DSM regulatory paralysis. This would be impractical from a procedural perspective and contrary to the public interest to the extent that the unveiling of new cost effective programs is delayed by reason of the inability of a utility to seek approval in respect of relevant input assumptions.

19. The DSM Generic Proceeding Decision is clear as to the roles of the Consultative and the EAC. In respect of the former, the matter was settled by Issue 7.1 which states, in part:

> "When required or useful, the utility will engage and seek advice from a variety of stakeholders and experts in the development and operation of its DSM program. As the utility is ultimately responsible and accountable for its actions, consultative activity shall be undertaken at its discretion.[8]"

20. Regardless of the merit of consultation, the above language makes it clear that whether any consultation with stakeholders occurs at all is at the discretion of the

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[7] DSM Generic Decision, EB-2006-0021 p. 10
[8] DSM Generic Decision, p. 14

gas utility. Accordingly, there is no threshold of consultation which must occur before gas utility may file a request for approval to update input assumptions.

21. In respect of the EAC, Issue 9.4 makes it clear that the EAC will have "an advisory role in the items identified at page 18 of the Board's Decision.[9] This advisory role includes "input on the research methodology used to determine the input assumptions". Issue 9.4, which was agreed to by all intervenors, does not require gas utilities to achieve a consensus with the EAC or the consultative in respect of the timing for approvals for changes to input assumptions. Certain intervenors appear to be attempting to create a role for the EAC which simply does not exist.

Issues Specific to Several Programs

(A) General

22. EGDI notes that several intervenors did not include in their submissions any specific concerns about input assumptions which EGDI proposes to be updated in this proceeding, with the exception of the spillover issue. It should also be noted that, in at least two instances, there appears to be disagreement between intervenors as to the appropriateness of the proposed assumption.

23. It should be recalled that input assumptions are to be based upon the best available information. Where relevant information is modest or of limited application, it becomes necessary to exercise professional judgment and common sense such that before a detailed study is undertaken to determine a more precise input assumption, it is appropriate to weigh the costs of same against the potential benefits. This is particularly true in respect of new and smaller programs.

24. It should be recalled that during the DSM Generic Proceeding, all parties agreed to Issue 8.1, which states that the appropriate level of budgets for research shall

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[9] Ditto p. 17

be determined by each Utility from time to time (depending upon need, market conditions, etc.)[10] Issue 8.2 confirms that gas utilities shall determine the research needed to inform program assessment.[11] All of this is consistent with the wording of Issue 3.1, which states, in part:

> "...assumptions shall be assessed for **reasonableness** prior to implementation of the plan or program and should be reviewed and updated on a regular basis during the plan period as part of each Utility's ongoing evaluation and audit processes."[12] (emphasis added)

25. The combined impact of these sections is to give utilities flexibility in determining when to undertake research and the resources that will be devoted to it. Thus, it is not reasonable nor practical to update every assumption yearly based on the principle of continuous improvement, the best available information is used until better information becomes available.

26. The above language also leads to the conclusion that the standard for the adoption of an input assumption (particularly in a situation where there is limited research data available) is one of "reasonableness". Accordingly, if a reasoned and cogent basis can be put forward for the use of a new input assumption or the continuation of an earlier approved input assumption, it is submitted that the proposed assumption should be approved or continued. In short, the availability of directly applicable research data is not a prerequisite to the approval of input assumptions.

<u>(B) Industrial Steam Trap Measure Life</u>

27. GEC takes issue with the Company's proposal to increase the measure life of industrial steam traps from three years to thirteen years. The Company submits that this proposal meets the test of reasonableness for the following reasons. First, the measure life of three years was originally chosen because of the

[10] EB-2006-0021, Decision with Reasons, p. 15
[11] Ditto
[12] Ditto, p. 10

absence of available data. Such a short measure life was chosen to be conservative.

28. Second, according to the Steam Trap Research Summary referenced in EGDI's filing (copy attached), EGDI has conducted 216 steam trap surveys to the end of 2005, through expert industry partners, Spirax Sparco and Preston Phipps. These surveys were completed over a period of seven years. Results of these surveys generated information which was used to develop a statistical evaluation of the lifespan of a steam trap. Using this data, it was possible to conclude the "average" years it takes for 50 percent of the units to fail. Some time between year 13 and 14, 50 percent of the sample units will fail. The resulting minimum expected lifespan would be 8 years, and the maximum 41 years. Accordingly, the analysis provided "strong support" for the "average life" of 13 years. The Research Summary was circulated to the EAC in July 2008.

29. Third, the Steam Trap Measure Life Study assessed various models including linear and non-linear models and selected the approach that was most suitable.

30. It is noteworthy that IGUA, at page 10 of its submission states:

> "...the only assumptions regarding DSM programs for industrial loads (referred to as "custom projects" in the DSM context) relate to the "Measure Life Assumptions" associated with equipment relevant to these programs. (In EGD's application documents, these assumptions are set out on a page immediately following the table of updated input assumptions.) IGUA has no cause, at this time, for concern with these assumed equipment life assumptions. For industrial programs, the balance of evaluation input parameters are determined on a project by project basis."

31. It therefore appears that the intervenor group which participates in this program and which will be allocated most of its costs appears to consider the measure life reasonable.

(C) Prescriptive School Boilers

32. GEC expresses concern about using prescriptive assumptions in respect of the replacement of boilers within schools given that this activity was formerly treated as a custom project. GEC suggests that the Company has not provided an answer to its concerns. The Company submits that a reasonable answer has been provided and has been confirmed by the submission made by SEC, at page 2 of its submission, wherein it states:

> "... The Prescriptive School Boilers program was developed by Enbridge in collaboration with the School Energy Coalition precisely to address the "paperwork" barrier that was preventing busy school plant personnel from considering participation in Enbridge programs. While the incentive in this new program is small, it is very simple to obtain, and so it is a more effective way of influencing boiler replacement decisions. This has made it a successful program to date. The terms of the program were worked out between the company and school representatives, and verified by reference to actual experience in schools. ..."

33. The Company submits that GEC appears to prefer form over function. By making the program prescriptive, as noted by SEC, the program becomes administratively simple and more effective in influencing boiler replacement decisions.

34. It is noteworthy that in the audit report by ECONorthwest dated June 24, 2008 filed as Exhibit B, Tab 2, Schedule 1 at page 18 in the EB-2008-0271 proceeding (the 2007 DSM Variance Account Recovery Proceeding). The independent auditor stated in respect of prescriptive savings values for schools:

> As part of the 2007 audit, two studies were reviewed that relate to boiler installations in schools..."...
>
> These studies were completed by the engineering firm AGVIRO and are designed to provide a single prescriptive savings value for boilers replaced in schools...
>
> The prescriptive schools program began with a few projects in 2007, although it was not formally supposed to begin until 2008. For this audit, we reviewed the savings study to determine if the

> savings value should be used for the 2007 prescriptive projects and to provide suggestions for using the savings values in future program years.
>
> In general, it appears that the AGVIRO report is a sound study and we recommend that the study values be used for gross savings for the prescriptive schools projects in 2007, as the study currently represents the best available information for a prescriptive savings values.

35. While the auditor did recommend that some additional research would be appropriate in future, at the present time, the AGVIRO report remains the best information available.

36. (D) Air Curtains/Air Doors

37. GEC makes comments in respect of this program, at pages 3 and 5 of its submission. It should be noted that this program is a small program in its relative infancy and has only been applied to a limited number of buildings (less than 25).

38. Savings for the several buildings where air doors have been installed were developed using an engineering savings calculator, and the results were averaged to result in a prescriptive gas savings value. The air door program involves the installation of an air barrier on an exterior entrance door to a retail facility to maintain air temperature. This air door calculator was developed by AGVIRO Inc., an independent engineering consultant.

39. A copy of the air door Research Summary which was circulated to the EAC in July 2008 and which is referenced in EGDI's filing is attached. In brief, it notes that in order to determine an appropriate average saving per air door, an analysis was done that compared the energy savings determined from monitored results (The Air Curtain Installation and Performance Study) with the results of the air door calculator developed by AGVIRO. The results have been used for the purposes of the input assumptions filed in this proceeding.

40. The Company views this as a promising program and believes that by its continuation, additional empirical data will be generated which will confirm positive results. One of the purposes behind aspects of the DSM Generic Proceeding Decision was to eliminate uncertainty. This includes the uncertainty associated with new programs. Accordingly, it is submitted that it is appropriate to accept and approve what appear to be reasonable input assumptions for use in respect of the air door program. The assumptions are reasonable because the gas savings are based on a savings calculator developed by an independent engineering consultant and applied to real customer sites. The free ridership rate of five percent is also reasonable because the program and the involved technology is relatively new. It stands to reason that freeridership rates will be their lowest when new programs are first launched. Until businesses learn of such programs and ideas, it is less likely that they will conjure up a similar program and proceed on their own. As the program develops, additional research will be undertaken and provided to the EAC and the Consultative.

(E) Energy Star Homes

41. The issues raised by GEC in respect of this program appear at pages 2 and 5 of GEC's submission. For the following reasons, the Company submits that GEC's concerns are unfounded.

42. EGDI's natural gas and electricity savings assumptions are based upon a report prepared by Bowser Technical Inc. entitled *Comparison of Energy Star Versus Ontario Building Code 2006 Energy Use,* July and August 2008. To the Company's knowledge, this report was undertaken at the suggestion of GEC by Union Gas. The report is clearly the best information available at this time and is independent and credible in that EGDI had no role in engaging and instructing the authors of the report. To the contrary, it appears that GEC had a role in recommending that the study be commissioned, but now has concern about some of the software modeling assumptions used by Bowser.

43. EGDI submits that neither it nor the Board can at this time determine whether there is any merit to GEC's concerns in respect of the Bowser report. Perhaps more importantly, even if these concerns were valid, there is no indication whether they would have any material impact on the relevant input assumption. GEC has the ability to ask Union to request that Bowser review its software models as part of the ongoing and continued valuation and audit process. The Company submits that in the face of clearly relevant, directly applicable information from a third party expert, the input assumptions derived from such information are reasonable and should be approved. The proposed savings assumption is common to the Union Gas Input Assumptions filing in EB-2008-0385 which has been endorsed by GEC.

44. Finally, the Company questions the credibility of GEC's concerns in respect of the proposed freerider rate in that the 5 percent rate proposed by EDGI is identical to the rate proposed by Union Gas, which GEC has accepted as appropriate for Union Gas for 2008. GEC has offered no explanation for why a different freeridership rates should be used by EGDI, nor has it made a case for a different freeridership figure. This program makes use of many new home energy savings technologies which are not broadly known. This intuitively results in a low freerider rate. There is no compelling reason why the rate Union Gas will employ should be different than the rate to be used by EGDI.

(F) Commercial Roof Top Units

45. The Company submits that GEC has not provided any basis to question the reasonableness of the 5 percent freeridership rate proposed for this program, particularly in light of the fact that it has agreed with Union Gas that the exact same 5 percent freeridership rate for such programs should be approved by the Board in Union Gas' companion proceeding (EB-2008-0385). The only issue which GEC appears to take in respect of EGDI's application is the extent of EGDI's commitment to undertake an evaluation of the 5 percent freeridership

rate for this program. It should be recalled that more than one year remains of EGDI's three-year DSM plan. EGDI acknowledges its obligation to review and update input assumptions on an ongoing basis and to reasonably consider requests from the EAC to evaluate specific input assumptions, such as the freerider rate for various programs.

(G) Energy Efficient Multi-Residential Washing Machines

46. At page 6 of its submission, GEC notes the history of the freeridership rate of 10 percent previously approved for this program, but provides no evidence or argument as to why it is no longer reasonable. This program, as the measure information sheets filed by the Company note, promotes the installation and use of high efficiency front loading washers at multi-unit residential buildings. In many instances, the machines are coin operated and hence, are either revenue neutral or perhaps a small source of income for a landlord or condominium corporation. As a result, replacement of such equipment is not seen as a high priority and, in the Company's view, is not likely to occur other than with the existence of programs such as this one. While, a ten percent freeridership rate remains reasonable, EGDI will undertake an evaluation of this free rider rate in 2009.

(H) GEC's Proposed Freeridership Rate

47. In place of the freeridership rates previously approved in respect of Energy Star homes, commercial roof top units, air doors and multi-unit building energy efficient washing machine programs, GEC proposes a 30 percent freeridership rate. However, GEC offers no report or study which suggests that a 30 percent rate is more reasonable than those proposed in EGDI's filing. It appears that GEC's primary motivation for this rate is unrelated to the reasonableness of the freerider rate, but rather GEC's unfounded belief that a higher freerider rate for these four programs would somehow provide additional incentive to rigourously research and evaluate freeridership rates.

48. It is noteworthy that there does not appear to be unanimity between intervenors in respect of GEC's position in respect of a 30 percent "placeholder" freerider rate. In the Board's consideration of CDM input assumptions presented by the OPA (EB-2008-0037), Pollution Probe strongly advocates against using a 30 percent figure as the assumed rate, for a number of reasons. In its November 21st, 2008 submission, Pollution Probe makes the following arguments against using a 30 percent rate:

(i) Accurate freerider estimates for CDM programs can thus only be determined by reviewing CDM program designs and delivery mechanisms on a case-by-case basis. It is only then that one can assess the respective impacts on freeridership rates. Pollution Probe then questions whether any empirical or logical support exists to justify the 30 percent placeholder freerider rate.

(ii) Perhaps most importantly, Pollution Probe argues that the adoption of the 30 percent freeridership rate will not motivate utilities to be cost effective by taking steps to minimize a program's freeridership rate.

49. Accordingly, the Company submits that GEC's proposal to arbitrarily increase the freerider rate in respect of these four programs should be rejected.

(l) Spillover

50. Contrary to inferences raised by several intervenors, the use of net-to-gross ratios ('NTG") is neither new to the total resource cost ("TRC") test nor a matter requiring further consultation. NTG, which takes into consideration both freeridership and spillover, is completely consistent with the DSM Generic Proceeding Decision at Issue 3.1, which reads, in part:

> "Parties agree that input assumptions **such as** freerider rates, prescriptive measure savings assumptions, incremental

> equipment costs, measure lives and avoided costs..." (emphasis added)

51. Issue 3.1 does not limit input assumptions to only those items raised. The words "such as" clearly indicate that the list of input assumptions is not limited to those named, but rather the assumptions mentioned are simply examples, and Parties agreed to use the best available information developed over the course of a multi-year plan.

52. Spillover is as important an input assumption (or contributing factor to the development of input assumptions) as are freerider rates. To include freerider rates but ignore spillover where reliable data exists in respect of the latter is inconsistent with TRC test methodology and its application in those jurisdictions where such data is available.

53. The TRC test has not changed since the DSM Generic Proceeding approved the current framework. An excellent summary of how the TRC test is used is set out in the attached recently released report *"Understanding Cost Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods, and Emerging Issues for Policy-Makers"*, dated November 2008. The paper is a product of the National Action Plan for Energy Efficiency, which is facilitated by the U.S. Department of Energy and the U.S. Environmental Protection Agency. The paper specifically notes on its inside cover that it was "provided to assist utility regulators, gas and electric utilities, and others..." The paper notes, at page 2 of the Executive Summary, that the TRC test is the most common primary measurement of energy efficiency cost effectiveness and, at page 3, that the NTG is a significant driver in the results of TRC. Specifically, the paper states:

> "The NTG adjusts the impacts of the programs so that they only reflect those energy efficiency gains that are the result of the energy efficiency program. Therefore, the NTG deducts energy savings that would have been achieved without the efficiency program (e.g., "free-riders") and increases savings for any "spillover" effect that occurs as an indirect result of the program.

54. Under the heading "Key Drivers in the Cost-Effectiveness Calculation", the paper discusses the NTG and states that:

> "A key requirement for cost benefit analysis is estimating the NTG. The NTG adjusts the cost-effectiveness results so that they only reflect those energy efficiency gains that are attributed to, and are the direct result of, the energy efficiency program in question. It gives evaluators an estimate of savings achieved as a direct result of program expenditures by removing savings that would have occurred even absent a conservation program. Establishing the NTG **is critical to understanding overall program success and identifying ways to improve program performance.** (emphasis added)

55. Until recently, gas utilities in Ontario did not have relevant empirical data which specifically considered the extent of spillover. In the latter part of 2007, and with the agreement of the EAC of both Utilities, Union Gas and EGDI retained industry expert Summit Blue "to conduct a forward looking evaluation of program influence attribution for freeridership and spillover associated with the custom projects programs offered by the Utilities."[13]

56. Summit Blue's Report is independent and the result of the consultative process. For these reasons, no intervenors in their submissions have called into question the methodology used by Summit Blue nor the legitimacy of its findings.

57. The Summit Blue Report describes specifically the methodology used to quantify spillover. The details of the methodology used are set out in Chapter 2 to the report and included questions in the participant and trade ally surveys and through the audit only survey. Chapter 3 of the report analyzed and critiqued the methods used to assess both freeriders and spillover. The methodology employed was the product of this analysis and an extensive review of relevant authoritative papers.

[13] Custom Projects Attribution Study, Final, Summit Blue, October 31, 2008, p. (i)

58. The NTG figures which are included in EGDI's updated input assumptions are based upon the Summit Blue Report. This information, quite clearly, is the best and most reliable information available.

59. Importantly, as noted in the Summit Blue report, the audit-only spillover survey and analysis was completed for EGDI only, as Union Gas was unable to find any companies who had an audit in 2005 and had not implemented one of the recommended measures through the program.

60. Another important distinction between the results applicable to Union and EGDI was the Utilities' specific total net-to-gross ratios. For EGDI, the net-to-gross ratio was determined by Summit Blue to be 79 percent; whereas it was calculated at 56 percent for Union. EGDI submits that these differences may underlie the decision by Union Gas to not seek approval of input assumptions at this time which apply the spillover results confirmed by Summit Blue. The fact that Union Gas is not seeking approval in its proceeding for the impact of spillover should not be a justification to delay recognizing spillover in respect of applicable programs undertaken by EGDI.

Differences with OPA Measures

61. The Company is not surprised that there are differences in terms of both savings and costs between its programs and those undertaken by or for the OPA. The time when a party commits to purchase products used in certain programs may partly explain the difference in costs. Another factor may be the quantity of product purchased and the bargaining power of the purchaser. It is also not surprising that savings estimates will vary in that the programs which EGD operates are not identical to those undertaken by or for the OPA. The mere appearance of a difference in costs and savings does not detract from the fact that, to the extent reasonable, the input assumptions adopted by each of the gas utilities are based upon its unique program parameters and cost structures. It

would therefore be inappropriate to align such assumptions between the OPA and the gas utilities as VECC suggests.

Conclusion

62. In conclusion, EGDI submits that:

(a) The process which it has followed is the same as past proceedings which considered and approved input assumptions;

(b) It has complied with the Consultative and EAC requirements of the DSM Generic Proceeding and any inability to reach agreement with the EAC in respect of spillover is no basis to not entertain EGDI's application for approval of its assumptions in this proceeding;

(c) Similarly, there is no basis for intervenors to argue, in effect, that a threshold level of consultation, either within the Consultative or in the EAC, must be met before all or some of the updated input assumptions can be considered by the Board for approval.

(d) There is no basis to accept GEC's submissions in respect of several programs' specific input assumptions and freerider rates;

(e) It is both consistent with the DSM Generic Proceeding Decision and appropriate for input assumptions to reflect spillover now that reliable data exists which quantifies the extent of spillover.

All of which is respectfully submitted.

Dated: December 19, 2008

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Enbridge Gas Distribution Inc.,

by its Counsel, Dennis M. O'Leary

4687812.1

CUSTOM PROJECTS ATTRIBUTION STUDY

FINAL

Submitted To:

DSM Evaluation
Union Gas Limited – A Spectra Energy Co.
Enbridge Gas Distribution

October 31, 2008

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E EXECUTIVE SUMMARY

Enbridge Gas Distribution (EGD and Union Gas deliver DSM programs to customer in their respective franchise areas.

In 2006, the Ontario Energy Board (OEB) convened a Generic Proceeding on the subject of natural gas DSM. Through the Proceeding, the OEB approved the utilities' DSM plans for the three-year period 2007 through 2009, including assumptions for measure savings and free ridership. Items identified as priorities for evaluation research included a free ridership study of the Custom Projects programs.

This report presents the results of market research conducted by Summit Blue Consulting, LLC/Summit Blue Canada, Inc. ("Summit Blue") during the winter of 2007-2008 to measure free ridership and spillover for the Custom Projects programs.

E.1 Definitions

To assist the reader in understanding the terms used throughout the document, Summit Blue has provided definitions for the following terms:

Free Ridership: Free riders are customers who received an incentive through an efficiency program, yet would have installed the same efficiency measure on their own had the program not been offered. This includes partial free riders, defined as customers who, at some point, would have installed the measure anyway, but the program persuaded them to install it sooner than otherwise.

Spillover represents energy savings that are due to the program but not counted in program records. Spillover can be broken out in three ways:

- **Participant inside spillover** represents energy savings from other measures taken by participants at participating sites not included in the program but directly attributable to the influence of the program.
- **Participant outside spillover** represents energy savings from measures taken by participants at non-participating sites not included in the program but directly attributable to the influence of the program.
- **Non-participant spillover** represents energy savings from measures that were taken by non-participating customers but are directly attributable to the influence of the program. Non-participant spillover is sometimes called the "Free-Driver effect."[1]

[1] See for example California Energy Efficiency Evaluation Protocols: Technical, Methodological and Reporting Requirements for Evaluation Professionals. TecMarket Works. Prepared for the California Public Utilities Commission. April 2006. Page 226.

Net-to-Gross Ratio: Gross impacts are the program impacts prior to accounting for program attribution[2] effects. Net impacts are the program impacts once program attribution effects have been accounted for. The net-to-gross ratio is defined as 1 - free ridership ratio + spillover ratio.

E.2 Study Overview

The study included the following research tasks performed during the winter of 2007-2008:

- Development of a project analysis plan detailing the study's methodology
- A history and critique of the methods that have been used to estimate free ridership and spillover in nonresidential programs.
- On-site interviews (plus a few telephone interviews) with participants and participating trade allies.
- Telephone interviews with customers who had a program-supported energy audit but had not implemented any measures through the program.
- Telephone surveys with nonparticipants to look for and quantify nonparticipant spillover.
- An analysis and scoring of the data to produce the free ridership and spillover estimates.

E.3 Free Ridership Results

The total free ridership rate across both utilities and all sectors is 48% as shown in Table E-1. The free ridership rate for EGD is 41% and it is 54% for Union Gas. Summit Blue recommends that the utilities use the utility-specific total free ridership values of 41% and 54% as the best estimate of free ridership. Those results are based on larger sample sizes than the sector-specific results and proved more stable in the sensitivity analysis. The sector-specific results are based on smaller sample sizes and should only be used to support program management, for example to support targeting and marketing decisions.

[2] For purposes of this study, attribution is defined as the influence the program has had on customers installing the target measure when they otherwise would not have done so, including inside spillover influences to take additional energy efficiency measures.

Table E-1. Free Ridership Results

Sector	EGD	Union	Total
Agriculture	40%	0%	18%
Commercial Retrofit	12%	59%	27%
Industrial	50%	56%	53%
Multifamily	20%	42%	26%
New Construction	26%	33%	28%
Total	41%	54%	48%

Assumptions (See Figure 2.1 for the interpretation of these assumptions):

Weight of Participant Reported Importance [F] in [K] compared to the planning [H] and influence [G] scores	Triple weight
Weight of Project-based estimate [14] in [20] compared to the measure-specific scores [9]	Triple Weight
Weight of Program Influence Score [L] compared to the Project-Based score [21]	Equal Weight

E.4 Spillover Results

Participant inside spillover, representing additional energy efficiency measures installed at the participant's same facility without going through the program, is 5% of gross reported savings for both EGD and Union.

Participant outside spillover, representing additional energy efficiency measures at *different* facilities without going through the program, is 5% combined across both utilities.

Customers who received an audit, implemented a recommended measure, but did not receive incentives through the program for that measure can be considered audit-only spillover. The audit-only spillover survey and analysis was completed for EGD only as Union Gas was unable to find any companies who had an audit in 2005 and had not implemented one of the recommended measures through the program. As a result, the savings inspired by the Union Gas audits will appear in the program tracking data rather than in spillover. For EGD, 35% of the gross recommended savings from energy audits were achieved, representing the audit-only spillover.

A screening survey of 1,228 non-participants found that 5.4% of non-participants were influenced by the program to implement measures (and did not receive a financial incentive). The study could not accurately calculate the m^3 savings from the respondents so the non-participant spillover was not factored into the net-to-gross ratio.

Summit Blue recommends the utilities use following spillover rates:

Table E-2. Spillover Results

Spillover Type	EGD	Union	Base
Participant Inside Spillover	5%	5%	Of gross reported savings
Participant Outside Spillover	5%	5%	Of gross reported savings
Audit-Only Spillover	35%	0%	Of gross audit-recommended savings
Nonparticipant Spillover	0%	0%	

E.5 Net-to-Gross Ratio

The net-to-gross ratio is defined as 1 - free ridership ratio + spillover ratio. As discussed above, spillover is in several parts: participant inside and outside spillover, audit-only spillover, and non-participant spillover. We know that 5.4% of the non-participants have spillover but cannot calculate its quantity so the calculation of net-to-gross in this report excludes it. Summit Blue recommends that the utilities use the utility-specific total net-to-gross ratios of 79% for EGD, 56% for Union, and 67% across both utilities as shown in the following table. As with the free ridership results, these recommended net-to-gross results are based on larger sample sizes than the sector-specific results.

Free ridership is calculated quite frequently in impact analysis studies. In the early days of attribution research, spillover was not often considered but over the past few years more and more jurisdictions are taking spillover into account along with free ridership. For example, California is now implementing studies to measure market transformation effects and spillover from its programs. NYSERDA takes both free ridership and spillover into account. Minnesota believes free ridership and spillover effectively cancel each other out. It is increasingly viewed that if programs are going to see their results discounted for free ridership that a more accurate view of net impacts can be had by adding in spillover. In 2006, Summit Blue researched the free ridership and spillover rates that have been found in studies in recent years. The 79% net-to-gross ratio for EGD is in the same range as several of the programs examined. The 56% ratio for Union Gas is lower than those found in this research.

Table E-3. Net-To-Gross Ratio

Utility	Sector	Free Ridership	Participant Inside + Outside Spillover	Audit-Only Spillover %	Net-to-Gross Ratio
EGD	Agriculture	40%			
EGD	Commercial Retrofit	12%			
EGD	Industrial	50%			
EGD	Multifamily	20%			
EGD	New Construction	26%			
EGD	Total	41%	10%	11%	79%
Union	Agriculture	0%			
Union	Commercial Retrofit	59%			
Union	Industrial	56%			
Union	Multifamily	42%			
Union	New Construction	33%			
Union	Total	54%	10%	0%	56%
Total	Agriculture	18%			
Total	Commercial Retrofit	27%			
Total	Industrial	53%			
Total	Multifamily	26%			
Total	New Construction	28%			
Total	Total	48%	10%	5%	67%

Free Ridership Assumptions (See Figure 2.1 for the interpretation of these assumptions):

Weight of Participant Reported Importance [F] in [K] compared to the planning [H] and influence [G] scores	Triple weight
Weight of Project-based estimate [14] in [20] compared to the measure-specific scores [9]	Triple Weight
Weight of Program Influence Score [L] compared to the Project-Based score [21]	Equal Weight

E.6 Limitations

Three areas typically form the basis for research projects' constraints and limitations including: budgetary constraints, time constraints and reliability of data. This study, like most research, encountered constraints and limitations and they are documented below.

Budgetary Constraints

- Given sufficient time and budget, it is possible to survey every participant in a program and produce a precise calculation of a given characteristic across the entire population. However, it is typically not possible or desirable (except perhaps for very small programs) to have a budget large enough for that level of effort. As a result, free ridership studies are most often done with a sample of participants. The estimate based on that sample has an error bounds around it, and the error bounds is determined by the sample size and the variance in the result from the sample. As with most such studies, the current study used a sampling approach but with a sample designed to be sufficient to provide a result at the 90/10 confidence level, which means we are 90% confident that the mean free ridership from the sample is within 10% of the mean free ridership in the population.

Time Constraints

- The study was conducted on custom projects that were completed between the fourth quarter of 2006 and the third quarter of 2007. It is possible that the characteristics of participants and projects in a custom project program may change over time in response to changing conditions in the region. Ideally, changes in program implementation efforts also discourage free riders from participating and thus also bring about a change in the population of participants. To the extent that the characteristics of the population of participants changes over time, the results of a given study have less predictive power for the new population. When a relatively small number of participants has a particularly large impact on the free ridership value, as with the current study, changes in the population of participants could have a significant effect on future free ridership results.

- Self-report free ridership studies like the current study depend— by design— on respondents recalling events from the past. Ideally, the interviews on which to base these studies are done as soon as possible after pivotal decisions are made for each project. C&I custom projects often have a long lead time, sometimes measured in years. Thus some projects in the current study could have been incubating from as early as 2004. The time lag between when a project is conceived or key decisions are made and when the free ridership interview was completed may mean that crucial information is unavailable to the interviewer. Key decision-makers may have forgotten details or even moved from the participating company. The study included efforts to remind respondents of the history of their interaction with the program but this can never bring the entire history of a decision back to mind. While the risks here could skew results toward higher or lower free ridership values, it is more likely that these factors will produce higher free ridership values than the opposite.

Reliability of the Data

- The free ridership interviews were completed by four separate individuals. Most were done in-person and some Union Gas interviews were done by phone. The key questions that affect the free ridership results were precisely worded and all interviewers were carefully trained. However the interviews were designed to be more like free-flowing conversations than highly-scripted surveys. The interviewers were instructed to probe for details and follow lines of thought to their natural conclusions rather than stick strictly to a set script. As a result, some variations from one interviewer to the next are inevitable and they may affect the bottom line results. The results were examined to look for evidence of interviewer bias but no patterns were evident.

- As discussed above, the study is dependent on respondents' memory of past events. This is magnified in some circumstances when one respondent is responsible for providing answers on several different projects. The sample was picked at the project level, that is, projects were picked for the sample rather than participants. However, participants may have implemented more than one project in the study period. In those cases, we surveyed the respondent once but asked them separately about the individual projects. Given the reliance on Channel Partners, in the Union Gas sample 77 projects were covered by interviews with 52 respondents. The extent to which respondents were unable to distinguish in their head between one project and another will be reflected in the inaccuracy of their responses.

1 INTRODUCTION

This section gives a brief background on the purpose of the research, describes the utility programs, and introduces the organization of the report.

In 2006, the Ontario Energy Board (OEB) convened a Generic Proceeding on the subject of natural gas DSM. Through the Proceeding, the OEB approved the utilities' DSM plans for the three-year period 2007 through 2009, including assumptions for measure savings and free ridership. Items identified as priorities for evaluation research included a free ridership study of the Custom Projects programs.

Summit Blue Consulting, LLC/Summit Blue Canada, Inc. ("Summit Blue") were retained by Union Gas Ltd. (Union Gas) and Enbridge Gas Distribution (Enbridge) (jointly, the Utilities) to conduct a forward-looking evaluation of program influence attribution for free ridership and spillover associated with the Custom Projects programs offered by the Utilities.

The study included the following research tasks performed during the winter of 2007-2008:

- Development of a project analysis plan detailing the study's methodology
- A history and critique of the methods that have been used to estimate free ridership and spillover in nonresidential programs.
- On-site interviews (plus some telephone interviews) with participants and participating trade allies.
- Telephone interviews with customers who had a program-supported energy audit but had not implemented any measures through the program.
- Telephone surveys with non-participants to look for and quantify non-participant spillover.
- An analysis and scoring of the data to produce the free ridership and spillover estimates.

1.1 Utility Programs

Both Union and Enbridge operate DSM programs that include custom projects for the Commercial and Industrial sectors. Custom projects cover opportunities where savings are linked to unique building specifications, uses and technologies. Each project is assessed individually for participation in the program.

1.2 Report Organization

This chapter (Chapter 1) outlines the purpose of the study, background on utility programs and the report organization. Chapter 2 describes the methodology used to assess free ridership and spillover. Chapter 3 presents a history and critique of free ridership methodologies. Chapter 4 presents the sampling strategy and sample disposition. Chapter 5 presents the results of our research. Chapter 6 presents supplementary results. Finally, Chapter 7 presents our conclusions.

2 METHODOLOGY

This section presents a high-level overview of the methods and data sources used to conduct the study. Full details are included in Appendix A in the revised Analysis Plan.

2.1 Free Ridership

Free ridership and spillover were estimated using data from surveys with participants, non-participants, trade allies, and utility staff. This approach is based primarily on participant self-reported information along with other perspectives to triangulate the net-to-gross estimates.

Experienced utility industry consultants conducted the interviews and most were done on-site at the participant's premise. To address the possibility of respondent bias, the interviews approached each topic from a variety of directions. The interviewer had the discretion to probe for supporting information and the analysis process checks for consistency across answers. Interviewees were promised confidentiality and assured that their answers will not affect the incentives or support they have received from the program. To address the possibility of interviewer bias, each interviewer was trained in the purpose of the research and the importance of objectively probing and recording responses. Four different interviewers performed the interviews and the data from their interviews were compared to look for uneven application of the methodology.

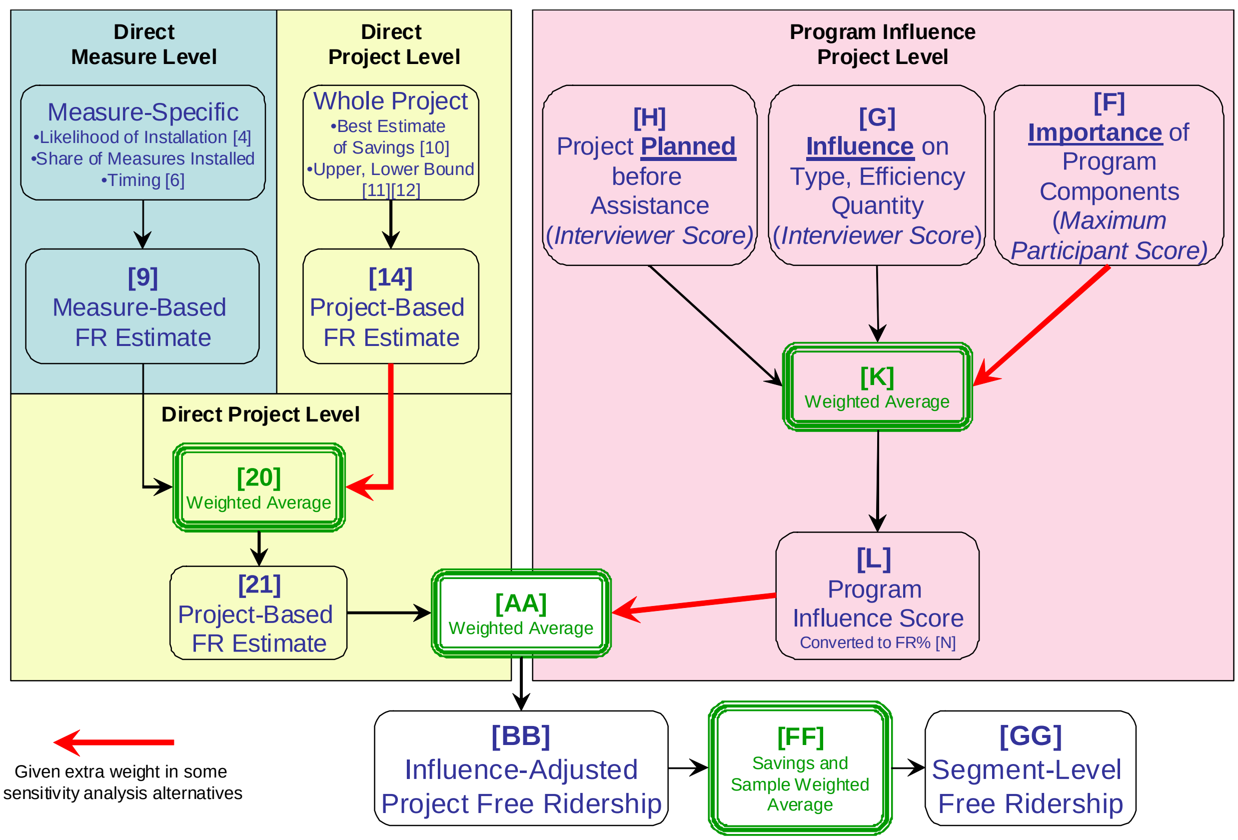
Figure 2-1 presents an overview of the survey and analysis approach. Key points in the diagram are labeled with numbers and letters in square brackets, which we will refer to below. Free ridership was discussed with each respondent in both **direct questions** aimed at obtaining respondent estimates of the appropriate (full or partial) free ridership rate to apply to them (represented by the large box on the left side of the diagram), and in **supporting or influencing questions** used to verify whether direct responses are consistent with participants' views of the program's influence on their equipment investment decisions (represented by the large box on the right side of the diagram). The direct questions were asked at the measure level [4] and [6] and at the whole project level [10]. They were then combined into a single, project-level direct free ridership score at [21]. Direct and program influence scores are combined into the final project-level free ridership score at [BB]. That project-level score is weighted by program-reported savings and sample weights [FF] to calculate the final savings-weighted free ridership percentage [GG].

Key calculations were examined in a sensitivity analysis to determine their effect on the final result. Three assumptions feeding into those calculations were found to have the most effect on the end result. Those assumptions relate to the weight given to various answers or answer categories in averages with other answers. The key calculations are shown at [20], [K], and [AA] in the calculation overview diagram. The sensitivity analysis tested the effect of increasing the weight given to [14] in the calculation at [20], the weight given to [F] in the calculation at [K], and the weight given to [L] in the calculation at [AA] (each represented by a thicker, red arrow).

Free ridership results were first calculated on the measure level. The measure-level gross and net savings are summed up across all customers and then net savings divided by gross savings produces the final savings-weighted, program-wide free ridership result. (Sample weights are applied during the summing step.)

Enbridge Gas Distribution designates some projects as "advancement" when they judge that the program moved a project forward in time. The designation of a project as an advancement project does not affect the annual savings but it does affect the TRC calculation. In their TRC calculations for advancement projects, EGD discounts the benefits and adjusts the incremental costs to account for the period which the program has moved projects forward in time. The current study addresses first-year annual savings only, it does not extend benefits and costs over time and does not include a cost/benefit analysis. On a measure-by-measure basis, respondents were asked if the program influenced them to install the equipment more than one year earlier than they otherwise would have otherwise [6]. If it did, the measure-level free ridership score is discounted in [9] in the diagram below. Several different scales were examined for discounting the free ridership score based on the number of months the project was brought forward in time. The final, utility-level free ridership score did not move significantly in that analysis. Because this study was focused on first-year savings only, it was agreed that the appropriate approach was to include this adjustment for all projects, including advancement projects. This is in keeping with standard practice in calculating free ridership. All respondents were asked the timing question [6] and their answers were accounted for in [9] whether they were being asked about an advancement project or not. Given the math of the calculation, the only possible effect of removing the timing question for advancement projects would be to **increase** the free ridership rate.

Figure 2-1. Free Ridership Analysis Overview



2.2 Spillover

Spillover represents energy savings that are due to the program but not counted in program records. Spillover can be broken out in three ways:

- **Participant inside spillover** represents energy savings from other measures taken by participants at participating sites not included in the program but directly attributable to the influence of the program.

- **Participant outside spillover** represents energy savings from measures taken by participants at non-participating sites not included in the program but directly attributable to the influence of the program.

- **Non-participant spillover** represents energy savings from measures that were taken by non-participating customers but are directly attributable to the influence of the program. Non-participant spillover is sometimes called the "Free-Driver effect."[3]

Summit Blue estimated **participant inside and outside spillover** through questions in the participant and trade ally surveys and through the Audit-Only Survey. Summit Blue estimated non-participant spillover through the non-participant survey.

The surveys did not address whether the respondent received funding from other sources to facilitate the energy efficiency measures. The survey questions were designed to designed to determine if the Custom Projects program was influential in the decision to install the spillover measure and if so the share of the savings from the extra equipment that can reasonably be attributed to the influence of the program. Given that approach, funding from other sources, if any, would not change the conclusions drawn from the survey. Even with other funding, if the utility program support was critical in convincing the respondent to implement the energy efficiency measure, then it should get credit for some of the savings.

2.2.1 Participant Inside and Outside Spillover

The spillover questions were incorporated in the participant and trade ally surveys and the spillover analysis was implemented in concert with the free ridership analysis.

For **inside spillover**, respondents are asked whether their experience with the programs caused them to install additional energy efficient equipment at the site that did not go through the program. This establishes whether inside spillover exists. For those respondents reporting that additional measures were installed, they are asked to identify in which year(s) the measures were installed, and to describe how the program influenced their decisions to install additional energy efficient equipment at their facility. An additional question is asked to determine the ratio of the savings from these additional measures compared to the savings from the measures installed under the program. That is, they are asked the percent of savings as a multiple of the savings achieved under the program (**savings multiplier**). Finally,

[3] See for example California Energy Efficiency Evaluation Protocols: Technical, Methodological and Reporting Requirements for Evaluation Professionals. TecMarket Works. Prepared for the California Public Utilities Commission. April 2006. Page 226.

respondents are asked to estimate the share of the savings from these additional measures that can "reasonably be attributed to the influence" of the program **(net-to-gross percentage)**.

Inside spillover is zero for those without additional measures (or those who failed to answer all of the questions), and it is the product of the savings multiplier and the net-to-gross percentage for those with inside spillover. Similar to the free ridership analysis, individual spillover estimates are weighted both by relative energy savings for each respondent, as well as by sample stratification to determine an inside spillover value for the group as a whole.

Similar to inside spillover, for **outside spillover**, respondents are asked first whether the influence of the program caused them to install any additional energy efficiency equipment, outside of the program, at other sites beyond what they would have done without their experience with the program. If they respond yes, they are asked several follow-up questions designed to provide an estimate of the level of savings from these actions that could be attributed to the program.

For outside spillover, the savings as a percent of the in-project measure is multiplied by the share of savings attributed to the program to calculate the outside spillover value.[4] Similar to the free ridership analysis, individual spillover estimates are weighted both by relative energy savings for each respondent, as well as by sample stratification to determine an outside spillover value for the group as a whole.

2.2.2 Audit-Only Spillover

Participants who received an audit, implemented a recommended measure, but did not receive incentives through the program for that measure can be considered spillover. These kinds of participants would not be included in either the participant or non-participant surveys. We implemented a survey specifically with this population and focusing solely on spillover measures to provide an additional estimate of program spillover.

The interviewer asks the respondent if they recall receiving the audit. If they do not, the interviewer attempts to speak to someone else who might recall the audit. The interviewer asks the participant about each measure recommended in the audit. (Although we will limit this to the measures with the largest savings if there are more than 5 measures recommended.) The interviewer examines whether the respondent remembers the recommendation and whether it has been installed and when. If the participant installed a measure, the interviewer asks the following:

1. On a scale of 1 to 5 where 1 is "no influence" and 5 is "a great deal of influence", how much influence did the audit have in your decision to implement this measure?

2. What share of the savings from this measure can reasonably be attributed to the influence of the program?

The analysis of audit-related spillover savings is fairly straightforward. The program tracking data have measure-specific savings estimates from the audit. The two influence scores are converted to the same scale and averaged. That average is applied to the audit savings to calculate audit-related spillover savings.

[4] A cap of five outside spillover projects per respondent is used to prevent outliers from skewing the results.

2.2.3 Non-Participant Spillover

Summit Blue estimated non-participant spillover using a survey targeted at non-participants only. The approach to the data collection and analysis took the following steps:

1. Obtain sample of non-participants from the utilities

2. Execute telephone screening survey to identify customers who had implemented relevant measures and were influenced by the program.

3. Conduct engineering follow-up interview to estimate savings from those measures influenced by the program.

The screening survey went through the following steps:

1. Find someone knowledgeable about the replaced or modified equipment.

2. Are they aware of the program? If no, terminate.

3. Did the company participate in the program in the past 3 years? If yes, terminate.

4. Has the company modified or installed equipment that might fall under the program's incentives since the beginning of 2005? (List target equipment.) If no, terminate.

5. Determine what effect, if any, the program had on their decision. If none or little, terminate.

6. Obtain permission for the follow-up engineering call.

In the engineering follow-up call Summit Blue engineers asked enough questions about the equipment to make an engineering estimate of the energy savings it produces.

3 History and Critique of Free Ridership Methodologies

This chapter was designed to analyze the methods used to assess both free riders and spillover for customized programs targeted to the commercial and industrial sector. Summit Blue conducted a literature review of methodology development and assessment and current practice, compared the various methods, and drew conclusions on the most appropriate method to use for C&I custom projects programs.

The recommended method to assess free riders and participant spillover is self-report in-person and telephone surveys with participants and market players. Issues such as self-selection bias would be controlled by using enhancements such as interviews with multiple decision makers at sampled sites, multiple question areas to address program influence on decision making, and well-thought out scoring algorithms. The market share method of estimating free ridership is not appropriate for custom projects with large customers mainly because the programs are focused on custom projects rather than promotion of specific equipment. Market sales methods rely on good equipment sales data and work best with programs targeted at measures that are uniform across applications and very specific definitions of technology. Econometric methods including billing analysis and discrete choice modeling are not applicable for C&I custom programs because large customers may skew the results, custom projects are less amenable to standardized approaches, difficulties with identifying comparable non-participant groups cast doubt on the validity of the model, the lack of good historical data (except for consumption) limits their scope, and the need to estimate a proportion rather than magnitude of net savings and the requirement to assess spillover limit their usefulness.

Self-report and econometric analyses have merit and often provide similar results. For example, a study by Torok in 1999 found consistent results from self-report, billing, and discrete choice analysis; net-to-gross (NTG) results for self-report and discrete choice methods differed by less than one percent. The study looked at the three methodologies used to estimate net impacts for Pacific Gas & Electric’s Commercial Energy Efficiency Program, which provided prescriptive rebates for equipment as well as funding for custom projects (gas or electricity). The authors preferred the two stage discrete choice model, but recommended the continued use of multiple approaches. Most econometric methods for NTG require survey information; the more they rely upon self-report data, intentions, and psychographic data, the more they are likely to have some of the same measurement issues as the survey-based approach. Billing analysis can produce biased results because of participant self-selection into programs; this can be dealt with by various statistical methods which unfortunately require excluding large customers as they can skew the results.

3.1 Background & Development of Methodology

This section briefly outlines the history of evaluation of social actions and the development of evaluation methodology to assess free riders and spillover effects.

Evaluation is rooted in the empirical study of social problems in Britain in the 1660s with the first evaluative studies published in the 1800s, looking at the impact of education on crime or the usefulness of public works, for example. However, until quite recently, most policies and programs did not include provision for evaluation, assuming the remedies provided would solve the problems. "*People working in education and health fields were among the first to do systematic studies of the outcomes of their work*"[5] starting in the early 1900s. In the 1940s, private foundations began funding evaluations of innovative social programs they sponsored, such as a youth worker program to prevent delinquency in suburban neighborhoods near Boston. By the 1950s, the U.S. federal government was sponsoring new curriculum efforts with funding for evaluations of the success of the curriculums. In the mid-60s, the War on Poverty marked the beginning of large-scale government-funded evaluation—the Elementary and Secondary Education Act of 1965 included a requirement for evaluation. Robert Kennedy was the moving force behind this, seeing "*evaluation as a tool to provide parents with the necessary information.*"[6] The same period saw the rise of cost-benefit analysis in the RAND Corp, Department of Defense and elsewhere; evaluation branched out into other areas such as environmental protection, energy conservation, military recruitment, and control of immigration. In the 1970s, the inauguration of a series of social experiments to test policy and program ideas prior to enactment—using pilot programs—was a high point in evaluation history. *"By the end of the 1970s evaluation had become commonplace across federal agencies."*[7] Evaluation was a growth industry until 1981 when funding for new social initiatives was cut drastically and then made a comeback in the late 80s and early 90s.

The major shift toward more accurate measurement of program-related energy savings came about in the mid-to-late 1980s, a time of least-cost planning and large increases in utility spending on energy efficiency programs. Most analysts used definitions for cost-effectiveness tests based on the 1987 California Public Utilities Commission Standard Practice Manual of Economic Analysis of Demand-Side Management Programs; these only addressed free rider impacts; not spillover. The authors found that the most widespread approach to measuring free riders and spillover was through surveys where respondents self-report the impact of the program on their actions. Many of the early studies asked a single yes/no question to determine free ridership. By 2002, methods of inquiry were more sophisticated, with a string of questions and answers to understand partial free riders.

The methodology to assess free riders has been developing over many years, but the assessment of spillover is a more recent development. Vine in 1993 noted that free drivers (customers who install spillover measures) are more likely to be a significant problem for programs in existence for several years with high participation levels and that *"research on free drivers is limited."*[8] He suggested that there were three approaches available to enhance measurement of free drivers: (1) use a historical baseline from the early years of the program; (2) use survey methods – non-participants and trade ally interviewing; and (3) use community(ies) outside the area as a comparison group. A study done by Quantec in 2002[9] provides a snapshot of what was happening about a decade later, finding several studies on free riders but few on free drivers. The study also found there was no agreement on the best way to measure free riders and spillover and no regulatory agreement on which impacts required estimation.

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[5] Weiss, Carol H. (1998). *Evaluation 2nd Edition: Methods for Studying Programs and Policy*. Upper Saddle River, New Jersey: Prentice Hall.

[6] Weiss, p. 12.

[7] Weiss, p. 14.

[8] Vine, Ed. *The Human Dimension of Program Evaluation.* Lawrence Berkley Lab, LBL-33601, 1993.

[9] Quantec, *Assessment of Energy and Capacity Savings Potential in Iowa Volume 2: Free Riders and Spillover – A Look Back, A Path Forward,* prepared for the Iowa Utility Association, 2002.

A notable feature of recent evaluation history is the growth of activity at state and local levels, the increasing use of qualitative methods for evaluation, and the development of professional associations in evaluation. According to Weiss in 1998, "*Not too long ago the only kind of evaluation with professional legitimacy…was quantitative evaluation, preferably using randomized experimental design.*"[10] However, some evaluators relied more on words than on numbers and did not collect data through stricter interview questions or quantitative records and their books and articles provided a "*spirited exchange with supporters of quantitative methods.*" Eventually, many key figures in evaluation concluded that there was room for both approaches and that they could complement each other. A common attribute of the quantitative approach is the collection of information through standardized instruments and usually include one or more comparison groups. The classical means to assess attribution is through a randomized experiment; without this ability, the evaluator uses a quasi-experimental design.[11] All of the methods discussed in this chapter, including self-report, are quantitative.

3.2 Methods to Assess Free Riders and Spillover

This section compares and critiques the key methods to assess net program impacts – self-report, econometric, and market share approaches.

Methods to estimate free ridership and spillover range from assuming a net-to-gross ratio (NTG) of 1.0 to triangulation of several methods (e.g., California's enhanced protocol). Iowa uses a NTG ratio of 1.0 based on a study done in 2002,[12] currently being updated by Summit Blue as part of a technical potential study. The new study is reviewing the literature on attribution and selected evaluation studies and found that several jurisdictions that look at both free riders and spillover are finding NTG ratios of about 1.0 (see Table 3-1)[13] and will likely recommend that "*this policy should not be changed.*"

In the early days of attribution research, spillover was not often considered but over the past few years more and more jurisdictions are taking spillover into account along with free ridership. It is increasingly viewed that if programs are going to see their results discounted for free ridership that a more accurate view of net impacts can be had by adding in spillover.

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[10] Weiss, p. 14.

[11] Vine, Ed. *The Human Dimension of Program Evaluation.* Lawrence Berkley Lab, LBL-33601, 1993.

[12] *Assessment of Energy and Capacity Savings Potential in Iowa Volume 2: Free Riders and Spillover – A Look Back, A Path Forward*, prepared for the Iowa Utility Association by Quantec, July 25, 2002.

[13] Personal correspondence with Gary Cullen, Summit Blue Consulting, October 2007.

Table 3-1. Selected Findings on NTG Ratios

		NTG Ratio
Residential	Efficiency Vermont[14] Energy Trust of Oregon[15]	1.19 1.00
Non-residential	NYSERDA (overall)[16] NYSERDA (CIPP)[17] Wisconsin Power & Light (Shared Savings)[18]	1.09 0.97 0.91

It is difficult to capture long-term market effects with an annual assessment of free ridership. A study done for Massachusetts regulators[19] noted that an annual snapshot of free-ridership and spillover measured without adequately considering the market effects associated with over a decade and a half of energy efficiency programs in Massachusetts will result in potentially biased estimates of net savings. Energy efficient technologies having high market share and few alternatives as a result of these market effects can mean energy efficiency programs now will have high free-ridership.

However, many other jurisdictions do conduct studies to assess the annual impact of free ridership and spillover using several methods. The most common methods used are described briefly below and in more detail in the rest of the section.

- **Self-Report** methods rely on responses to survey questions asking end users and/or vendors what they would have done in the absence of the program support. These methods are primarily used to determine if participating end users would have installed program measures without the program. However, these methods can also determine what additional efficiency improvements participating customers have made outside the program, how participating vendor sales practices would have been different without the program, and how nonparticipating vendor and customer practices have changed since the advent of the program.

- **Econometric Methods** consist of statistical models that compare participants' and non-participants' energy and demand patterns, their knowledge about efficiency options, and/or the trade-offs they are willing to make between efficiency options and the costs of purchasing and installing them. They

[14] *Final Report: Phase 2 Evaluation of the Efficiency Vermont Residential Programs*, prepared for the Vermont Department of Public Service, prepared by KEMA, Inc, December 2005.

[15] *2003-2004 Home Energy Savings Program Residential Impact Evaluation,* prepared for the Energy Trust of Oregon, prepared by Itron, Inc., December 2006.

[16] *New York Energy $mart Program Evaluation and Status Report for the Year Ending December 31, 2006*, New York State Energy Research and Development Authority, March 2007.

[17] *Commercial/Industrial Performance Program (CIPP) Market Characterization, Market Assessment and Causality Evaluation*, prepared for New York State Energy Research and Development Authority by Summit Blue Consulting and Quantec, April 2006.

[18] *Shared Savings Decision-Making Process Evaluation Research Results,* prepared for Wisconsin Power & Light by Summit Blue Consulting, April 11, 2006.

[19] *Standardized Methods for Free Ridership and Spillover Evaluation – Task 5 Final Report (Revised).* (PA Consulting Group Inc. 2003).

include billing analysis, econometric models, and discrete choice models and often include survey inputs as well as other non-program-related factors such as weather and rates.

- **Billing analysis** determines the effect of efficiency measures and/or a program by analysis of (usually monthly) consumption data from participating customers, often along with similar data for nonparticipating customers.
- **Other econometric models** expand on billing analysis methods to compare participants' and non-participants' energy and demand patterns, adjusting for external variables that could account for changes in use and patterns.
- **Discrete choice analysis** uses data on equipment or practice choices by participating and nonparticipating customers together with other information about customers to model choices participants would have made in the absence of the program.[20]

- **Market share methods** include the *market sales* approach which relies on aggregate data of total sales of a particular technology in a specific location, and compares this sales volume with a baseline estimate of the volume that would have been sold in the absence of the program. This method is generally used to assess transformations of markets and depends on completeness and accuracy of sales data and the validity of the baseline estimate. A similar method is *saturation data analysis* which uses observations at two points in time of the share of existing equipment stock that is high efficiency. Translating these successive observations into incremental attributable sales requires information (estimates or assumptions) about equipment turn-over rates, stocking practices, and changes that would have occurred over the time period without the program. Collecting reliable saturation data is typically expensive and not repeated frequently.

3.2.1 Econometric Methods

Billing analysis involves the use of multivariate regression models with historical utility billing data (kW and kWh) to calculate annual demand and energy savings. In general, billing analysis is used with complex equipment retrofits and controls projects and provides retrofit performance verification for projects where whole-facility baseline and post-installation data are available. Billing analysis usually involves collecting historical whole-facility baseline energy use data and a continuous measurement of the whole-facility energy use after measure installation. Energy consumption is calculated by developing statistically representative models of historical whole-facility energy consumption, and the model yields statistically adjusted engineering coefficients to modify gross engineering estimates and calculate net energy impacts.

The advantage of billing analysis is that it estimates the magnitude of net impacts rather than a fraction of total impacts attributable to the program; however, the method also has limitations. The net billing model specification incorporates both participants and nonparticipants into one model, and the resulting sample is not randomly determined. In particular, participants self-select into the program and therefore are unlikely to be randomly distributed; the unobserved characteristics that influence the decision to participate must be accounted for in the model to avoid producing biased coefficient estimates. The Inverse Mills method which includes a ratio in the model to account for self-selection was developed to

[20] Delphi methods which collect judgmental estimates from a panel of experts and develop a consensus or central range estimate are typically used only if more objective methods are not available.

correct for this bias but has several limitations: 1) large customers can exert such a significant influence that they overly bias results; 2) the usable sample is reduced by the need for good historical billing data for each customer; and 3) the method does not produce an estimate of spillover, rendering it an incomplete model of net impact[21]. Billing analysis also depends on finding a comparable non-participant population, which can be very difficult for custom projects. It also will have difficulty identifying energy savings if the expected savings are a small percentage of the total facility energy use or if other major events occur at facilities that significantly affect energy use (e.g., changes in plan schedules, adding new or closing old production lines).

Other econometric models expand on billing analysis methods to compare participants' and non-participants' energy and demand patterns, adjusting for external variables that could account for changes in use and patterns. Econometric models are used to analyze co-relational relationships, usually with the hope of determining causation. They are used to estimate macroeconomic trends and in microeconomics to estimate virtually any sort of social relationship (much as metric models, involving these same regression techniques, are used in other social sciences). The use of statistical/econometric models to estimate net impacts can avoid both the concern over the potential for bias and cognitive dissonance issues with survey research by analyzing participant and non-participant actions, characteristics and attitudes to predict free ridership and spillover. The disadvantage of this method is its inability to estimate spillover upstream in the distribution channel. A robust statistical analysis includes surveys designed to minimize self-reporting bias while collecting data on other program and participant characteristics. This level of sophistication requires a relatively large expenditure on evaluation, which can impact the cost-effectiveness of a marginal program. In California, econometric methods are preferred in situations with enough participants and comparable non-participants, and when the program is large enough to justify the expense. However, programs with either a very small number of participants or non-participants or where comparability is a severe problem are not amenable to these methods and need to rely on a survey-based method. Ed Vine of the Lawrence Berkeley Lab[22] identified the key analytical issue to assess the NTG ratio is determining an appropriate control group. Certain types of building, e.g., large industrial firms, may have unique facilities that have no comparative buildings, for example.

Another method of estimating the net-to-gross ratio is a two-stage **discrete choice model**. Discrete choice analysis uses data on equipment or practice choices by participating and nonparticipating customers together with other information about customers to model choices participants would have made in the absence of the program. This model is used to simulate the decision to purchase various types of commercial equipment. Once estimated, the model is used to determine the probability of purchasing high-efficiency equipment in the absence of the program. The probability of purchasing any given equipment option A can be expressed as the product of two probabilities—the probability that a purchase is made multiplied by the probability that equipment option A is chosen given that a purchase has been made. This method can work when the equipment examined is relatively simple in description and where choices exist in the market for different efficiency levels for that piece of equipment. Thus this can work well with prescriptive rebate programs where the types of equipment that meet and do not meet program requirements can be spelled out in detail ahead of time. Given that custom programs *by their very nature* do not follow this pattern, discrete choice models do not function well attempting to make sense of the choices involved in their necessarily more complex systems.

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[21] Torok 1999.

[22] Vine, Ed. *The Human Dimension of Program Evaluation, Lawrence* Berkley Lab, LBL-33601, 1993

3.2.2 Self-Report Surveys

Generally, the simplest and lowest cost NTG method is using the survey-based stated intentions method with a telephone survey for data gathering. Although research has shown that this method can provide biased results, coming at the question of what the participant would have done in the absence of the program from a variety of different perspectives (directly asking, decision-making criteria, where they were in the process, etc.) and assessing these together is one way the survey methods have used to triangulate on the correct construct.[23].

The self-report approach used in the current study was based on Summit Blue's assessment of approaches taken in a variety of jurisdictions. Much of that research has been summarized in a paper by Schare and Ellefsen (2007)[24] that discusses the approach used to estimate free ridership for several New York State Energy Research and Development Authority (NYSERDA) programs The method used for NYSERDA evolved from previous NYSERDA evaluations and work done in California (described in more detail in the following section) and Massachusetts.

In 2002, Massachusetts regulators asked for a study to create a standardized free ridership survey method to be used by all Massachusetts utilities for program evaluations.[25] The objective was to develop standardized sampling techniques, data collection approaches, survey questions, survey instrument(s), and an analysis methodology that each of several sponsors[26] can use to determine free-ridership and spillover factors for C&I programs. This standardization project was designed to provide a methodology to meet the regulatory requirements to report annual program impacts (along with disaggregated free-ridership and spillover values)—an annual snapshot of the market as it currently operates.

The approach used in the current study was enhanced in subsequent studies of Wisconsin Power and Light's Shared Savings program and Arizona Public Service programs.

The method used in the current study overcomes a key limitation of self-report approaches—the difficulty of systematically converting opinions of participating customers into quantifiable free ridership values. It also provides a highly defensible approach to estimating net program impacts, which are critical inputs to benefit-cost analyses and policy decisions on the direction of energy efficiency programs.[27] The approach is based on participant self-reports and offers unique benefits of a clearly defined and repeatable method to quantify free ridership, while also incorporating qualitative information from program participants often used only as supporting illustration. The core principles of the approach include the following:

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[23] TecMarket Works, *California Energy Efficiency Evaluation Protocols: Technical, Methodological and Reporting Requirements for Evaluation Professionals*, April 2006.

[24] Schare, S. & Ellefsen, J. *Advancing the "Science" of Free Ridership Estimation: An Evolution of the Self-Report Method for New York Energy $mart[SM] Programs, 2007.*

[25] *Standardized Methods for Free Ridership and Spillover Evaluation – Task 5 Final Report (Revised).* (PA Consulting Group Inc. 2003).

[26] National Grid (Massachusetts Electric, Nantucket Electric), NSTAR Electric, Northeast Utilities (Western Massachusetts Electric), Unitil (Fitchburg Gas & Electric Company), Cape Light Compact).

[27] Schare, S. & Ellefsen, J. Advancing the "Science" of Free Ridership Estimation: An Evolution of the Self-Report Method for New York Energy $mart[SM] Programs, 2007.

- Set the stage with the respondent by talking about the various ways the participant interacted with the program (including, for example, technical assistance, training, and financial incentives).

- Direct estimation of free ridership from the perspective that is most appropriate for the **project** and to which the respondent can best relate his program experience. This takes the form of either the likelihood that the high-efficiency measures would have been installed without the program, or the share of high-efficiency measures that would have been installed without the program.

- Separate estimation of free ridership addressing the complete project across all measure types and, alternatively, addressing decisions to install specific measures. The dual line of questioning allows respondents to provide a big-picture view of the program's influence on the project as well as to focus on specific measures, which may have been influenced by the program to varying degrees.

- Quantitative incorporation of qualitative responses based on interviewers' probing for details and causality. This aspect of the approach relies on experienced interviewers who are able to apply appropriate judgment to assign influence scores reflecting the degree to which the program affected equipment-purchasing decisions.

- Ask supporting or influencing questions that could be used to verify whether direct responses are consistent with participants' views of the program's influence.

The theory behind attribution analysis is that only impacts caused by the program should be included in net savings estimates; however, absolute proof of causality is unattainable since one can never observe what would have happened in the absence of the program. Consequently, causality "must be justified or rationalized on the basis of *a priori* argument, outside evidence, intuition, theory, or some other informal means."[28] The necessity of this approach to attribution analysis, relying in part on intuition and outside assumptions, is supported by Heckman in his argument that "there is no mechanical algorithm for producing a set of 'assumption free' facts or causal estimates based on those facts."[29]

3.2.3 Triangulation of Methods

California's new evaluation protocols for NTG impact evaluation rely heavily on self-report methods but require triangulation of methods for the enhanced level of rigor. In 2006-2007, California awarded contracts to over 70 consulting firms to perform impact evaluations of all IOU energy efficiency programs; as part of this process the CPUC supported the development of an Evaluation Framework[30] and a set of protocols[31] developed by a NTG Working Group composed of industry leaders in the evaluation field[32]. The Evaluation Framework notes that NTG can be expected to vary depending upon the maturity

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[28] Moffitt, R., "*Causal Analysis in Population Research: An Economist's Perspective*," Johns Hopkins Univ., 2003.

[29] Heckman, J., "Causal Parameters and Policy Analysis in Economics: A Twentieth Century Retrospective," *The Quarterly Journal of Economics*, Volume 115, No. 2, 2000, pp. 45-97.

[30] TecMarket Works, *The California Evaluation Framework*, Southern California Edison, 2004.

[31] TecMarket Works, *California Energy Efficiency Evaluation Protocols: Technical, Methodological and Reporting Requirements for Evaluation Professionals*, April 2006.

[32] Summary of Guidelines for Estimating Net-To-Gross Ratios Using the Self-Report Approach, Self-Report_NTG_Checklist_Ridge for CA_sept 07

of the equipment or service, type of delivery in the program, maturity of the program, and customer sector. The California documents classify NTG methods as econometric (comparing participant and non-participants and adjusting for selectivity biases through econometric models) and survey-based (asking participants what they would have done).

California has three levels of rigor that can be applied to NTG analysis—basic, standard, and enhanced. Participant self-report through surveys is the required method for the basic level of rigor; for the standard level of rigor, one of three methods can be used (billing analysis, self-report, econometric or discrete choice). The enhanced level requires triangulation using more than one of the methods in the standard rigor level. The enhanced level must include analysis and justification for the method for deriving the triangulation estimate from the various methodologies used.

Guidelines were developed for using the self-report method to estimate NTG ratios; these are consistent with Summit Blue's methodology:

1) identify the correct respondent
2) use multiple questions
3) assess validity and reliability of each question
4) include consistency checks
5) make the questions measure-specific
5) include and document partial free-ridership
6) assess deferred free-ridership [This is equivalent to EGD's "advancement" approach – see the discussion under section 2.1]
7) develop scoring algorithms
8) explain handling of non-responses and "don't knows"
9) weight the NTG for size of impacts
10) report precision of the estimated NTG
11) pre-test the questionnaire
12) use multiple respondents
13) consider third-party influence.

3.2.4 When to Use Market Share or Self-Report

Market sales methods can also be used to estimate free riders and spillover. A study done for Wisconsin Focus on Energy in 2006[33] developed an approach to assist in determining whether market sales or self-report methods are appropriate for net-to-gross assessment of results for various programs. The screening criteria outlined below provide a description of the screening process used to determine which method to use. For the first two criteria, the quality of available data depends in part on the details involved in data collection which in turn depends on resources available.

[33] *Net-to-Gross Method Selection Framework for Evaluating Focus on Energy Programs*, Goldberg M.L., Bloch, O., Prahl, R., Sumi, D., Ward, B., Winch, R. and Talerico, T., March 16, 2006.

Table 3-2. Screening Criteria for Self Report versus Market Share NTG Approaches

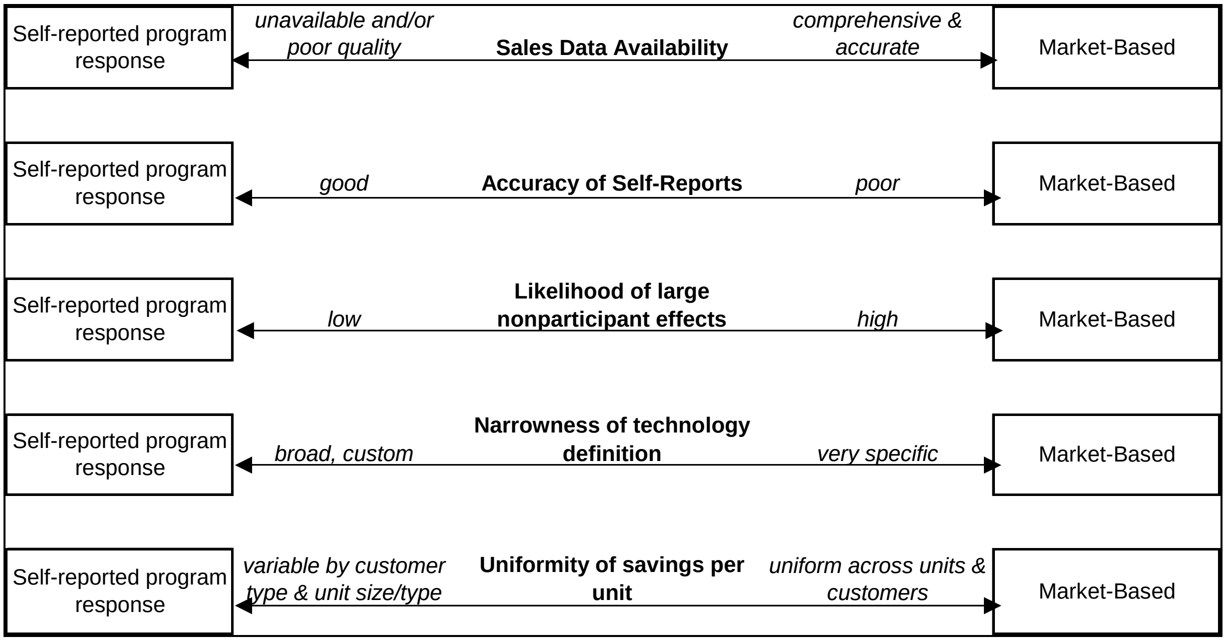
Screening Criteria	Example Screening Questions
Sales Data Availability: The availability of current and baseline market sales data enables estimating free ridership based on such data.	Are current and baseline data readily available? Are the data comprehensive and complete? Able to supplement/overcome shortcomings in data with other data collection techniques? Is the baseline estimate reliable?
Accuracy of Self-Reports: The ability of end users and vendors to report accurately what would have occurred in the absence of the program enables the use of program-response self-report methods.	Can end users/vendors accurately report what would have occurred without program? Supply-side actors can comment on programmatic versus non-programmatic influence on market? Has program altered the supply side in ways a participant would not be able to recognize?
Likelihood of Large Non-participant Market Effects: The likelihood of substantial non-participant market effects may indicate a need for applying methods for adequately capturing such effects.	Is the scale of program large relative to overall market? Are primary sales driving components (promotions, incentives) available at a consistent level throughout the year? Does the program have broad reach across market niches? Does program theory predict significant non-participant effects?
Narrowness of Technology Definition: A market data approach is suggested if the technology is a single type and well-defined, versus encompassing multiple categories, types, or wide variations.	Does program offer “custom” solutions (broad definition) or “prescriptive” measures (narrow definition)? Does program target specific technologies (narrow definition) or a broad range of technologies (broad definition)?
Uniformity of Unit Savings: The choice of method is guided by whether savings per unit is sufficiently consistent across types of units & customers to adequately quantify in terms of total units sold, or needs information on unit characteristics by customer type.	Do units promoted through the program come in widely varying size ranges/savings levels? Is an engineering estimate of necessary? Large variation in customer application of measures? Do savings per unit vary by customer application? Expect savings to vary widely by customer?

Source: Goldberg M.L. et al Net-to-Gross Method Selection Framework for Evaluating Focus on Energy Programs, March 2006.

Taken together, these factors can indicate an overall preference for one method or another. In some cases, the preference will be clear-cut. In others, the two methods may be nearly equally good—or nearly equally poor. The diagram in Figure 3-1 below indicates for each criterion what condition points toward use of market sales approaches and what condition points toward self-reported program responses.

By definition, measures implemented in custom programs do not fall into easily defined buckets for which market sales can be easily or accurately estimated. Even if discrete pieces of equipment can be identified, obtaining relevant and adequate market sales information can be very difficult.

Figure 3-1. NTG Method Selection Screening Criteria[34]



3.2.5 Overview of Pros and Cons

The survey approach is the most straightforward way to estimate free ridership and spillover and is usually the lowest cost approach. As noted by the NAP Guidelines…"survey methods can be used with any program regardless of the number of participants" whereas econometric methods "can only be used with programs with large numbers of participants because the models need large amounts of data to provide reliable results".[35] In California, econometric methods are preferred in situations with enough participants and comparable non-participants, and when the program is large enough to justify the expense. However, programs with either a very small number of participants or non-participants or where comparability is a severe problem (such as industrial plants with unique facilities) are not amenable to these methods and need to rely on a survey-based method[36]. Market share methods are generally used to assess market transformation programs or in situations where participation is not well defined.

Table 3-3 below shows an overview of the pros and cons of all of the methods discussed above.

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[34] *Net-to-Gross Method Selection Framework*, ibid, Figure 1 p. 4.

[35] National Action Plan for Energy Efficiency. Model Energy Efficiency Program Impact Evaluation Guide 2007.

[36] Vine, Ed. *The Human Dimension of Program Evaluation*, *Lawrence* Berkley Lab, LBL-33601, 1993

Table 3-3. Comparison of Free Rider and Spillover Methodologies

Methodology	Pros	Cons
Billing Analysis	Quantitative estimates of magnitude of net impacts from statistically valid methods based on historical billing data.	Includes participants and non-participants in one model; sample not randomly determined due to self-selection. Could produce biased coefficient estimates if unobserved characteristics, which influence decision to participate, are not accounted for. Needs good historical data for each customer and this can reduce the number of data points. Large customers can overly bias results.[37]
Other Econometric or Discrete Choice Methods	Useful for programs that seek to transform the market. Modeling can provide more accuracy because tests for bias and precision can be included.	Econometric models need good historical data for each customer and this can reduce number of data points. Also needs data to account for variables that might be influencing the results. For discrete choice models it is difficult and costly to get accurate data on types and efficiency levels of existing equipment.[38] Neither method includes trade allies effects.
Self-Report	Simpler and less expensive than all other approaches. Can use all data points unlike billing or econometric analysis which requires historical data. Can be used in a variety of situations. Directly addresses the behaviours the program is seeking to affect. Flexible and so can take into account the complexities of program-participant interaction.	Potential for non-response bias, limited respondent recall of program influence on decision-making, and potential investigator bias in translating responses into free ridership values. Tends to underestimate spillover.
Market Share Approaches	Addresses trends in the entire market for equipment.	By definition, measures implemented in custom programs do not fall into easily defined buckets for which market sales can be easily or accurately estimated. Even if discrete pieces of equipment can be identified, obtaining relevant and adequate market sales information can be very difficult.

[37] Torok, C., Cavalli, J. and O'Drain, M. *Any Way You Slice It: Issues of Behavior and Influence in Net Impact Analysis*, 1999.

[38] Kandel, A. *Theory-Based Estimation of Energy Savings from DSM, Spillover, and Market Transformation Programs Using Survey and Billing Data*. Program Measurement and Evaluation, 2002.

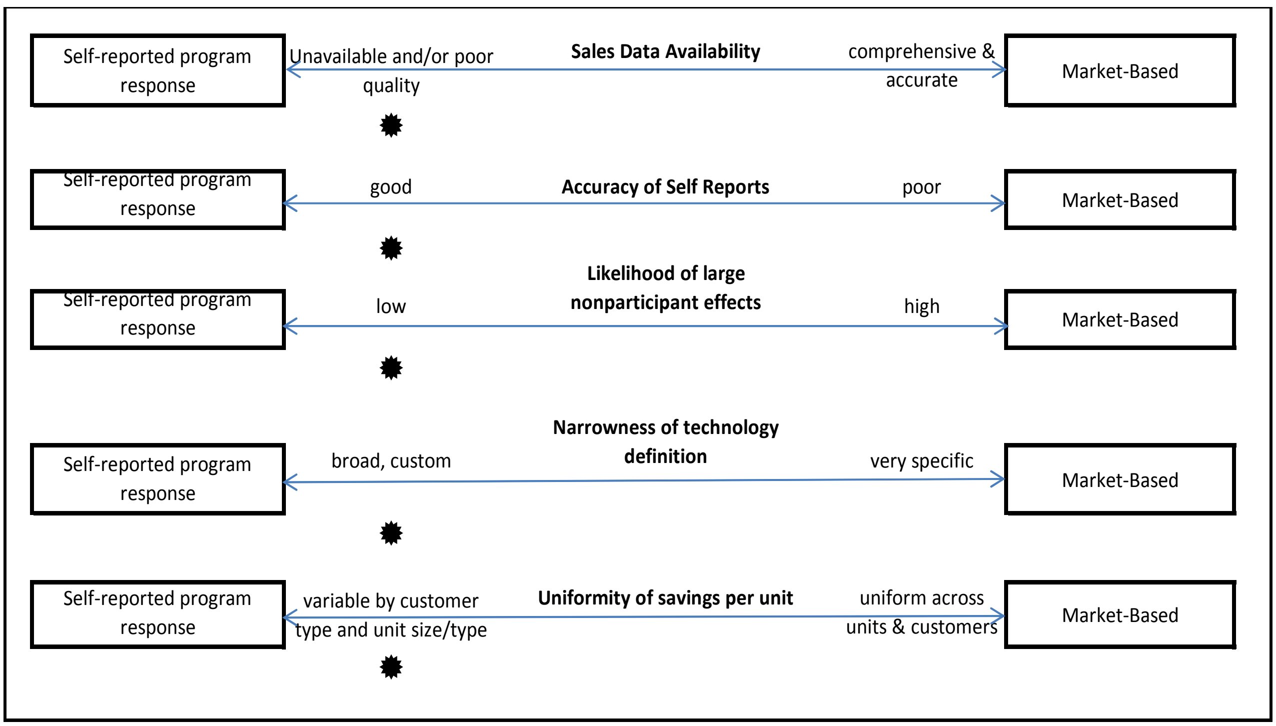
3.3 Best Method to Assess Union-Enbridge Custom Projects Free Riders and Spillover

This section applies the information discussed in the previous section about various methodologies to the Union-Enbridge research requirements to determine NTG for custom projects with large industrial and commercial customers.

It is clear that neither discrete choice models nor market share methods are appropriate methodologies for this research. Discrete choice models must focus on clear, standardized equipment choices. However, the Custom Projects measures are by definition custom and not easily placed into categories that are amenable to discrete choice analysis.

Applying the NTG method selection criteria to the custom projects program, as shown in Figure 3-2 below, clearly indicates that the self-report method is preferred over the market share approach.

Figure 3-2. Applying NTG Screening Criteria to Custom Projects



The self-report method using interviews with customers is more appropriate for this research than billing analysis or other econometric models. Table 3 compares self-report to the other two methods (combined as pros and cons are similar) based on relevant program characteristics. For example, the Custom Projects programs offered by Union Gas and Enbridge Gas Distribution are targeted specifically at large commercial and industrial customers and target complex and unique systems rather than offering prescriptive rebates. In addition, in some segments, e.g., agriculture, most eligible customers participate, making the selection of a non-participant group problematic. As shown in the table, there are problems in applying econometric methods which do not occur with self-report methods. The ideal methodology would be to apply California's Enhanced Level of Rigor which requires triangulation of estimates by at least two methods. This approach is very costly however, and still has the problems identified in Table 3-3 for econometric models.

Table 3-4. Compare Self-Report to Econometric Methods

Program Characteristic	Self-Report Methods	Econometric Methods
Targets large customers.	In-person or telephone surveys can be used with large customers.	Large customers can overly bias results
Non-participants difficult to identify.	Does not require non-participant data for free ridership or inside spillover.	Requires both participants and non-participants in analysis.
May not detect savings at whole building/facility level.	Targets measure level information.	Energy use data generally only available at building/facility level.
External factors likely to be significant.	Survey accounts for relevant external factors.	Need to collect appropriate data to adjust for external factors.
Focused on process changes rather than equipment.	Survey accounts for changes to processes as well as equipment.	Discrete choice and other models focus on equipment choices.

Based on this assessment, Summit Blue recommends using self-report methodology as described in the Analysis Plan, which modifies the methodology developed for other jurisdictions to the specific Union-Enbridge programs.

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4 SAMPLING AND DATA COLLECTION

This section reports on the sample design and data collection process for the study.

4.1 Participant and Trade Ally Survey

The sample was drawn from customers who participated in the Custom Projects Program between the fourth quarter of 2006 and the third quarter of 2007, inclusive. (As a result, the population of participants shown below will not match numbers reported by the utilities.)

There were 594 projects in the population for EGD and 345 for Union. We completed interviews covering 233 projects. For EGD 156 or 26% of the projects were completed and for Union 77 or 22% , which is an average of 25% across both utilities (see Table 4-1). Multifamily projects represented 35% of the population and 31% of the completed interviews. Industrial projects represented 24% of the projects and 18% of the completed interviews.

Table 4-1. Participant and Trade Ally Sample Disposition

	Population			Completes			Percent of Total		
Sector	**EGD**	**Union**	**Total**	**EGD**	**Union**	**Total**	**EGD**	**Union**	**Total**
Agriculture	39	20	59	9	8	17	23%	40%	29%
Building Retrofit	114	138	252	44	21	65	39	15	26
Industrial	111	114	225	23	19	42	21	17	19
New Construction	58	13	71	24	12	36	41	92	51
Multi-Family	272	60	332	56	17	73	21	28	22
Total	594	345	939	156	77	233	26	22	25
Percent of Total									
Agriculture	7%	6%	6%	6%	10%	7%			
Building Retrofit	19%	40%	27%	28%	27%	28%			
Industrial	19%	33%	24%	15%	25%	18%			
New Construction	10%	4%	8%	15%	16%	15%			
Multi-Family	46%	17%	35%	36%	22%	31%			
Total	100%	100%	100%	100%	100%	100%			

4.2 Audit-Only Survey

The sample was taken from customers who had audits in 2005 to provide the optimal balance between providing enough time for the customers to have acted on the recommendations in the audit and ensuring that the audit is not so far in the past that respondents have trouble recalling details of the recommendations. Because the sample will be based on a single year, the result of the analysis can be expressed in spillover per year.

The audit-only spillover survey and analysis was completed for EGD only as Union Gas was unable to find any companies who had an audit in 2005 and had not implemented one of the recommended measures through the program. As a result, the savings inspired by the Union Gas audits will appear in the program tracking data rather than in spillover. EGD provided a sample of 37 customers who had an audit but did not appear in the tracking data as having implemented a relevant measure. We attempted to complete a survey with each of those customers to estimate spillover and completed 24 surveys (including one who did not recall the audit).

4.3 Non-participant Survey

The utilities provided contact information for 1,228 non-participating customers and Global Target Marketing attempted to contact all customers for a screening interview (see Table 4-2). As expected, many respondents (32%) were screened out because they did not implement a measure since 2005. A further 10% were screened out because they were participants and 26% were screened out because they were not aware of the program. Just over one quarter (26%) had implemented a measure since 2005 and were aware of the program but the measure was not influenced by the program. Together, 94.6% of the respondents were screened out for the reasons stated above, leaving a total of 66 customers, or 5.4% of the total population, who were influenced by the program to implement measures (and did not receive a financial incentive).

These 66 customers were asked to participate in a follow up interview to help quantify savings and 38 agreed (3.1% of the total).

Table 4-2. Non-participant Spillover Screening and Engineering Survey Disposition

	Total		Union Gas				Enbridge Large Volume			
			Commercial		Industrial		Commercial		Industrial	
Screened (Total)	1,228	100.0%	1,078	100.0%	41	100.0%	72	100.0%	37	100.0%
Unaware of Energy Efficiency Program	321	26.1%	297	27.6%	3	7.3%	11	15.3%	10	27.0%
Received Financial Incentives	124	10.1%	88	8.2%	20	48.8%	14	19.4%	2	5.4%
Did Not Install/Modify Equipment Since 2005	398	32.4%	354	32.8%	8	19.5%	26	36.1%	10	27.0%
Installed Measure and Aware Of But Not Influenced By Program	319	26.0%	284	26.3%	6	14.6%	16	22.2%	13	35.1%
Installed Measure and Influenced by Program	66	5.4%	55	5.1%	4	9.8%	5	6.9%	2	5.4%
Agreed To Follow-Up	38	3.1%	33	3.1%	3	7.3%	1	1.4%	1	2.7%
Total Follow-up Interviews	27	2.2%	22	2.0%	3	7.3%	-	0.0%	1	2.7%
Total Providing Savings Estimates	5	0.4%	3	0.3%	2	4.9%	-	0.0%		0.0%

Note: The numbers in the middle rows (between the dark lines) sum to the total in the top row. The last three rows are components of the row titled "Installed Measure and Influenced by Program".

5 FINDINGS

The findings are presented in four parts, representing free ridership and three kinds of spillover, inside, outside, and audit-only. The final section combines the free ridership and spillover into one calculation to produce the final net-to-gross ratio.

5.1 Free Ridership Results

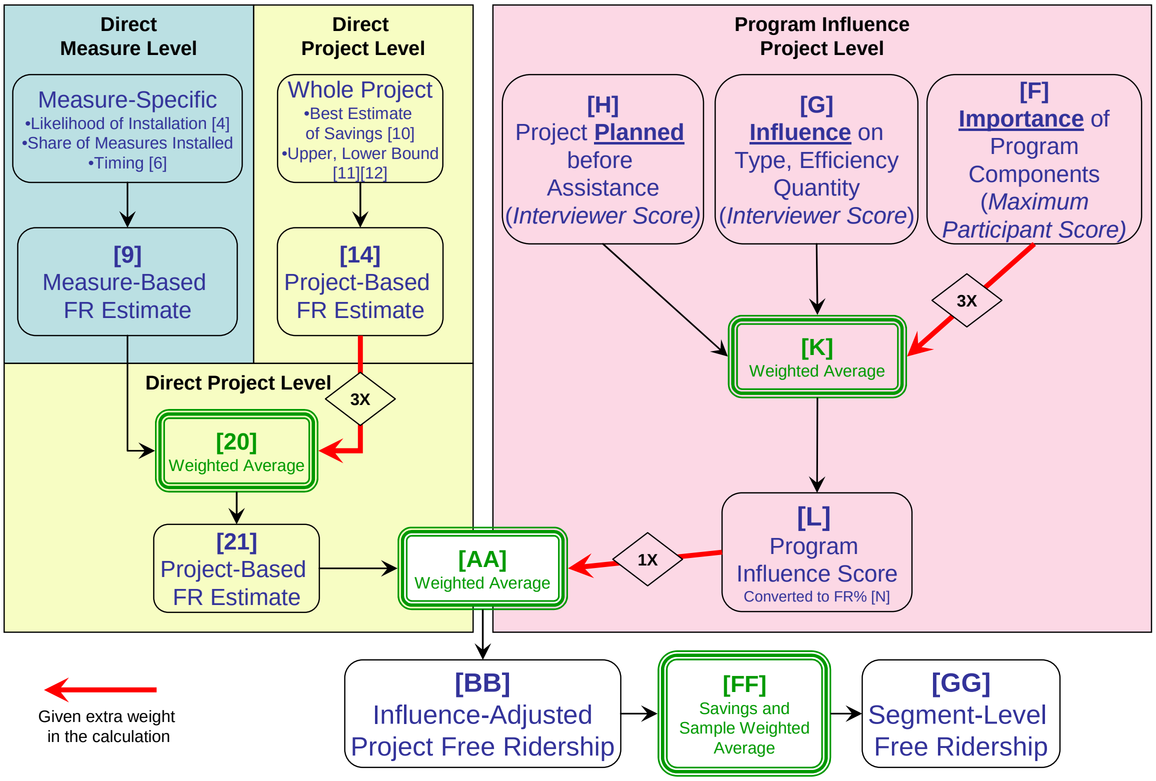
As discussed in the methodology chapter (and in the analysis plan), the calculation of free ridership requires combining answers from several different questions to come up with a single free ridership number for each measure. At several points in the calculation assumptions have to be made about how to combine answers. Should we take the maximum answer from a group of related questions? Should answers be averaged? Should some answers get more weight than others? Some calculation assumptions lend themselves to a clear decision. For example converting a 1-5 score into a free ridership percentage using a straight line conversion seems the obvious choice (where 1=0%, 3=50%, and 5=100%). Other calculation assumptions, do not present a clear answer. For example, when combining the project-based free ridership estimate with the program influence score, should they be averaged? If so, should one carry more weight than another? For those assumptions, we performed a sensitivity analysis, examined the open-ended responses and interview notes, and took into account the program approach to identify the most appropriate calculation approach. The next few paragraphs describe the recommended calculation approach. Following that are the results produced from that approach.

5.1.1 Recommended Calculation Approach

Three assumptions in the calculation had the most effect on the end result and were of the type that required a broad analysis of the program and survey data to suggest the appropriate calculation approach. Those three are shown at [20], [K], and [AA] in the calculation overview diagram in Figure 5-1. After examining all available evidence, we conclude that the most appropriate approach is to give the weights shown in the diamond shapes in those calculations. First, giving triple weight to [14] in the calculation at [20] is appropriate for the following reasons:

- The calculation at [20] averages direct measure level questions [9] and direct project level questions [14]. The direct measure level questions expect the respondent to think discretely about separate components of the project decision. The direct project level question [10] asks them to think about the project as a whole, and considering all program involvement. Given that the utility interacts with the customer over a long period of time, in a variety of ways, and that the measures are typically complex with many factors influencing the decision, it seems less likely that the respondent will be able to successfully think about a component of the decision than about the decision taken as a whole. As a result, the answer to the direct project level question [10] is probably more believable than the measure-based estimate [9]. Because of that conclusion, we weight the project-based estimate more heavily than the measure-based estimate in [20] by a factor of 3.

Figure 5-1. Final Calculation Overview



Second, giving triple weight to [F] in the calculation at [K] is appropriate for the following reasons:

- Point [H] in this calculation is an interviewer score of the amount of planning that went on for the measure before the program got involved. There are several potential weaknesses in the answers to this question that argue for reducing its weight in the calculation at [K]:
  - Program staff were frequently providing assistance to the participants over a long period of time. By the time the measure was installed (and we called on the participant for an interview), respondents may have forgotten the history of the project planning. Those involved in the initial planning may no longer be at the company or in a position to pass along the history of the planning to those ultimately interviewed.
  - Because the program projects are often complex and related to equipment central to a company's output, the fact that plans were in place prior to program involvement does not necessarily imply that the program had no influence. For example, the decision to modify a production line may be driven by changes in the market for their product. Thus plans might be in place to change equipment prior to program involvement but the program involvement could still affect the efficiency of the equipment chosen.
  - Because the program projects are often complex, planning takes place over a long period of time and proceeds through several steps. The program could get involved after initial planning took place – e.g., the decision was made to modify a production line – but before the specifications were written for the equipment affected by the program. Assessing the program's influence on planning in such a circumstance can be difficult to apply in a standard and uniform fashion across projects.

- Point [G] in the calculation at [K] is an interviewer score of the program's influence on the type, efficiency and quantity of the equipment installed. The driving question at [G] was as follows: "Did the assistance you received from [Enbridge/Union] in any way influence your capital funding acquisition process, the type or efficiency level of the equipment or the amount of high efficiency equipment you installed or process changes implemented?" Many of the projects implemented under this program were implemented primarily to address issues other than energy costs. In many cases, the program's hoped-for impact was to increase the energy efficiency of the project rather than inspire the change in the first place. As a result, factors other than energy are often driving decisions about capital funding and the type and quantity of equipment installed and it is unlikely that the program will have much if any affect on those factors. The question at hand was designed to measure the program's influence on those factors in addition to the efficiency of the equipment. This has the effect of diluting the impact of the efficiency issue in the final interviewer score. These weaknesses in this question argue for reducing its weight in the calculation at [K].

- Point [F] represents several questions on the importance of several program components or types of assistance in the participant's decision to install energy efficiency equipment. The questions in [H] and [G] ask the respondent to think about <u>all</u> program assistance as a bundle while focusing on a specific aspect of the decision process. The questions in [F], on the other hand, ask the respondent to think about individual components of program assistance while focusing on the whole decision process. As discussed above, given that the measures are typically complex with many factors influencing the decision, it seems less likely that the respondent will be able to successfully think about a component of the decision (as in [H] and [G]) than about the decision taken as a whole (as in [F]). The [F] series of questions brings in the specific components of the program assistance and, particularly given the drawbacks with [H] and [G], seems more likely to give a more accurate picture of the program's influence.

Finally, giving equal weight to [21] and [L] in the calculation at [AA] is appropriate for the following reasons:

- The conclusions drawn above on [20] and [K] give more weight to questions that address the whole project rather than specific components. They provide two different approaches for the respondent to address the program's influence: estimating savings that would have happened in the absence of the program in [14], and the how important program components were in the decision to install energy efficiency equipment in [F]. Addressing the same general issue from two different perspectives ought to provide a more robust estimate of the true impact.

- Given that the questions at [14] and [F] have already had their weight in the calculation increased, giving more weight to one or the other of these components in the calculation at [AA] would have the effect of ensuring that the final result is largely driven by the answer to one question (or one type of question in the case of [F]). This places too much importance on a single question and is contrary to the philosophy of the general approach which is of triangulating at the answer from a variety of perspectives.

5.1.2 Results

Using the calculation approach defined above produces a total free ridership rate across both utilities and all sectors of 48% as shown in Table 5-1. The free ridership rate for EGD is 41% and it is 54% for Union Gas. Free ridership rates of near 50% are not uncommon in custom programs throughout North America. In a 2006 study Summit Blue performed for Alliant Energy, we found five programs out of 21 with free ridership rates above 40%.[39] Summit Blue recommends that the utilities use the utility-specific total free ridership values of 41% and 54% as the best estimate of free ridership. Those results are based on larger sample sizes than the sector-specific results and proved more stable in the sensitivity analysis. The sector-specific results are based on smaller sample sizes and should only be used to support program management, for example to support targeting and marketing decisions.

Table 5-1. Free Ridership Results

Sector	EGD	Union	Total
Agriculture	40%	0%	18%
Commercial Retrofit	12%	59%	27%
Industrial	50%	56%	53%
Multifamily	20%	42%	26%
New Construction	26%	33%	28%
Total	41%	54%	48%

Assumptions (See Figure 2.1 for the interpretation of these assumptions):

Weight of Participant Reported Importance [F] in [K] compared to the planning [H] and influence [G] scores	Triple weight
Weight of Project-based estimate [14] in [20] compared to the measure-specific scores [9]	Triple Weight
Weight of Program Influence Score [L] compared to the Project-Based score [21]	Equal Weight

5.1.3 Bin Analysis

As discussed above, there are several potential weaknesses in the answers to some of the questions asked of participants. Given that the utility is often involved well in advance of project implementation, it is possible that in the intervening time the institutional memory of the history of the utility's program involvement has been lost. It is also possible that the participant has taken ownership of the information or approach that originally came with support from the utility and now views it as their own, not something brought to them by the utility. Now of course without defining away the possibility of free ridership even existing, we cannot say that prior utility program involvement prior to project implementation is evidence that free ridership does not exist. However, there is one area that is more concrete than simple "prior program involvement" that is worth examining. In some cases, the utilities supported energy audits that looked for and provided support to decisions to implement specific energy efficiency measures. It seems reasonable to conclude that at least in some cases those audits inspired the subsequent installation or modification. It also seems possible that if the audit were some time before implementation, the respondents we talked to may not have been aware of the influence of the audit.

[39] Shared Savings Decision-Making Process Evaluation Research Results. Jeff Erickson, Summit Blue Consulting for Wisconsin Power & Light (Alliant). August 11, 2006.

To examine the possible implications of this issue, we performed a bin analysis. We received from the utilities dates of energy audits or studies done in advance of specific measures that were addressed in our participant interviews. The free ridership savings were placed in two bins based on historical data provided by the utilities. Projects that met any of the following criteria were placed in a "Preceding Audit" bin:

- A utility-sponsored audit or feasibility study preceded the measure implementation and was directly related to the measure installed.
- The same measure had been installed through the program in a previous program year.
- EGD paid part or all of the salary for an on-site energy manager at the facility prior to the measure implementation.

All other projects were placed in a "No Preceding Audit" bin. In this way, on a measure-by-measure basis, we put the m^3 savings that had been defined as free ridership into one of two bins. The results are shown in the following table. As in the previous table, the total free ridership across both utilities is 48% (the bottom right cell in the table). Splitting this into two pieces shows that the total free ridership is made of 25% from projects that had preceding audits and 23% that did not. (Note that 25%+23%=48%, the total free ridership percentage.) The "Preceding Audit" values represent just over half of the total free ridership for the two utilities combined and represent well over half of Union's free ridership.

Table 5-2. Free Ridership Split Based on Preceding Audit

	Preceding Audit			No Preceding Audit			Total		
Sector	**EGD**	**Union**	**Total**	**EGD**	**Union**	**Total**	**EGD**	**Union**	**Total**
Agriculture	6%	0%	3%	34%	0%	15%	40%	0%	18%
Commercial Retrofit	0%	7%	2%	12%	52%	25%	12%	59%	27%
Industrial	12%	44%	31%	38%	12%	22%	50%	56%	53%
Multifamily	0%	0%	0%	20%	42%	26%	20%	42%	26%
New Construction	0%	6%	2%	26%	27%	26%	26%	33%	28%
Total	8%	38%	25%	33%	16%	23%	41%	54%	48%

One possible interpretation of the "Preceding Audit" free ridership values is that they are spillover caused by the audit and the "No Preceding Audit" values are pure free ridership. If the audit altered the participant behavior and/or plans, but the respondent either was not aware of that change or had forgotten about the program's earlier influence, then the "Preceding Audit" values would accurately be described as spillover. If, on the other hand, the earlier measure implementations were also free riders and the audit truly did not significantly affect the decision-making process, then the "Preceding Audit" values would not be spillover.

The preparation for the surveys, the surveys themselves, and the survey process were designed to get to respondents with knowledge of the history of the project and remind participants of their company's past involvement in the program. Given the high free ridership rates, it seemed appropriate to do some additional research in this area. We called back three of the largest participants who had prior audits to verify whether they were aware of the audits and to gauge the impact of the audits on their planning and decision process. In two of the three cases, we judged that our original free ridership estimate was accurate and that the prior audits were not driving factors in the decision. In the third case we adjusted responses from the earlier interview to reflect the new information we received in the follow-up call.

5.1.4 What is Driving the Results?

This section examines various factors that may help explain where the most significant issues with free ridership are.

Sector

Industrial gross m^3 savings represent 84% of the total program savings (Table 5-3) and therefore drive the final results. The Industrial sector accounts for 77% of EGD's gross savings and 89% of Union's.

Table 5-3. Gross m^3 Savings as Percent of Total by Sector

Sector	EGD	Union	Total
Agriculture	3%	3%	3%
Industrial	77%	89%	84%
Multifamily	8%	1%	4%
New Construction	2%	1%	1%
Commercial Retrofit	10%	6%	7%
Total	100%	100%	100%

The EGD Industrial free ridership rate is 50% and Union's is 56% (see Table 5-4, which is identical to Table 5-1). The other EGD sectors have relatively low free ridership rates, with the exception of Agriculture, which is only 3% of the total savings. The other Union sectors (with the exception of agriculture) have fairly high free ridership rates, which explains why the total Union free ridership rate is higher than EGD's, given that their Industrial rates are close.

Table 5-4. Free Ridership Results

Sector	EGD	Union	Total
Agriculture	40%	0%	18%
Commercial Retrofit	12%	59%	27%
Industrial	50%	56%	53%
Multifamily	20%	42%	26%
New Construction	26%	33%	28%
Total	41%	54%	48%

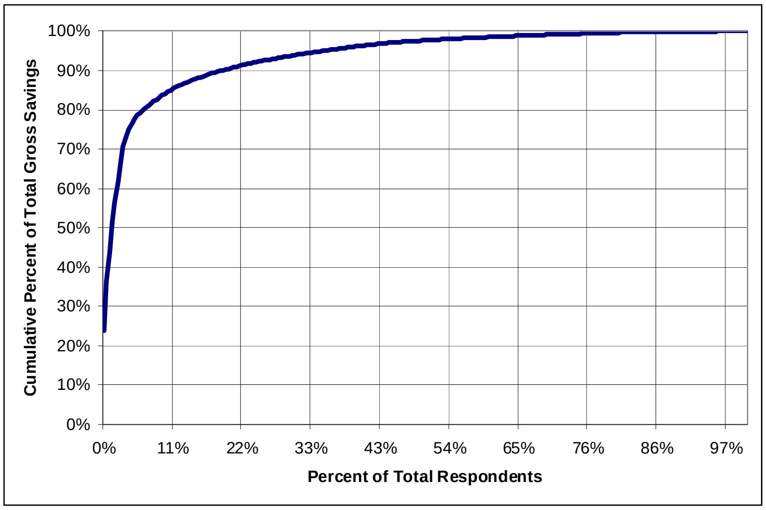
Assumptions (See Figure 2.1 for the interpretation of these assumptions):

Weight of Participant Reported Importance [F] in [K] compared to the planning [H] and influence [G] scores	Triple weight
Weight of Project-based estimate [14] in [20] compared to the measure-specific scores [9]	Triple Weight
Weight of Program Influence Score [L] compared to the Project-Based score [21]	Equal Weight

Company Size

Program gross m^3 savings are concentrated in a relatively small number of participants. The top 10% of respondents based on gross m^3 savings consume 84% of total program savings (among those interviewed) (Figure 5-2). The 15 companies with the most m^3 savings together save 80% of total gross m^3 savings. The free ridership rate for those 15 companies is 56% across both utilities. If we eliminate those 15 companies, the free ridership rate drops to 34%.

Figure 5-2. Cumulative Percent of Gross Savings



Measure Type

Machine/Process measures account for 44% of the gross savings and HVAC measures account for 39%; together they drive the final results. The Machine/Process free ridership rate is 56% and HVAC is 46%. Lighting and "Other" measures have fairly high free ridership rates and Hot Water, Envelope, and Controls have fairly low rates.

Table 5-5. Free Ridership By Measure Type

Measure Type	Free Ridership Rate
Machine/Process	56%
HVAC	46%
Lighting	43%
Other	37%
Agriculture	29%
Envelope	22%
Hot Water	15%
Controls	13%

Assumptions (See Figure 2.1 for the interpretation of these assumptions):

Weight of Participant Reported Importance [F] in [K] compared to the planning [H] and influence [G] scores	Triple weight
Weight of Project-based estimate [14] in [20] compared to the measure-specific scores [9]	Triple Weight
Weight of Program Influence Score [L] compared to the Project-Based score [21]	Equal Weight

Other Observations

There are several factors that influence the free ridership results, which can be loosely categorized into factors that increase free ridership, those that decrease free ridership, and those that reflect well on the program but that do not improve the free ridership value.

Factors that increase free ridership

- In many energy efficiency programs for large, complex projects the utility incentive will typically not be particularly large compared to the overall project cost. As a result, the respondents may feel that it has relatively little impact on the direction of their project. (On the other hand, the existence of an incentive can raise the level of interest and still have an effect even if the incentive is not large.)

- Regardless of the size of the incentive, it can only have an impact on decision making if the potential recipient feels the chances of receiving the incentive are reasonably high. Because custom projects can involve multiple vendors any confusion about who will receive the incentive will reduce its overall impact on the decision process.

- Design Engineers and Energy Performance Contractors see themselves as sophisticated energy users, and pride themselves on being knowledgeable and competent on energy efficiency issues and in providing the most energy efficient solutions to their clients. This may imply that approaches that aim to influence these channels are not as effective in changing existing energy efficiency choices.

- Again because custom projects can involve multiple vendors, some vendors may be insulated from the key decision makers by other vendors. As a result, any program activities targeting these vendors may fail to influence the final decisions.

- Large industrial end-users often have the accounting mechanisms in place to understand the effects of energy use on their bottom line, they require highly specialized technologies for their application, and they have the in-house expertise to identify and evaluate efficient options for those specialized technologies. In addition, there may be a number of very competent consultants and suppliers who assist the industry with energy efficiency and in a number of other technical support areas. For this kind of company, assistance provided by utility programs must stand out in some particular way to be noticed. The subtleties of that assistance may be lost as time goes on and as staff change, making it harder to identify the effects of that assistance when looking back over time.

Factors that decrease free ridership

- The Utility provides an independent third party verification of the predicted savings and this is very valuable in the decision making process in many organizations.

Positive stories, but ones that do not improve the free ridership

- The participants are quite pleased with their involvement with the program, glad to get the Utility’s assistance, and satisfied with the program.

- The Program assistance and incentives help grease the skids, but they do not change the direction or destination of the sled.

- One trade ally reported “The program gives a comfort factor on value of energy efficiency measures. It improves the interaction between the utility and the customer.”

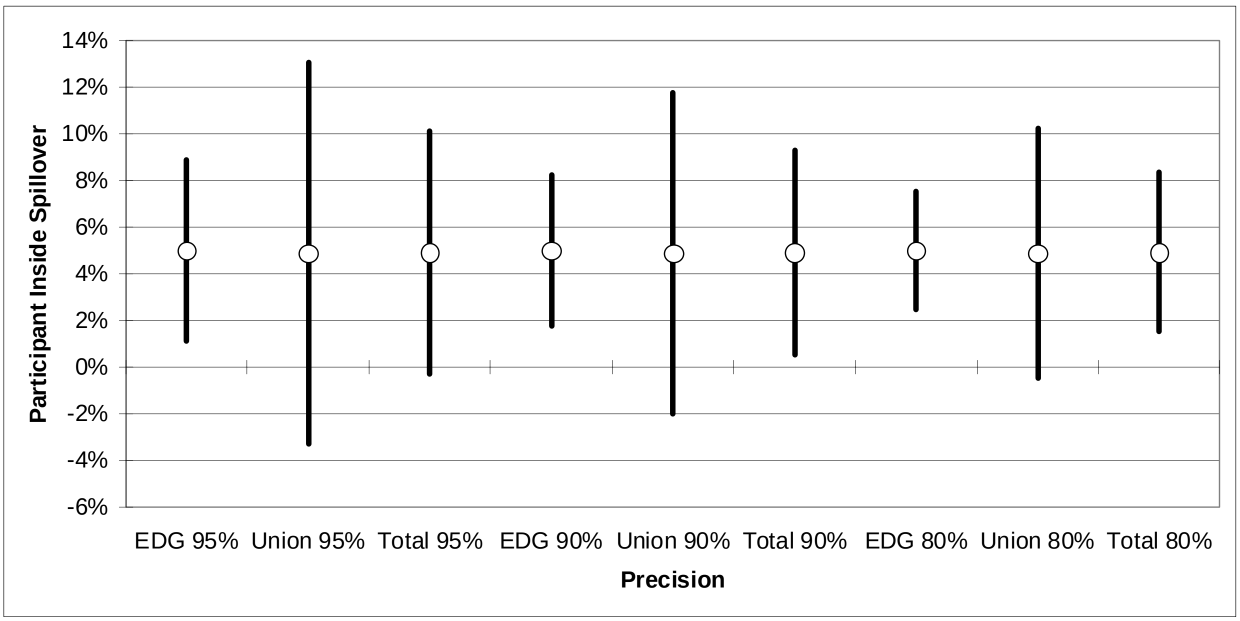
5.2 Spillover Results

Spillover represents energy savings that are due to the program but not counted in program records. Summit Blue estimated **participant inside and outside spillover** through questions in the participant and trade ally surveys and through the Audit-Only Survey. Summit Blue estimated non-participant spillover through the non-participant survey.

5.2.1 Participant Inside Spillover Results

Nine respondents for EGD and five for Union indicated that they had installed additional energy efficiency measures at the same facility without going through the program, those measures count as inside spillover. By extrapolating the m^3 savings from those measures to the population, we calculate that **inside spillover was 5% of gross reported savings for both EGD and Union**. The results for EDG are statistically significant at the 95% level. However, the results for Union are not statistically significant, even at the 80% level. The following figure shows the error bounds around the mean estimate. When the error bounds crosses zero, we cannot say with statistical precision that the results are not zero. The EDG-Union combined total is statistically significant at 90%. Given that the spillover numbers are based on a rather small number of respondents, it is appropriate to calculate spillover across the entire pool of respondents, for Union and EGD combined.

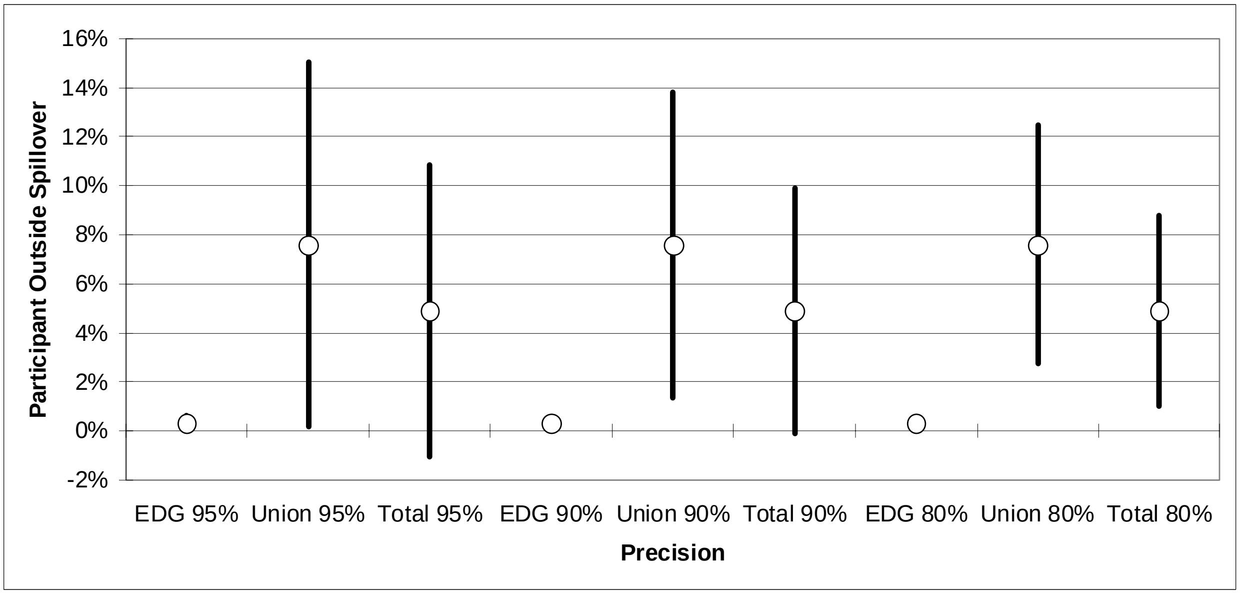
Figure 5-3. Participant Inside Spillover



5.2.2 Participant Outside Spillover Results

Four respondents for EGD and three for Union indicated that they had installed additional energy efficiency measures at *different* facilities without going through the program. Those measures count as outside spillover. By extrapolating the m^3 savings from those measures to the population, we calculate that **outside spillover for Union was 7.6% of gross reported savings, less than 1/2 percent for EGD, and 5% combined across both utilities.** The following figure shows the error bounds around the mean estimate. Given that the spillover numbers are based on a rather small number of respondents, it is appropriate to calculate spillover across the entire pool of respondents, for Union and EGD combined, which is statistically significant at the 80% confidence level.

Figure 5-4. Participant Outside Spillover



5.2.3 Participant Audit-Only Spillover Results

Customers who received an audit, implemented a recommended measure, but did not receive incentives through the program for that measure can be considered audit-only spillover. The audit-only spillover survey and analysis was completed for EGD only as Union Gas was unable to find any companies who had an audit in 2005 and had not implemented one of the recommended measures through the program. As a result, the savings inspired by the Union Gas audits will appear in the program tracking data rather than in spillover. EGD provided a sample of 37 customers who had an audit but did not appear in the tracking data as having implemented a relevant measure. We attempted to complete a survey with each of those customers to estimate spillover and completed 24 surveys (including one who did not recall the audit).

For each respondent, we calculated the share of the recommended measure savings that could be attributed to the influence of the program. 43% of the m^3 savings estimated in the audit were achieved by those who completed a survey. We then applied the 43% savings to parts of the population that can be assumed to follow the same pattern as the respondents (non-respondents and refusals) and assumed zero savings for those who did not recall the audit or whose business was sold or closed (one company was sold, 3 were closed). Summing spillover savings over the whole group then dividing by the sum of the recommended savings gives the final realization rate for spillover savings for the population, which was 35%. **Thus 35% of the gross recommended savings from energy audits are achieved, representing the audit-only spillover.** The total audit-only spillover savings (1,969,700 m^3) will be brought into the final calculation of the program's net-to-gross ratio.

Since the sample was a census of the eligible population there is no need to extrapolate beyond the calculation explained above.

5.2.4 Non-participant Spillover Results

Screening Survey Results. The utilities provided contact information for 1,228 non-participating customers and Global Target Marketing attempted to contact all customers for a screening interview (see Table 5-6). As expected, many respondents (32%) were screened out because they did not implement a measure since 2005. A further 10% were screened out because they were participants and 26% were screened out because they were not aware of the program. Just over one quarter (26%) had implemented a measure since 2005 and were aware of the program but the measure was not influenced by the program. Together, 94.6% of the respondents were screened out for the reasons stated above, leaving a total of 66 customers, or **5.4% of the total population, who were influenced by the program to implement measures** (and did not receive a financial incentive).

These 66 customers were asked to participate in a follow up interview to help quantify savings and 38 agreed (3.1% of the total). Three engineers attempted to contact all 38 customers and conducted interviews with 27 customers (2.2% of the total population and a 71% response rate). Of these, only 5 Union Gas customers (3 commercial and 2 industrial, representing 0.4% of the population) were able to provide enough information to the engineers to enable them to quantify savings. The engineers rated their confidence in the accuracy of their spillover estimates for each project, given the information the respondent was able to provide and the assumptions that they had to make given shortfalls in the data. None of the engineers felt more than modestly confident that the estimates were accurate and several estimates were rated “weak”.

Conclusion. Because of the large size of the sample submitted to the screening effort, the fact that **5.4% of the population had spillover measures** is a meaningful and important result. However, given that we were able to estimate m^3 savings for only 5 respondents, which was less than 10% of those with spillover, and that our engineers were not very confident in the accuracy of the savings calculations, we cannot extrapolate m^3 spillover savings to the population.

Our engineers reported that most respondents could not provide useful information about the equipment installed. As a result, any effort to improve on this effort should include on-site visits by evaluation engineers so that they can directly observe the equipment and collect the data they need to make the savings estimates. This will increase the accuracy of the site-specific savings estimates and will likely increase the number of sites for which estimates can be calculated.

Table 5-6. Non-participant Spillover Screening and Engineering Survey Disposition

	Total		Union Gas				Enbridge Large Volume			
			Commercial		Industrial		Commercial		Industrial	
Screened (Total)	1,228	100.0%	1,078	100.0%	41	100.0%	72	100.0%	37	100.0%
Unaware of Energy Efficiency Program	321	26.1%	297	27.6%	3	7.3%	11	15.3%	10	27.0%
Received Financial Incentives	124	10.1%	88	8.2%	20	48.8%	14	19.4%	2	5.4%
Did Not Install/Modify Equipment Since 2005	398	32.4%	354	32.8%	8	19.5%	26	36.1%	10	27.0%
Installed Measure and Aware Of But Not Influenced By Program	319	26.0%	284	26.3%	6	14.6%	16	22.2%	13	35.1%
Installed Measure and Influenced by Program	66	5.4%	55	5.1%	4	9.8%	5	6.9%	2	5.4%
Agreed To Follow-Up	38	3.1%	33	3.1%	3	7.3%	1	1.4%	1	2.7%
Total Follow-up Interviews	27	2.2%	22	2.0%	3	7.3%	-	0.0%	1	2.7%
Total Providing Savings Estimates	5	0.4%	3	0.3%	2	4.9%	-	0.0%		0.0%

5.2.5 Recommended Spillover Rates

Summit Blue recommends the utilities use following spillover rates:

Table 5-7. Spillover Results

Spillover Type	EGD	Union	Base
Participant Inside Spillover	5%	5%	Of gross reported savings
Participant Outside Spillover	5%	5%	Of gross reported savings
Audit-Only Spillover	35%	0%	Of gross audit-recommended savings
Nonparticipant Spillover	0%	0%	

5.3 Net-to-Gross Ratio

The net-to-gross ratio is defined as 1 - free ridership ratio + spillover ratio. As discussed above, spillover is in several parts: participant inside and outside spillover, audit-only spillover, and non-participant spillover. We know that 5.4% of the non-participants have spillover but cannot calculate its quantity so the calculation of net-to-gross presented below excludes it. Together participant inside and outside spillover amount to 10%. The audit-only savings were 1,969,700 m^3 for EGD, which represents 11% of EGD total gross savings (see Table 5-8). With zero Union audit-only savings, the total audit-only savings equals the EGD savings and the combined audit-only spillover rate is 5%. Subtracting free ridership and adding spillover produces a final **net-to-gross ratio of 79% for EGD, 56% for Union, and 67% across both utilities.** Summit Blue recommends that the utilities use the utility-specific total net-to-gross ratios, as they are based on larger sample sizes than the sector-specific results.

Table 5-8. Net-To-Gross Ratio

Utility	Sector	Gross m^3 Savings	Free Ridership	Participant Inside + Outside Spillover	Audit-Only m^3 Savings	Audit-Only Spillover %	Net-to-Gross Ratio
EGD	Agriculture	1,111,398	40%				
EGD	Commercial Retrofit	3,052,840	12%				
EGD	Industrial	10,028,771	50%				
EGD	Multifamily	1,575,482	20%				
EGD	New Construction	798,310	26%				
EGD	Total	18,588,008	41%	10%	1,969,700	11%	79%
Union	Agriculture	1,387,850	0%				
Union	Commercial Retrofit	1,406,897	59%				
Union	Industrial	14,874,847	56%				
Union	Multifamily	520,974	42%				
Union	New Construction	304,991	33%				
Union	Total	23,209,837	54%	10%	0	0%	56%
Total	Agriculture	2,499,248	18%				
Total	Commercial Retrofit	4,459,738	27%				
Total	Industrial	24,903,618	53%				
Total	Multifamily	2,096,456	26%				
Total	New Construction	1,103,302	28%				
Total	Total	41,797,844	48%	10%	1,969,700	5%	67%

Free Ridership Assumptions (See Figure 2.1 for the interpretation of these assumptions):

Weight of Participant Reported Importance [F] in [K] compared to the planning [H] and influence [G] scores	Triple weight
Weight of Project-based estimate [14] in [20] compared to the measure-specific scores [9]	Triple Weight
Weight of Program Influence Score [L] compared to the Project-Based score [21]	Equal Weight

6 SUPPLEMENTARY RESULTS

The participant surveys included several questions that illuminate the customer's decision-making process, but do not necessarily feed directly into the free ridership calculation. This section will present some of those results, first for end users, next for trade allies, and then at the sector level. Following that will be a brief summary of free ridership, spillover, and net-to-gross results from other jurisdictions.

6.1 End Users

Most (35 out of 40 or 88%) EGD end user respondents have a policy that specifies energy efficiency requirements. 18 target specific energy efficiency levels.

For Union 12 out of 24 (50%) have a policy that specifies energy efficiency requirements (4 target energy efficiency levels).

Table 6-1. Company Has an Energy efficiency Policy

	Missing	Yes	No	Total
EGD	1	35	3	39
Union	0	12	12	24
Total	1	47	15	63

Those who had a policy were asked about the efficiency level stated in the policy. The results are shown in the following table.

Table 6-2. Efficiency Level Stated in the Policy

Efficiency Level Stated in the Policy	EGD	Union	Total
Missing	22	8	30
1	0	1	1
20	1	0	1
35	0	1	1
5 % reduction in energy cost per vehicle	2	0	2
8	1	0	1
80+	0	1	1
84 % efficiency on boilers	4	0	4
86 % for boilers	1	0	1
86 % for boilers; new school perspective specifies nature of any equipment	1	0	1
Better than code but no specific amount set.	2	0	2
Exceed National Building code by 25 % on new buildings	1	0	1
reduce fossil fuels by 15% per year, starting in 2002	0	1	1
Total	35	12	47

Virtually all respondents had criteria for energy efficient equipment.

Table 6-3. Do You Have Criteria For Energy Efficient Equipment?

	Yes	No	Total
EGD	39	0	39
Union	23	1	24
Total	62	1	63

The criteria for approving energy efficiency equipment is predominantly simple payback period (multiple respondents mentioned this). 95% of EGD respondents mentioned payback, 17% life cycle cost analysis, 14% internal rate of return (IRR).

78% of Union respondents mentioned payback, 22% mentioned IRR, 9% mentioned life cycle cost analysis.

Only 7 respondents (3 EGD, 4 Union) changed their energy efficiency policy since the project. The table below shows the changes they made.

Table 6-4. How has your energy efficiency policy changed since the project?

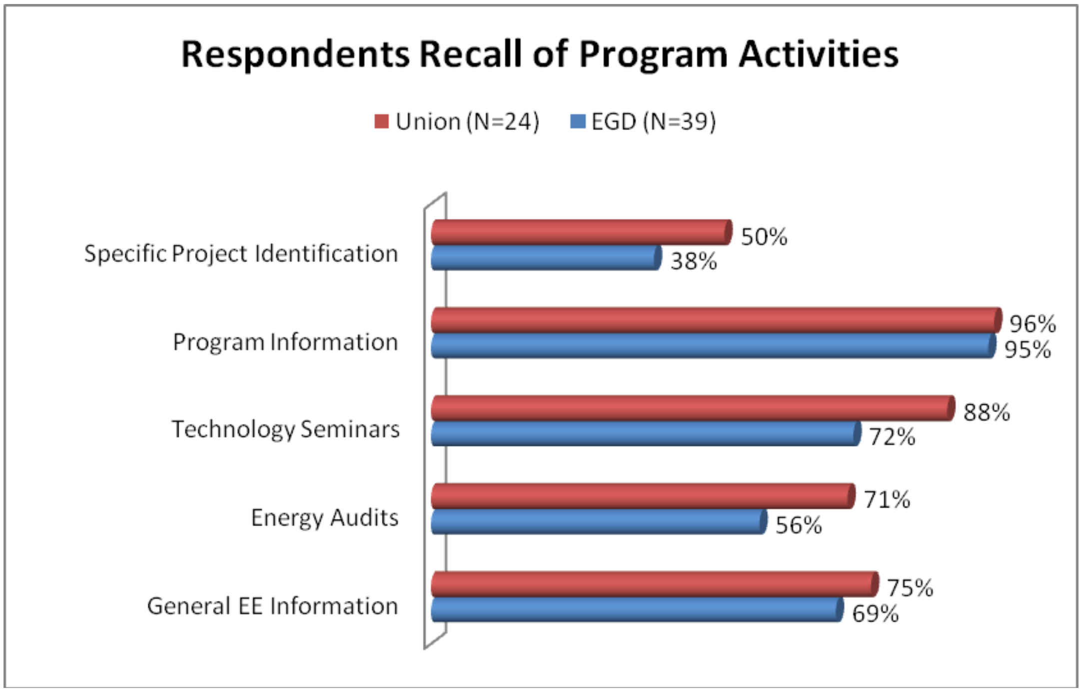
	EGD	Union	Total
EE is now part of their business plan, with a target reduction of 5% annually	0	1	1
Energy wise program has raised awareness of energy efficiency	0	1	1
Greater awareness of need to maintain energy efficiency	0	1	1
Payback has been extended to 5 years	1	0	1
Since the project, the end user has developed a corporate energy policy with a target of a 20% reduction by 2020	0	1	1
Total energy reduction of 6 %	2	0	2
Total	3	4	7

Table 6-5. Percent of respondents recalling program initiative by utility

	General energy efficiency Information	Energy Audits	Technology Seminars	Program Information	Specific Project Identification
EGD (N=39)	69%	56%	72%	95%	38%
Union (N=24)	75%	71%	88%	96%	50%
Total (N=63)	71%	62%	78%	95%	43%

Respondents were asked whether they recalled participating in various program activities. Almost all recalled getting program information (Figure 6-1). Approximately three-fourths remembered going to technology seminars and getting general energy efficiency information.

Figure 6-1. Respondents' Recall of Program Activities



Respondents were asked what the payback was for their project after figuring in the utility incentive. For EGD, 18 of 39 did not respond and 6 had paybacks under a year after incentive (Table 6-6 and Figure 6-2). For Union Gas, 19 of 24 did not respond. Of the 5 who responded, 1 had a payback period under a year.

Table 6-6. What was the project's payback after figuring in the utility incentive?

	EGD	Union	Total
Missing	18	19	37
LT 1 YR	6	1	1
1 to 3 Years	6	3	1
4 to 11 years	9	1	1
Total	39	24	63

6.2 Trade Allies

Consulting Engineers were the most common type of trade ally among the respondents followed by installation contractors (Table 6-7, Figure 6-2, and Figure 6-3). Among our respondents, Enbridge had no manufacturer or distributor/sales as business partners and Union had no property managers as allies.

Table 6-7. Primary Line of Business

	EGD	Union	Total
Consulting Engineer	17	21	38
Installation Contractor	8	6	14
ESCO	5	7	12
Manufacturer	0	8	8
Distributor or Equipment Sales	0	5	5
Property Manager	3	0	3
Other	2	0	2
Total	35	47	82

Figure 6-2. Types of Trade Allies

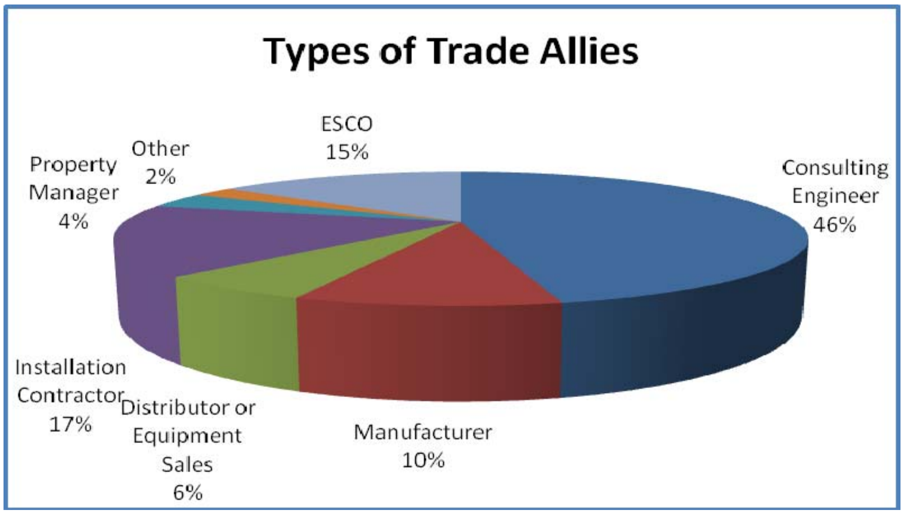
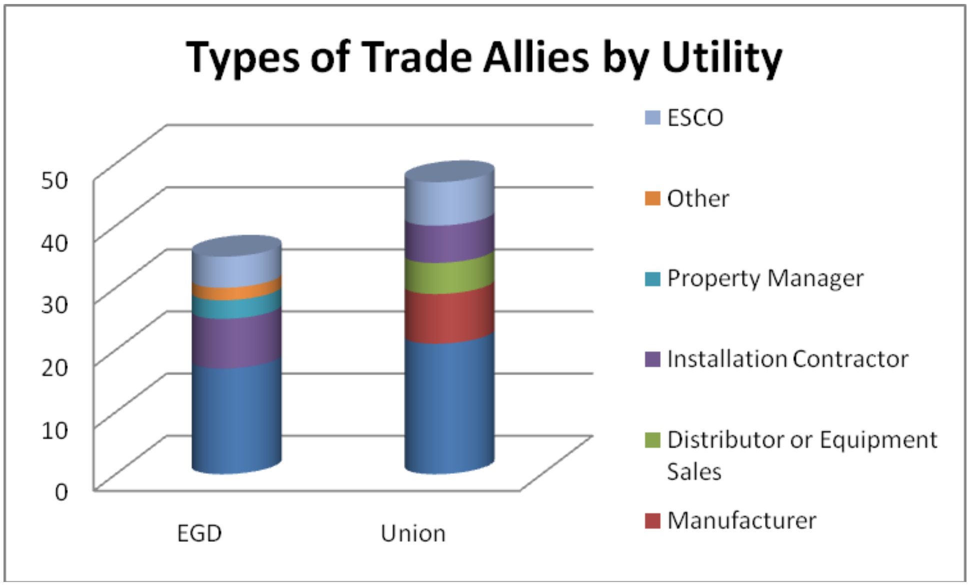
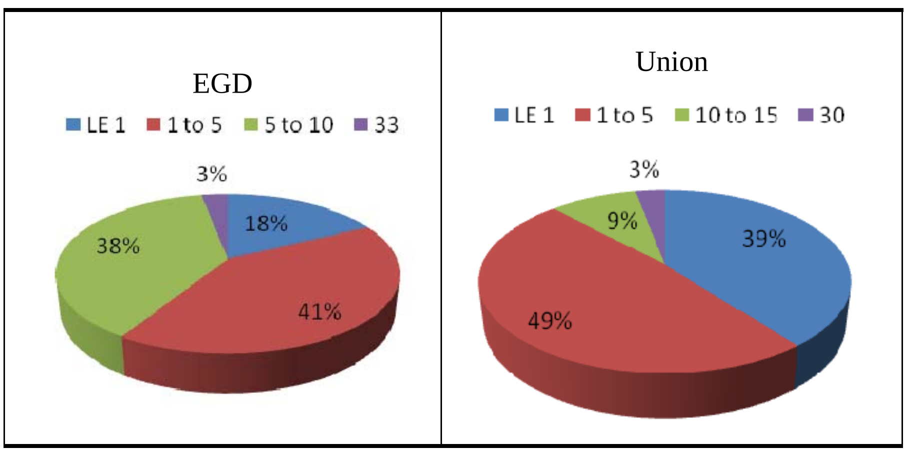


Figure 6-3. Types of Trade Allies by Utility



Respondents were asked to quantify the program incentives as a percent of total project costs. The most common answer was 1-5%, named by just under half of the respondents (Figure 6-4). Over one third of trade allies associated with Union Gas projects thought the incentives were less than or equal to 1%, compared to 18% of the EGD respondents.

Figure 6-4. Incentives as a % of Project Costs



According to the trade allies, all of Enbridge customers were aware of the utility role in the project but only 2/3 of the Union customers were aware.

Table 6-8. Customer Aware Of Utility Role

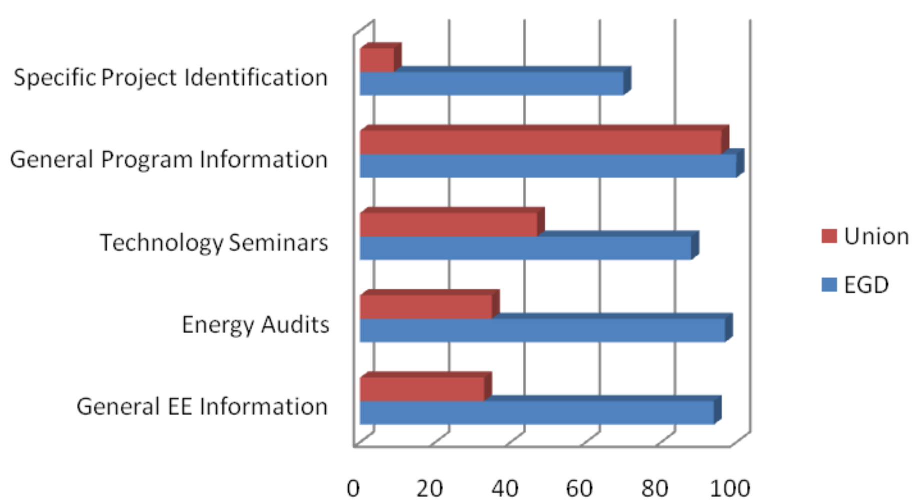
	Yes	Total	%
EGD	34	34	100
Union	27	40	68

Trade allies were asked "Do you recall receiving energy efficiency information and/or training in any of the following areas that was sponsored or delivered by Union Gas/Enbridge Gas Distribution?" Almost all remembered getting general program information (Table 6-9 and Figure 6-5). Among the EGD trade allies, almost all remembered getting information or training in energy audits and general energy efficiency information, compared to around one third for Union trade allies. Over two thirds of EGD respondents recalled getting "specific project identification" compared to nine percent for Union.

Table 6-9 % of Mentions by Utility

	EGD	Union
General Program Information	100	96
Energy Audits	97	35
General EE Information	94	33
Technology Seminars	88	47
Specific Project Identification	70	9
Software	0.38	0.20
Lunch N Learns	0.26	0.22

Figure 6-5. Percent Recall Information Etc. by Utility



6.3 Sector-Specific Answers to Key Questions

This section will present answers to the questions that carry the most weight in the free ridership calculations broken out by utility and sector. The results are presented as percentages after sector weights have been applied. This corresponds to the weighting used when the sector-specific free ridership results were calculated. The key questions that will be presented in this section are shown in the following table.

Table 6-10. Key Questions Influencing Free Ridership Calculation

Label in Text	Marker in Figure 5-1	Description and Survey Question
Direct Measure Level		
Likelihood and/or Share	[4] and [7]	Free Rider percentage based on likelihood (question E2a) and/or share (question E2b)
Months of Early Replacement	[6]	Number of months program caused the project to be moved forward, used to calculate the early replacement adjustment multiplier (question E1a)
Direct Project Level		
Best Estimate of Savings	[14]	Interviewee best estimate of the extra savings that would have been achieved without the program (question E3).
Program Influence Project Level		
Planning	[H]	Project planning interviewer score (question D3b)
Influence	[G]	Interviewer-assigned influence score (question D2b)
Importance	[F]	Program importance participant score (question D1)

The sector level free ridership results are shown in Tables E-1 and 5-1, which can be summarized as follows:

EGD: Industrial and Agriculture are relatively higher than Commercial Retrofit, Multifamily, and New Construction with Commercial Retrofit being particularly low.

Union: Commercial Retrofit and Industrial are relatively higher than Multifamily and New Construction with Agriculture being particularly low (zero).

The discussion of the question-specific results will address those sector differences. Those sectors that saw relatively high free ridership rates are shaded in the tables that follow.

6.3.1 Direct Measure Level

Likelihood and/or Share. Respondents were asked to estimate the *likelihood* that they would have incorporated measures “of the same high level of efficiency” if not for the financial and technical assistance of the program (Figure 5-1 [4]). In cases where respondents indicate that they may have incorporated some, but not all, of the measures, they are asked to estimate the *share of measures* that would have been incorporated anyway at the same level of high-efficiency. The answers they gave were converted into a free ridership percentage, which is shown in the following table.

EGD Notes: In the industrial sector, 67% of the respondents had free ridership scores of 70% or more based on this measure, which was significantly higher than the other sectors, and 89% of the agriculture respondents had free ridership scores at 50% or higher.

Union Gas Notes: Fully 84% of the commercial retrofit respondents had free ridership scores of 100% based on this measure. The industrial scores were somewhat better than multifamily and new construction on this measure. Most of the very largest industrial companies had very high free ridership rates in this area, which is the primary driver of the final free ridership score.

Table 6-11. Likelihood and/or Share – EGD

Free Ridership Percent	Agriculture	Industrial	Multifamily	New Construction	Commercial Retrofit
0	0%	29%	42%	25%	39%
10	0%	0%	0%	0%	0%
20	11%	0%	2%	0%	0%
25	0%	0%	5%	0%	3%
30	0%	0%	0%	8%	0%
40	0%	0%	0%	0%	0%
45	0%	0%	0%	0%	6%
50	44%	5%	14%	25%	0%
60	11%	0%	0%	0%	0%
65	0%	0%	0%	0%	3%
70	0%	10%	7%	0%	0%
75	11%	19%	2%	0%	0%
80	0%	14%	9%	0%	3%
85	11%	0%	0%	21%	0%
90	0%	0%	5%	4%	0%
100	11%	24%	14%	17%	47%
Total	100%	100%	100%	100%	100%
N	9	22	56	24	44

Table 6-12. Likelihood and/or Share – Union Gas

Free Ridership Percent	Agriculture	Industrial	Multifamily	New Construction	Commercial Retrofit
0	67%	6%	0%	0%	5%
30	0%	17%	0%	0%	0%
40	0%	0%	6%	0%	0%
50	0%	17%	13%	8%	0%
60	11%	0%	0%	0%	0%
70	0%	6%	0%	0%	0%
75	0%	0%	6%	0%	0%
80	22%	6%	6%	25%	5%
85	0%	6%	0%	0%	0%
90	0%	6%	13%	8%	5%
100	0%	39%	56%	58%	84%
Total	100%	100%	100%	100%	100%
N	8	19	17	12	20

Early Replacement Adjustment Multiplier. On a measure-by-measure basis, respondents were asked if the program influenced them to install the equipment more than one year earlier than they otherwise would have otherwise. If it had, they were asked when they would have installed the equipment without the program (Figure 5-1 [6]). That answer was converted to months and then converted to a percentage multiplier to discount the measure-specific free ridership rate. The answers given are shown below.

EGD Notes: Few projects were moved forward in time in most sectors except for the multifamily sector.

Union Gas Notes: Very few projects in any sector were moved forward by more than 12 months, with the exception of commercial retrofit.

Table 6-13. Months the Program Moved the Project Forward in Time – EGD

Months	Agriculture	Industrial	Multifamily	New Construction	Commercial Retrofit
0	67%	86%	14%	100%	82%
2	0%	7%	7%	0%	0%
6	0%	7%	7%	0%	0%
9	0%	0%	11%	0%	0%
12	17%	0%	29%	0%	0%
18	0%	0%	14%	0%	0%
24	17%	0%	4%	0%	6%
36	0%	0%	11%	0%	0%
240	0%	0%	4%	0%	12%
Total	100%	100%	100%	100%	100%
N	6	15	32	9	20

Table 6-14. Months the Program Moved the Project Forward in Time – Union Gas

Months	Agriculture	Industrial	Multifamily	New Construction	Commercial Retrofit
0	0%	92%	0%		50%
6	0%	8%	0%		0%
9	0%	0%	100%		0%
12	100%	0%	0%		0%
24	0%	0%	0%		50%
Total	100%	100%	100%		100%
N	1	13	6	0	3

6.3.2 Direct Project Level

Best Estimate of Savings. Respondents are asked to give an upper, lower and their best estimate [10] of the overall energy savings attributable to the program across all measure categories. If a “best estimate” is not provided, the midpoint between the lower and upper bound is used (Figure 5-1 [14]). Their answers are presented in the following two tables.

EGD Notes: Only two agriculture respondents answered this question, which minimized its effect on this sector, although both said 100% of the savings were attributable to the program. Industrial respondents attributed relatively more of the savings to the program, which would tend to *reduce* their free ridership score.

Union Gas Notes: Industrial and commercial retrofit respondents attributed relatively more of the savings to the program, which would tend to *reduce* their free ridership score.

Table 6-15. Respondent Estimate of Savings Attributable to the Program – EGD

Savings Attributable to the Program (%)	Agriculture	Industrial	Multifamily	New Construction	Commercial Retrofit
0	0%	6%	19%	8%	0%
10	0%	0%	0%	0%	0%
20	0%	0%	12%	17%	36%
25	0%	6%	0%	0%	0%
35	0%	0%	7%	0%	0%
50	0%	0%	17%	0%	8%
65	0%	0%	5%	0%	0%
70	0%	6%	10%	0%	0%
75	0%	11%	0%	0%	8%
80	0%	17%	14%	25%	6%
85	0%	11%	5%	21%	0%
90	0%	0%	2%	0%	0%
100	100%	44%	10%	29%	42%
Total	100%	100%	100%	100%	100%
N	2	20	56	24	44

Table 6-16. Respondent Estimate of Savings Attributable to the Program – Union Gas

Savings Attributable to the Program (%)	Agriculture	Industrial	Multifamily	New Construction	Commercial Retrofit
0	75%	6%	0%	0%	5%
20	0%	0%	0%	0%	0%
40	0%	0%	0%	8%	0%
50	0%	19%	14%	0%	0%
70	0%	0%	14%	0%	0%
80	0%	6%	7%	25%	0%
90	0%	0%	0%	17%	0%
100	25%	69%	64%	50%	95%
Total	100%	100%	100%	100%	100%
N	7	15	16	12	20

6.3.3 Program Influence Project Level

Planning. Point [H] in Figure 5-1 is an interviewer score of the amount of planning that went on for the measure before the program got involved, based on open-ended questions to the respondent and probing questions as appropriate. The planning score shown in the following tables is on a scale where 5 indicates that respondent had no plans at all and 1 indicates that respondent had documented plans and had budgeted for all of the efficient equipment.

EGD Notes: Compared to the other sectors, only commercial retrofit stands out as having respondents who had relatively far advanced plans prior to program involvement so this question does not contribute meaningfully to explaining the high free ridership scores for agriculture and industrial.

Union Gas Notes: Three quarters of the commercial retrofit respondents had planning scores of 2 or 1, significantly more than the other sectors. The 42% of industrial respondents having a planning score of 1 is significantly higher than agriculture and multifamily, but less than new construction. Most of the very largest industrial companies had planning scores of 1 or 2.

Table 6-17. Project Planning Score – EGD

Planning Score	Agriculture	Industrial	Multifamily	New Construction	Commercial Retrofit
1	11%	13%	18%	17%	22%
2	11%	9%	7%	0%	14%
3	0%	0%	4%	0%	8%
4	11%	48%	31%	25%	44%
5	67%	30%	40%	58%	11%
Total	100%	100%	100%	100%	100%
N	9	23	56	24	41

Table 6-18. Project Planning Score – Union

Planning Score	Agriculture	Industrial	Multifamily	New Construction	Commercial Retrofit
1	22%	42%	7%	50%	58%
2	0%	0%	27%	0%	16%
3	0%	16%	53%	0%	16%
4	0%	26%	0%	25%	0%
5	78%	16%	13%	25%	11%
Total	100%	100%	100%	100%	100%
N	8	19	16	12	19

Influence. Point [G] Figure 5-1 is an interviewer score of the program's influence on the type, efficiency and quantity of the equipment installed. The driving question at [G] was as follows: "Did the assistance you received from [Enbridge/Union] in any way influence your capital funding acquisition process, the type or efficiency level of the equipment or the amount of high efficiency equipment you installed or process changes implemented?" After asking probing questions to understand the answer, the interviewer assigns a 1-5 score where "1" indicates that the program had no influence and "5" indicates that the program was the primary reason that energy efficient equipment was installed. The results are in the following tables.

EGD Notes: Agriculture and industrial respondents are somewhat more likely to score low on this question than multifamily and commercial retrofit (33% agriculture and 29% industrial at 3 or lower compared to 16% multifamily and 25% commercial retrofit) with a low score being correlated with a higher free ridership score.

Union Gas Notes: All commercial retrofit respondents got a program influence score of 3 or lower, which was significantly lower than the other sectors. The industrial respondents had lower program influence scores than the agriculture respondents but higher than the other sectors.

Table 6-19. Program Influence – EGD

Program Influence	Agriculture	Industrial	Multifamily	New Construction	Commercial Retrofit
1	0%	0%	0%	0%	4%
2	0%	6%	0%	25%	7%
3	33%	24%	16%	42%	14%
4	67%	35%	35%	0%	4%
5	0%	35%	48%	33%	71%
Total	100%	100%	100%	100%	100%
N	3	17	35	24	35

Table 6-20. Program Influence – Union Gas

Program Influence	Agriculture	Industrial	Multifamily	New Construction	Commercial Retrofit
1	0%	0%	0%	0%	50%
2	0%	10%	0%	20%	25%
3	0%	30%	67%	60%	25%
4	0%	50%	0%	20%	0%
5	100%	10%	33%	0%	0%
Total	100%	100%	100%	100%	100%
N	6	11	3	5	5

Importance. Point [F] in Figure 5-1 represents several questions on the importance of several program components or types of assistance in the participant’s decision to install energy efficiency equipment. The maximum score among those questions is carried forward in the calculation where 1 is “not at all important” and 5 is “very important”. The maximum score by sector is shown in the following tables.

EGD Notes: Over half of the Agriculture respondents had an importance score of 3 or less, with lower numbers correlated with higher free ridership. This was significantly lower than the other sectors. The industrial scores were lower than multifamily and new construction.

Union Gas Notes: Commercial retrofit importance scores were significantly lower than the other sectors. Industrial importance scores were higher than the other sectors.

Table 6-21. Program Importance – EGD

Importance	Agriculture	Industrial	Multifamily	New Construction	Commercial Retrofit
1	11%	0%	0%	0%	3%
2	11%	0%	0%	0%	3%
3	33%	22%	0%	4%	16%
4	22%	26%	14%	38%	3%
5	22%	52%	86%	58%	76%
Total	100%	100%	100%	100%	100%
N	9	23	56	24	44

Table 6-22. Program Importance – Union Gas

Importance	Agriculture	Industrial	Multifamily	New Construction	Commercial Retrofit
1	0%	0%	7%	0%	37%
2	22%	0%	7%	8%	21%
3	0%	6%	13%	17%	5%
4	0%	50%	13%	75%	16%
5	78%	44%	60%	0%	21%
Total	100%	100%	100%	100%	100%
N	8	19	17	12	20

6.3.4 Summary

The following table summarizes the top-level information from the previous tables. It indicates which questions are driving the results for each of the sectors with relatively high free ridership rates.

Table 6-23. Summary of Sector-Specific Questions on High Free Ridership Sectors

Label in Text	EGD Industrial	EGD Agriculture	Union Gas Industrial	Union Gas Commercial Retrofit
Direct Measure Level				
Likelihood and/or Share	High	High	High*	High
Months of Early Replacement				
Direct Project Level				
Best Estimate of Savings	Low	Low	Low	Low
Program Influence Project Level				
Planning			Medium High*	High
Influence	Medium	Medium	Low	High
Importance	Medium	High	Low	High

High = Answers strongly supported the relatively high free ridership scores for these sectors.
High = High for the very largest industrial participants.*
Medium = Answers somewhat supported the relatively high free ridership scores for these sectors.
Low = Answers tended to bring down the free ridership scores for these sectors compared to other sectors.
Blank = Answers neither support nor contradict the free ridership scores.

EGD Summary. The high EGD industrial free ridership results are driven by high scores in the Likelihood and/or Share questions with support from the Influence and Importance questions. The high EGD agriculture free ridership results are driven by high scores in the Likelihood and/or Share and Importance questions with support from the Influence questions.

The EGD commercial retrofit has a relatively low free ridership rate at 12%. This sector had scores corresponding to low free ridership rates on four of the six main questions examined:

- Likelihood and/or Share: One of the lowest free ridership scores.
- Best estimate of savings: One of the highest estimates with 42% saying 100%
- Influence: The highest score (corresponding to a low free ridership rate), with 71% with a score of 5
- Importance: The second to the highest score (corresponding to a low free ridership rate), with 76% with a score of 5.

Union Gas Summary. The Union Gas commercial retrofit respondents show answers correlated with high free ridership results across most questions examined, except the Best Estimate of Savings.

The Union Gas industrial free ridership results are driven by the responses of a small number of very large industrial participants, who are significantly larger than the other Union Gas industrial participants (based on gross m^3 savings). The scores of these large participants on the Likelihood and/or Share and Project Planning questions were the primary drivers in their high free ridership scores.

6.4 Free Ridership, Spillover, and Net-to-Gross from Other Jurisdictions

Free ridership, spillover, and net-to-gross ratios from other jurisdictions can put the Union and EGD results in context.

The Database for Energy Efficiency Resources (DEER) is one commonly-cited source for free ridership numbers. DEER developed by the California Public Utilities Commission and the California Energy Commission, with support and input from the Investor-Owned Utilities and other interested stakeholders. The net-to-gross ratios in DEER take only free ridership into account and not spillover. As of late 2006 the DEER net-to-gross rates were as follows:[40]

0.83	Commercial and agricultural information, tools, or design assistance services
0.80	Default
0.96	Express Efficiency (rebates)
0.83	Energy Management Services, including audits (for small and medium customers)
0.74	Industrial Information and Services
0.70	Large Standard Performance Contract
0.80	All other nonresidential programs

[40] DEER is currently being updated and is off-line as of this writing. The original source of these numbers was : http://eega.cpuc.ca.gov/deer/Ntg.asp.

In 2006, Summit Blue researched the free ridership and spillover rates that have been found in studies in recent years. The results of that benchmarking exercise are presented in the following pages (with some slight updates from studies we are aware of that occurred since 2006). The 79% net-to-gross ratio for EGD is in the same range as several of the programs examined. The 56% ratio for Union Gas is lower than those found in this research.

Table 6-24. Results from Other Jurisdictions

State/Region	Utility	Program Name	Report Title	Year of Research	Program Description	Market Sector	Measures Covered	Free ridership values	Total Spillover Value	NTG Ratio
California	PG&E	Advanced Performance Options (All Measures)	Evaluation of Pacific Gas and Electric Company's 1997 Commercial Energy Efficiency Incentives Program: HVAC Technologies PG&E Study ID number: 333B	1999		Commercial	Adjustable Speed Drives, Water Chillers, Customized EMS, Convert to VAV, Other Custom Equipment, Other HVAC Technologies	0.46	0.21	0.75
California	PG&E	Commercial Energy Efficiency Incentives Program: Lighting Technologies	Evaluation of Pacific Gas and Electric Company's 1997 Commercial Energy Efficiency Incentives Program: Lighting Technologies PG&E Study ID number: 333A	1999	This evaluation covers indoor lighting technology retrofits that were rebated during 1997. These retrofits were performed under three different PG&E programs: the Retrofit Express (RE), Customized Efficiency Options (CEO) and Advanced Performance Options (APO) Programs.	Commercial	Lighting	0.24	0.05	0.82
California	Southern California Edison	Non-Residential Financial Incentives Program	Evaluation of the Southern California Gas Company 2004-05 Non-Residential Financial Incentives Program June 7, 2006	2006	The program focuses on small to medium nonresidential gas customers served under core rate schedules. The program incorporates technical support, education, training, outreach, contractor referral, prescriptive rebates and equitable financial incentives through three program elements.	Small and Medium Commercial, Agricultural, and Industrial		0.3	10% (not evaluated, just an estimate)	0.8
California	PG&E	Retrofit Efficiency Options Program	Evaluation of Pacific Gas and Electric Company's 1997 Commercial Energy Efficiency Incentives Program: HVAC Technologies PG&E Study ID number: 333B	1999	The REO program targeted commercial, industrial, agricultural, and multi-family market segments. Customers were required to submit calculations for the projected first-year energy savings along with their application prior to installation of the high efficiency equipment. PG&E	Commercial, Industrial, Agricultural, and Multifamily	Adjustable Speed Drives, Water Chillers, Cooling Towers	0.46	0.21	0.75

State/Region	Utility	Program Name	Report Title	Year of Research	Program Description	Market Sector	Measures Covered	Free ridership values	Total Spillover Value	NTG Ratio
					representatives worked with customers to identify cost-effective improvements, with special emphasis on operational and maintenance measures at the customers' facilities. Marketing efforts were coordinated amongst PG&E's divisions, emphasizing local planning areas with high marginal electric costs to maximum the program's benefits.					
California	PG&E	Retrofit Express Program	Evaluation of Pacific Gas and Electric Company's 1997 Commercial Energy Efficiency Incentives Program: HVAC Technologies PG&E Study ID number: 333B	1999	The RE program offered fixed rebates to customers who installed specific electric energy efficient equipment. It covered covers lighting, air conditioning, refrigeration, motors, and food service. Customers were required to submit proof of purchase with their applications in order to receive rebates. The program was marketed to small- and medium-sized commercial, industrial, and agricultural (CIA) customers.	Small and Medium Commercial, Industrial, and Agricultural Customers	Central A/C, Adjustable Speed Drives, Package Terminal A/C, Set-Back Thermostat, Reflective Window Film, Water Chillers, Other HVAC Technologies	0.39	0.21	0.82
California		SPC	2003 Statewide Nonresidential Standard Performance Contract (SPC) Program Measurement And Evaluation Study	2005	The program offered fixed-price incentives to project sponsors for kWh energy savings achieved by the installation of energy-efficiency measures. The fixed price per kWh, performance measurement protocols, payment terms, and other operating rules of the program were specified in a standard contract. PG&E and SDG&E also offer incentives for energy efficient gas measures.	Nonresidential	Lighting, lighting controls, VSDs, HVAC	49% / 59% / 35% / 55% / 41% (1999-2003)	5% (not evaluated, just an estimate)	63% (for 2002-2003)
Colorado	Xcel	Bid 2001 Program	Impact and Process Evaluation of the Bid 2001 Program	2003	Demand-side bidding program that acquires demand reductions by	Commercial and Industrial		0.36	0.06	0.7

State/Region	Utility	Program Name	Report Title	Year of Research	Program Description	Market Sector	Measures Covered	Free ridership values	Total Spillover Value	NTG Ratio
					soliciting proposals for demand reduction projects from customers, and third-party bidders contractors. This program has subsequently been succeeded by the Custom Efficiency program.					
Colorado	Xcel	Custom Efficiency	Colorado Demand-Side Management Programs Impact, Cost-Effectiveness, Process, and Customer satisfaction Evaluations	2005	Launched on December 1, 2001, this program is a C&I DSM bidding program and successor to Bid 2001. The program's goal is to obtain reliable and verifiable electric demand reduction in Company's Front Range service territory. To participate, eligible customers and qualified providers of energy related services respond to RFPs seeking electric demand reduction projects within eligible facilities.	Commercial and Industrial		0.398	0.139	0.741
Massachusetts/ New Hampshire	National Grid	Accelerated Application Process	National Grid 2001 Commercial and Industrial Free-ridership and Spillover Study	2002				0.121	0.146	1.025
Massachusetts/ New Hampshire	National Grid	Comprehensive Project	National Grid 2001 Commercial and Industrial Free-ridership and Spillover Study	2002				0.154	0.109	0.955
Massachusetts/ New Hampshire	National Grid	Design 2000plus	National Grid 2001 Commercial and Industrial Free-ridership and Spillover Study	2002	The program offers technical assistance and financial incentives to large commercial and industrial customers who are building new facilities, adding capacity for manufacturing, replacing failed equipment or undergoing major renovations.	Large Commercial and Industrial	Motors, VFD, HVAC, Lighting, Custom	0.307	0.188	0.881
Massachusetts/ New Hampshire	National Grid	Energy Initiative Program	National Grid 2001 Commercial and Industrial Free-	2002	The program offers technical assistance and incentives to help large C&I customers	Large Commercial and Industrial	Motors, VFD, HVAC, Lighting,	0.096	0.111	1.015

State/Region	Utility	Program Name	Report Title	Year of Research	Program Description	Market Sector	Measures Covered	Free ridership values	Total Spillover Value	NTG Ratio
			ridership and Spillover Study		purchase energy-efficient measures for their existing facilities.		Custom			
Massachusetts	NSTAR	Business Solutions	PY2002 Business Solutions Impact Evaluation for NSTAR Electric	2004	The program provides technical and financial assistance to NSTAR Electric's commercial, industrial, and institutional customers (except in Cape Light Compact territory) to facilitate the installation of energy saving equipment in existing buildings.	Commercial, Industrial, Institutional	Lighting, lighting controls, VSDs, HVAC, EMS, Refrigeration, Compressed Air, Motors	0.277	0.103	0.854
Massachusetts	NSTAR	Construction Solutions	Construction Solutions Program Year 2002 Impact Evaluation Final Report	2004	The program (previously the C&I New Construction Program) offers technical and financial assistance to design professionals and developers to promote the use of efficient design measures and electrical equipment in the construction, remodeling, or renovation of commercial and industrial buildings. The program also offers incentives to encourage the installation of energy efficient replacement equipment when existing systems fail during operation or at the time of purchasing new equipment.	Commercial and Industrial	Chillers, VSDs, Refrigeration, Lighting, Lighting Controls, Controls, Compressed Air	0.173	0.003	0.848
New York	NYSERDA	CIPP	Commercial/Industrial Performance Program (CIPP) Market Characterization, Market Assessment and Causality Evaluation	2006	CIPP began in June 1998. It provides financial incentives to energy service companies (ESCos) and other contractors to promote energy efficiency capital improvement projects. Program objectives are to: 1) foster the growth of the ESCO industry in New York State and 2) encourage end-use customers to invest in energy-efficient equipment based on the potential	Commercial and Industrial	Lighting, EMS, motors and VSDs, unitary HVAC and chiller replacements, heat pump water heaters, Energy Star vending machines, custom measures with paybacks of greater than one year, including	0.35	0.58	1.04

State/Region	Utility	Program Name	Report Title	Year of Research	Program Description	Market Sector	Measures Covered	Free ridership values	Total Spillover Value	NTG Ratio
					energy cost savings. Eligible energy efficiency measures must reduce electric energy consumption at the project site and this reduction must be measurable and verifiable. In addition, cost effective renewable energy measures and measures that reduce summer peak demand are eligible for funding consideration as custom measures whether or not electric energy consumption is reduced.		renewable measures and measures that reduce peak summer demand.			
New York	NYSERDA	New Construction Program (NCP)	New Construction Program (NCP) Market Characterization, Market Assessment, and Causality (MCAC)	2006	This comprehensive evaluation covered the period from program inception through year-end 2005. In late 2006, the MCAC Team was tasked with updating certain aspects of the earlier comprehensive evaluation effort. This report discusses the results of the update work.	Commercial and Industrial		0.40	0.85	1.22
New York	NYSERDA	Technical Assistance Program	Technical Assistance Program Market Characterization, Market Assessment And Causality Evaluation	2007	The Program provides customers with objective, customized information by funding detailed energy studies capable of facilitating better energy efficiency, energy procurement, and financing decisions.	Commercial and Industrial		0.27	0.44	1.17

7 CONCLUSIONS

The total free ridership rate across both utilities and all sectors is 48% as shown in Table 7-1. The free ridership rate for EGD is 41% and it is 54% for Union Gas. Summit Blue recommends that the utilities use the utility-specific total free ridership values of 41% and 54% as the best estimate of free ridership. Those results are based on larger sample sizes than the sector-specific results and proved more stable in the sensitivity analysis. The sector-specific results are based on smaller sample sizes and should only be used to support program management, for example to support targeting and marketing decisions.

Table 7-1. Free Ridership Results

Sector	EGD	Union	Total
Agriculture	40%	0%	18%
Commercial Retrofit	12%	59%	27%
Industrial	50%	56%	53%
Multifamily	20%	42%	26%
New Construction	26%	33%	28%
Total	41%	54%	48%

Assumptions (See Figure 2.1 for the interpretation of these assumptions):

Weight of Participant Reported Importance [F] in [K] compared to the planning [H] and influence [G] scores	Triple weight
Weight of Project-based estimate [14] in [20] compared to the measure-specific scores [9]	Triple Weight
Weight of Program Influence Score [L] compared to the Project-Based score [21]	Equal Weight

Summit Blue recommends the utilities use following spillover rates:

Table 7-2. Spillover Results

Spillover Type	EGD	Union	Base
Participant Inside Spillover	5%	5%	Of gross reported savings
Participant Outside Spillover	5%	5%	Of gross reported savings
Audit-Only Spillover	35%	0%	Of gross audit-recommended savings
Nonparticipant Spillover	0%	0%	

Summit Blue recommends the utilities use the following net-to-gross ratios, reflecting both free ridership and spillover:

Table 7-3. Net-to-gross Results

	EGD	Union
Net-to-gross ratio	79%	56%

Appendix A. Revised Analysis Plan

Appendix B: Survey Instruments

Appendix A

Custom Project Free Ridership and Spillover Study Analysis Plan

FINAL

Submitted To:

Union Gas Ltd.

Enbridge Gas Distribution Inc.

January 15, 2008

Annotated July 28, 2008 to reflect decisions made for the final calculations.

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Note: The analysis plan presented here has changed from the original approved plan in two ways:
1. Assumptions left undefined in the original plan were finalized.
2. Some details of the free ridership calculation had to be changed to appropriately adjust to realities in the actual data.

INTRODUCTION

This document presents the detailed analysis plan that will govern the free ridership and spillover study for the Custom Projects programs implemented by Enbridge Gas Distribution and Union Gas. This document will present the planned survey and analysis approach and sample design for three surveys:

1. Participant and Trade Ally survey covering free ridership and spillover

2. Participant Audit-Only survey covering spillover

3. Nonparticipant Survey covering spillover.

Finally, this document will outline the final report.

Approach Overview

Free ridership and spillover will be estimated using data from surveys with participants, nonparticipants, trade allies, and utility staff. This approach is based primarily on participant self-reported information along with other perspectives to triangulate the net-to-gross estimates. It is the most common and generally accepted approach to measuring free ridership and spillover in a commercial and industrial energy efficiency program.

Experienced utility industry consultants will personally conduct the interviews and most will be done on-site. This is standard practice for our firm where estimating attribution[1] is a primary objective of the research. Typically the internal champion in an industrial firm will have the most complete information on influences, and this information can best be extracted in an in-person interview which encourages the free flow of significant information.

To address the possibility of respondent bias, the interviews will approach each topic from a variety of directions. The interviewer has the discretion to probe for supporting information and the analysis process checks for consistency across answers. Interviewees will be promised confidentiality and assured that their answers will not affect the incentives or support they have received from the program. To address the possibility of interviewer bias, each interviewer will be trained in the purpose of the research and the importance of objectively probing and recording responses. Three different interviewers will perform the interviews and the data from their interviews will be compared to look for uneven application of the methodology. The interviewers chosen for this effort each have a long history of tackling evaluation projects from an objective point of view.

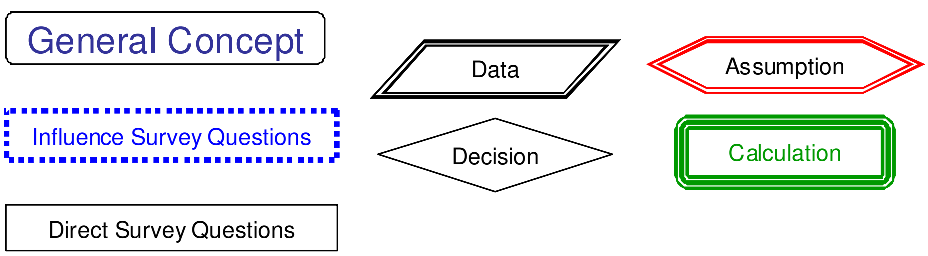
[1] In this study and Analysis Plan, "attribution" is defined as the combined program market influence of free ridership and spillover.

Introduction to the Flow Diagrams

The description below contains references to diagrams of the flow of survey questions and analysis logic shown after page 7. The first diagram (Figure 3) shows a high-level overview of the analysis and survey logic. The revised version of Figure 3 shows revisions to the general approach and the weights given to various parts of the analysis in the calculations used to produce the final, recommended results. Figures 4 through 6 show the direct question sequence with Figure 4 showing the measure-level approach, Figure 5 the project-level approach, and Figure 6 the combined approach. Figure 7 shows the program influence sequence, and Figure 8 shows the combination of the direct and program influence sequences to produce the final results.

Key points in the diagrams are labeled with bold, large numbers and letters. Those labels are referred to in the text in brackets, e.g., [1] [2] [A] [B]. Key assumptions in the logic are noted in the text with bold, italics set off by < > symbols (e.g., ***<Average>***). Key assumptions in the diagrams are noted with the figure labeled "Assumption" shown in the key in Figure 1.

Figure 1. Key to Symbols in the Analysis Diagrams



PARTICIPANT SURVEY – FREE RIDERSHIP

This section will first outline the survey and analysis approach for the participant and trade ally survey, covering the free ridership aspect, and then discuss the sample design.

Participant and Trade Ally Survey and Free Ridership Analysis Approach

We will design and implement surveys with participating end users and trade allies (Channel Partners for Union Gas and Business Partners for Enbridge) to measure free ridership and spillover. The discussion that follows is largely written with the participants in mind. The survey for the trade allies follows the same general logic and they will be asked for their opinion on the impact of the program on specific participants. (The spillover approach will be discussed in the following section.)

Figure 3 presents an overview of the survey and analysis approach. Free ridership will be discussed with each respondent in both **direct questions** aimed at obtaining respondent estimates of the appropriate (full or partial) free ridership rate to apply to them, and in **supporting or influencing questions** used to verify whether direct responses are consistent with participants' views of the program's influence on their equipment investment decisions. The direct questions will be asked at the measure level and at the whole project level. They will then be combined into a single, project-level direct free ridership score. Direct and program influence scores are combined into the final project-level free ridership score. That project-level score is weighted by program-reported savings to calculate the final savings-weighted free ridership percentage. Each of these steps is explained in more detail below, corresponding to the diagrams following Figure 3.

Direct Free Ridership Questions

The direct free ridership questions are posed first for each major category of measures that were reported to the program (*e.g.,* HVAC, building controls, process technologies) (Figure 4), and then for the project as a whole (Figure 5). The measure-level and project-level results are combined in the analysis (Figure 6). For the measure-specific questions, respondents are first asked when, if at all in the foreseeable future, they would have replaced existing equipment or installed new equipment if not for the technical and financial assistance of the program (Figure 4 [1]).

Respondents are then asked to estimate the *likelihood* that they would have incorporated measures "of the same high level of efficiency" if not for the financial and technical assistance of the program (Figure 4 [4]). In cases where respondents indicate that they may have incorporated some, but not all, of the measures, they are asked to estimate the *share of measures* that would have been incorporated anyway at the same level of high-efficiency. This flexibility in how respondents could conceptualize and convey their views on free ridership allows respondents to give their most informed answer, thus improving the accuracy of the free ridership estimates.

Additional direct project-level free ridership questions are then asked to obtain a lower bound, an upper bound, and a best estimate of overall energy savings attributable to the program across all measure categories (Figure 5 [10, 11, 12]). These questions focus on incremental savings from incorporating high-efficiency equipment or controls instead of standard-efficiency equipment and controls. The questions are asked after measure-specific questions so respondents have the decisions they made on individual measures fresh in their minds. Asking respondents about a lower and an upper bound has been successfully used by Summit Blue in several past net-to-gross studies to help respondents narrow down the possible range of free ridership values before making a best estimate.

Program Influence Questions

The **"program influence"** questions (Figure 7) are designed to clarify the role that program interventions (*e.g.*, technical assistance and financing) played in decision-making, and to provide supporting information on free ridership. Questions address the following topics:

- Figure 7 [A] – The importance of features of the program in the decision to incorporate high-efficiency measures in the project. The dimensions include the following:
    - program technical assistance
    - program financial assistance
    - ongoing relationship with the utility (providing impartial advice and facilitating unbiased contacts, e.g., business partners)
    - utility education activities
        - providing best practice information through case studies, as well as specific industry adoption, proven track records, operating experience to help instill confidence etc.
        - training, workshops, and seminars to improve the general or specific knowledge and competencies of customers
        - on-going advertisements re: energy efficiency to heighten customer awareness and concerns

- promotion of energy efficiency at conferences, trade shows and other industry events

- Figure 7 [B] – The influence of the program on the type or efficiency level of the measures, or the amount of high-efficiency measures, incorporated into the project.
  - Figure 7 [B1] – Each respondent indicating some degree of program influence was asked to describe how the program influenced the decision to install high-efficiency equipment in the project.

- Figure 7 [C] – The customer's plans (or lack thereof) to incorporate the energy efficiency measures included in the project prior to participating in the program.
  - Figure 7 [C1] – Each respondent indicating any degree of planning for high efficiency prior to participating in the programs is asked to describe these plans in detail and is asked for the equipment type, timing, quantity, and efficiency, as well as for any prior budgeting for the high efficiency equipment.

Program influence questions are both closed-ended and open-ended and may require probing by experienced interviewers to elicit complete responses that accurately reflect the level of program influence. If the responses are inconsistent across the three types of questions, the interviewer will probe to attempt to resolve the inconsistency (Figure 7 [J]). Some responses to open-ended questions are quantitatively scored by interviewers using a pre-prepared scoring guide (Figure 7 [G][H]), while other questions ask respondents directly to quantify program influence (Figure 7 [F]).

Using the Participant and Trade Ally Survey Responses to Estimate Free Ridership

Direct Free Ridership Estimate

The direct free ridership estimate is based on both the measure-specific questions and the "whole project" questions. For each measure category for which the respondent had installed equipment through the program, the survey collects information on when, if ever, the equipment would likely have been installed (Figure 4 [2]) and the *likelihood* that the same high efficiency equipment would have been used, or the *share of high-efficiency measures* that would have been installed (Figure 4 [4]). The response to the likelihood/share-of-measures questions are used as the initial free ridership value for the measure category (Figure 4 [7]). This value is then discounted if the respondent indicated that the program influenced them to install the equipment more than one year earlier than they otherwise would have (Figure 4 [6]). The specific discount values (*i.e.,* adjustment multipliers), when defined, will likely follow the outline presented in Table 1.

Options for the specific discount values (*i.e.,* adjustment multipliers) have not yet been determined. The history and critique task will look for precedents in the field in this area and specific values will then be developed.

Enbridge Gas Distribution designates some projects as "advancement". For "advancement" projects, the TRC calculation already discounts the TRC benefits to account for the period which the program has moved projects forward in time. However, there is no need to modify the survey and analysis to take this into account and Enbridge and Union customers will be asked the same questions, including the timing questions.

Table 1. Early Replacement Adjustment Multipliers

Early Replacement ***Within ____ years of program participation***	Adjustment Multiplier <Assumption>	Early Replacement ***Within __ months of program participation***	Adjustment Multiplier <Final>
Within ___ Months	100%	Within 12 Months	100%
__ Months to __ years	__%	13 to 24 months	75%
__ to __ years	__%	25 to 36 Months	50%
__ to __ years	__%	37 to 48 Months	25%
More than __ years	0%	More than 48 Months	0%

Each measure category is also assigned an energy savings value (in cubic metres (m^3)) from the gas savings recorded for that respondent in the program database (Figure 6 [16]). The direct free ridership estimate for each measure category (after any adjustment for early replacement) is weighted according to the relative savings from the category to determine a weighted average free ridership estimate across all measures (Figure 6 [17]). As it turned out, measure-specific gas savings values were not available for the sample period under examination so this adjustment could not be made and the measure adjusted free ridership value [9] fed straight through to the weighting calculation in [18].

A second direct free ridership estimate is determined based on answers to the direct free ridership questions regarding the lower bound (Figure 5 [12]), upper bound [11], and best estimate [10] of the overall energy savings attributable to the program across all measure categories. If a "best estimate" is provided, this value is used as a second direct free ridership estimate (Figure 5 [14]) in addition to the measure-based estimate discussed above. If a "best estimate" is not provided, the midpoint between the lower and upper bound is used (Figure 5 [13]).[2] The final direct free ridership estimate (Figure 6 [21]) is the ***<weighted average>*** (Figure 6 [20]) of the measure-based estimate [17] and the "best estimate" [14]. If sufficient information is available for only one of these values, then this value is used as the final direct free ridership estimate. ***<Equal weight>*** will be given to the measure-specific and best estimate values to calculate the final direct free ridership estimate (Figure 6 [18][19]). In the final approach, the best estimate values were given three times the weight of the measure-specific estimates.

Program Influence Free Ridership Estimate

As previously discussed, additional questions are included in the surveys to support an analysis of the consistency of responses. Responses to these "program influence" questions are used to adjust the direct free ridership estimates using objective criteria described below. Adjustments are made to individual respondents' free ridership estimates—not to the aggregate free ridership value across respondents. **Adjustments are only made if the respondent's direct free ridership score is beyond the bounds that could reasonably be expected based on responses to the influence questions.** Specifically, the process for whether and by how much to adjust a respondent's direct free ridership estimate is as follows:

Step 1. Calculate an *<average>* program influence score (Figure 7 [L]) (on a 5-point scale) from the scores assigned to the three sets of program influence questions regarding program's importance (Figure 7 [A]), influence of the program [B], and project planning [C]. In the final approach, the importance score [F] was given three times the weight of the Influence [G] and Planning [H] scores (as shown in the revised Figure 3). The ***<maximum score>*** [E] for the program influence dimensions is carried forward in the calculation [F]. A higher score for program influence and importance suggests greater program

[2] Previous research showed that the average "best estimate" was within 3 percentage points of the midpoint.

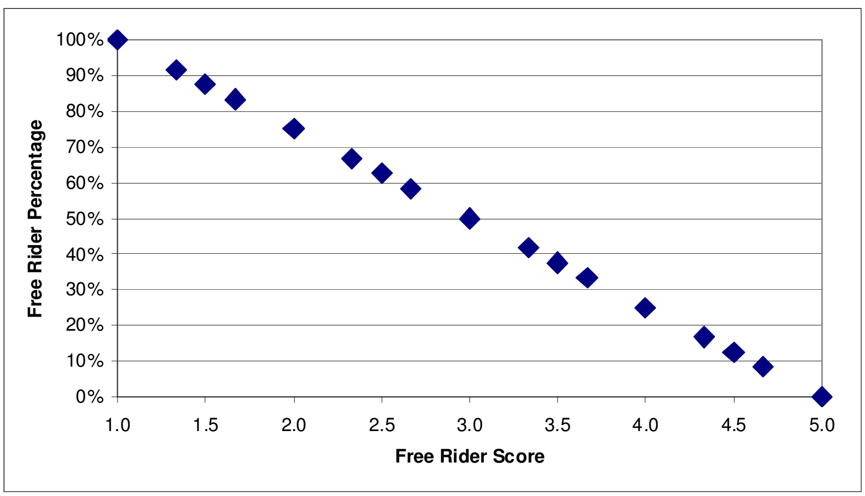
impact, but a higher score for planning indicates lower impact. Therefore, prior to calculating an average score across the three sets of questions, the planning score is inverted so that 1=5, 2=4, etc. In this way, a higher average score across these questions unequivocally represents greater program impact. If the participant's contractor was the most significant influence [D], ***<the results of the trade ally survey will determine the free ridership score>*** [I].

Step 2. Translate the program influence score into a free ridership rate. The influence score has to be converted into a free ridership rate (Figure 7 [M] to [N]) to be used in subsequent calculations. The assumption governing the conversion is that ***<the relationship should be linear>*** with an influence score of 5 converting to 0% free ridership and an influence score of 1 converting to 100% free ridership (see Table 2 and Figure 2).

Table 2. Translate Influence Score to Free Ridership Percentage *<Assumptions>*

Average Influence Score	**1.00**	**1.33**	**1.50**	**1.67**	**2.00**	**2.33**	**2.50**	**2.67**	**3.00**	**3.33**	**3.50**	**3.67**	**4.00**	**4.33**	**4.50**	**4.67**	**5.00**
Free ridership	100%	92%	88%	83%	75%	67%	63%	58%	50%	42%	38%	33%	25%	17%	13%	8%	0%

Figure 2. Translate Influence Score to Free Ridership Percentage



Step 3. Define reasonable bounds for the program influence score (Figure 7 [P][Q]). These bounds are intended to reflect the range of free ridership values that could reasonably characterize a project based on a respondent's answers to the program influence questions. For example, if a respondent's program influence score is the maximum possible value of 5.0 (implying that the program was very influential), then a reasonable free ridership value would be as low as 0% and ought to be no higher than 50% to be logically consistent. The width of the range that defines the reasonable bounds (50% in this example) will be identified in the data analysis phase. A reasonable bounds width ought to cause a reasonable number of scores to be adjusted by this step, which probably means less than a third of the scores but more than 5%. Exactly what that "reasonable number" should be can only be determined by examining the results.

Adjusting Direct Estimate with the Influence Estimate

The upper and lower bound estimates derived from the program influence questions are used to adjust the direct free ridership estimate. ***<If the direct free ridership value falls outside of the bounds, then it is***

adjusted to a final free ridership estimate equal to the closest lower or upper bound value> (Figure 8 [AA]). Thus, if the direct free ridership value is higher than the program influence upper bound, then the upper bound is used as the final free ridership value. Conversely, if the direct free ridership value is lower than the program influence lower bound, then the lower bound is used as the final free ridership value.[3] This creates the influence-adjusted, customer-specific final free ridership estimate (Figure 8 [BB]). In the final analysis, because the final direct project level free ridership rate [21] was almost always significantly different from the program influence score [N], the influence upper [Q] and lower bounds [P] had to be very wide or the vast majority of scores were adjusted to the influence bounds. As this gave too much weight to [N], it was decided that a more appropriate approach was to average [21] and [N]. In the final results, [N] and [21] were given equal weights (also shown in Figure 3).

Scaling Customer-Specific Results to the Population

The customer-specific free ridership results are scaled up to the population using project-level energy savings to create a savings-weighted free ridership result (Figure 8). The customer-level free ridership score is multiplied by the customer-level gross energy savings [CC] to calculate customer-level net free rider savings [EE]. The gross and net savings are summed up across all customers and then net savings divided by gross savings produces the final savings-weighted, program-wide free ridership result (Figure 8 [GG]). (Segment-level strata weights, if any, are applied during this step [FF] to calculate the final results.)

[3] The actual calculation shown in the diagram is: Maximum(Lower bound, Minimum(Upper bound, direct free ridership result)).

Figure 3. Free Ridership Analysis – Overview – Original

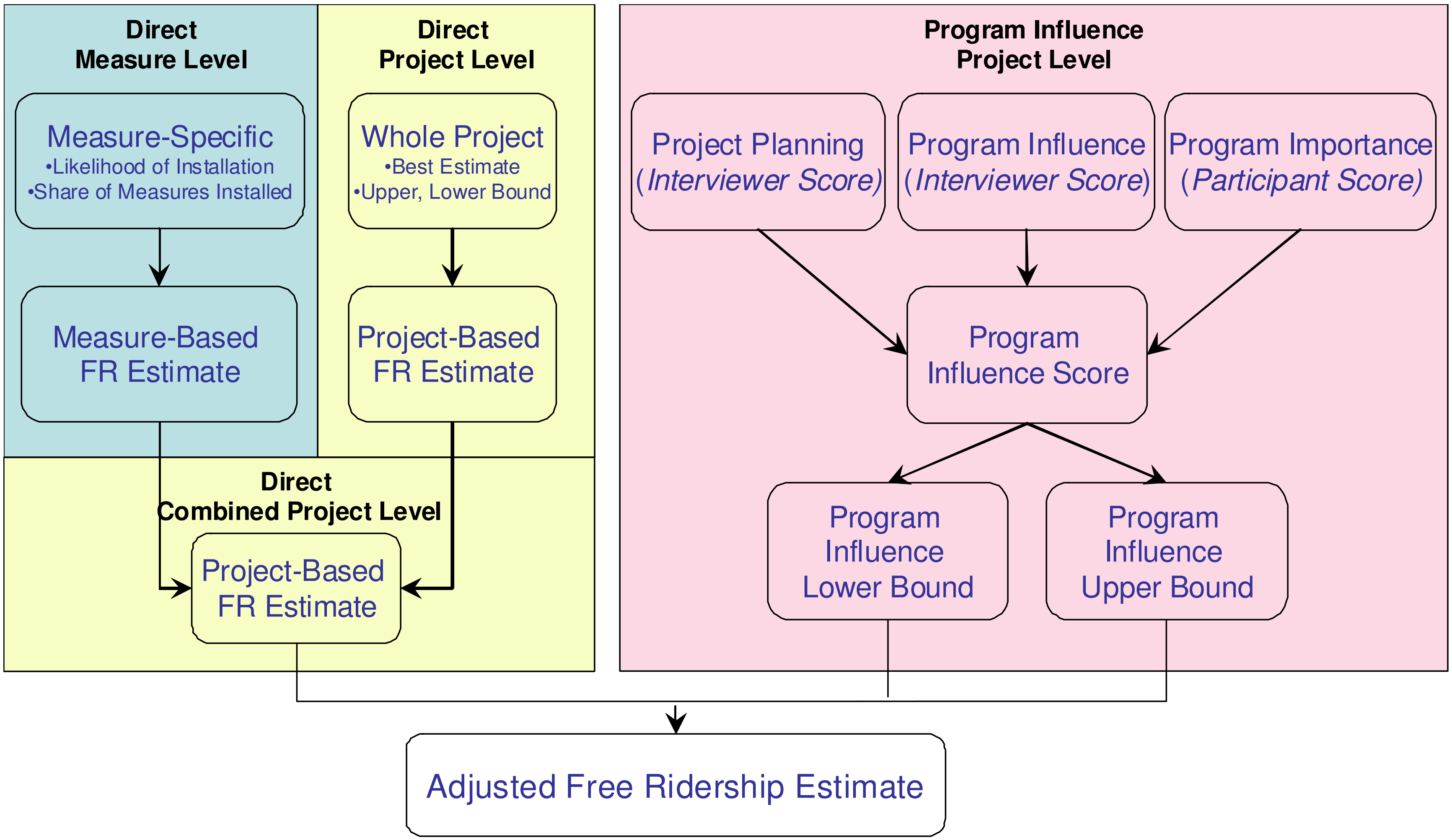


Figure 3. Free Ridership Analysis – Overview – Final Approach

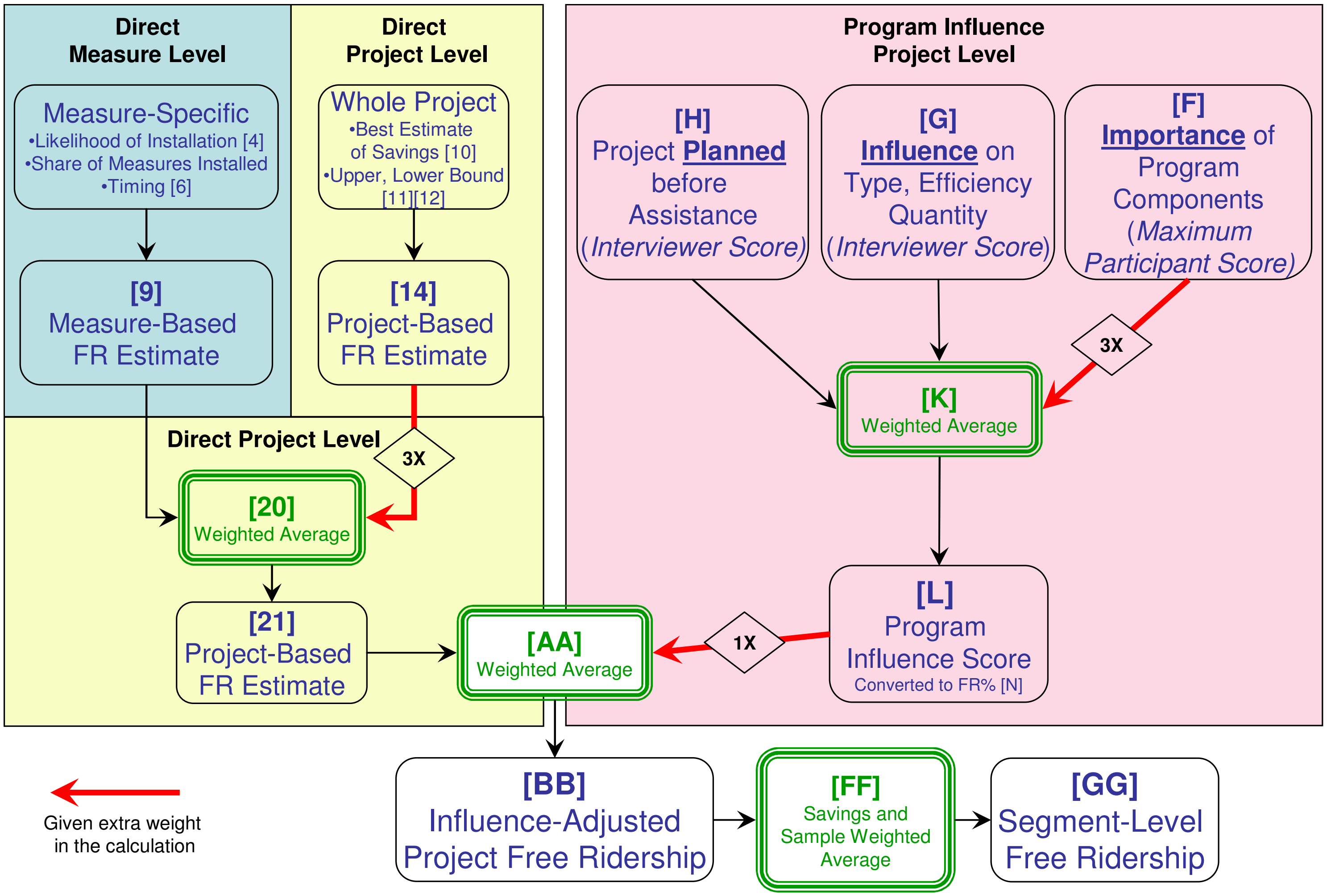


Figure 4. Free Ridership Analysis – Direct, Measure Level

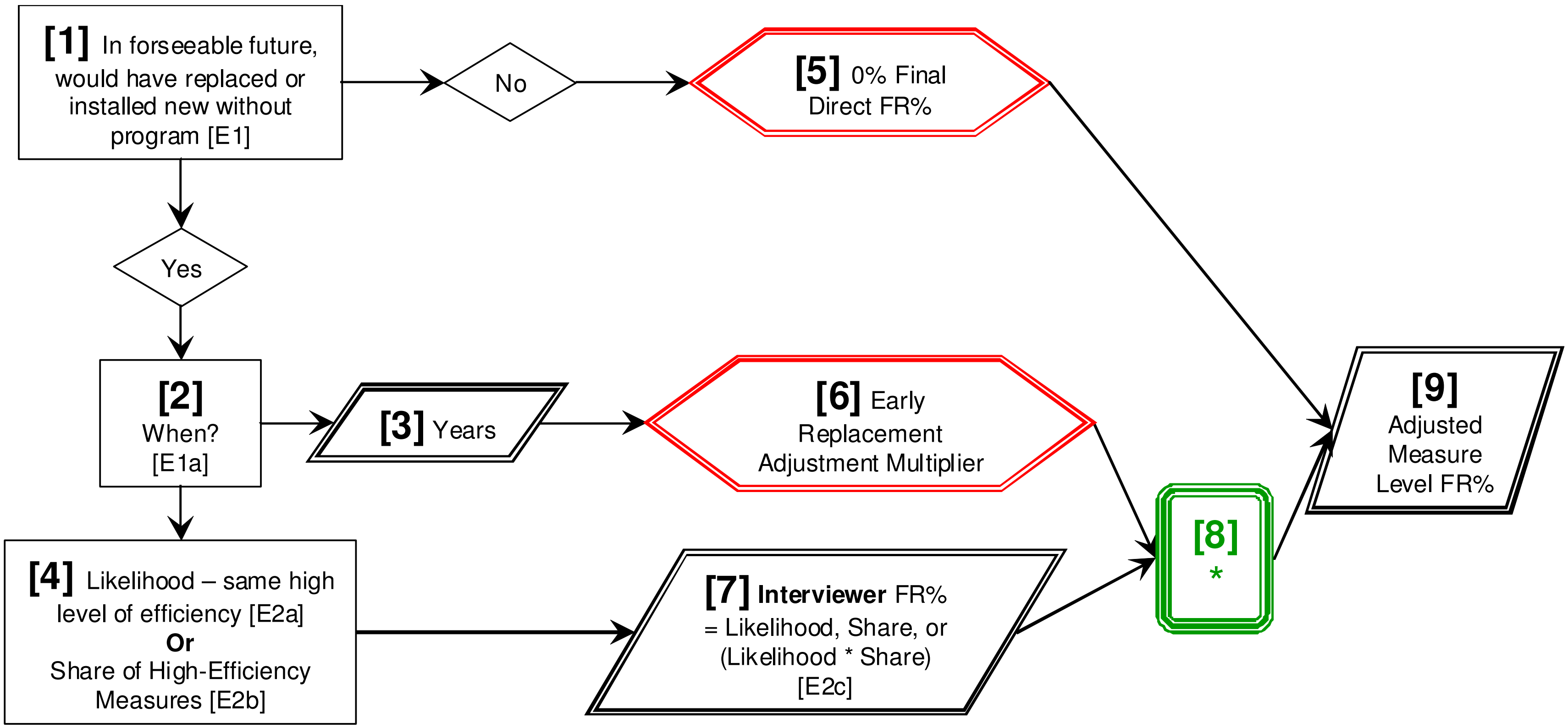


Figure 5. Free Ridership Analysis – Direct, Project Level

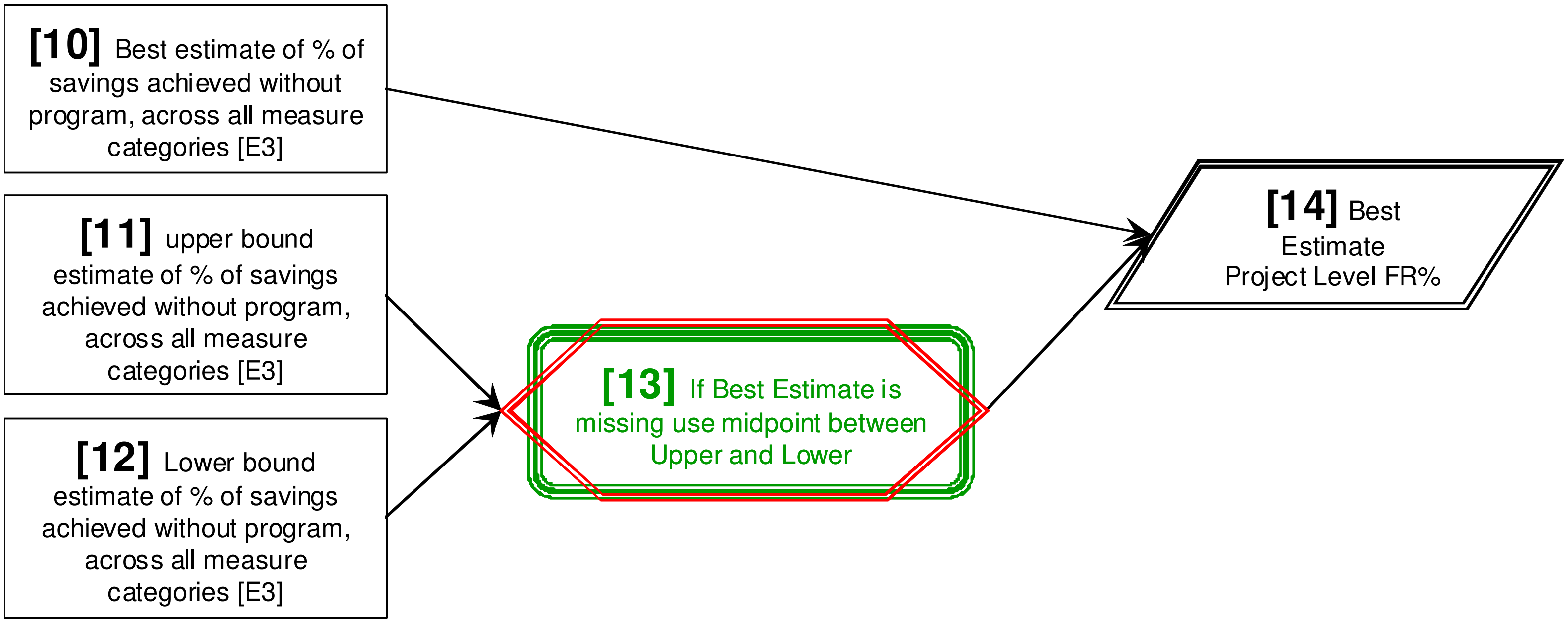


Figure 6. Free Ridership Analysis – Direct, Combined Project Level - Original

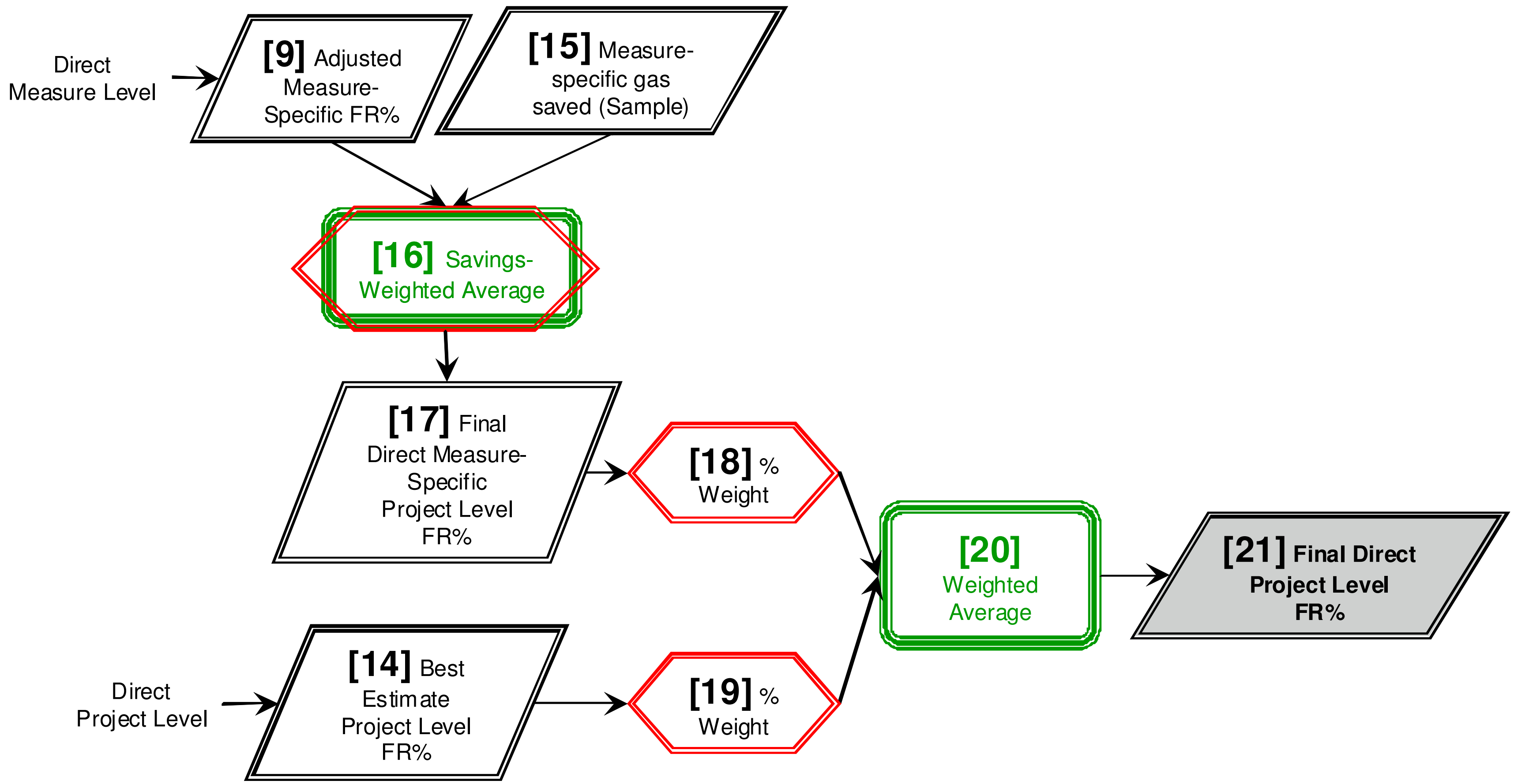
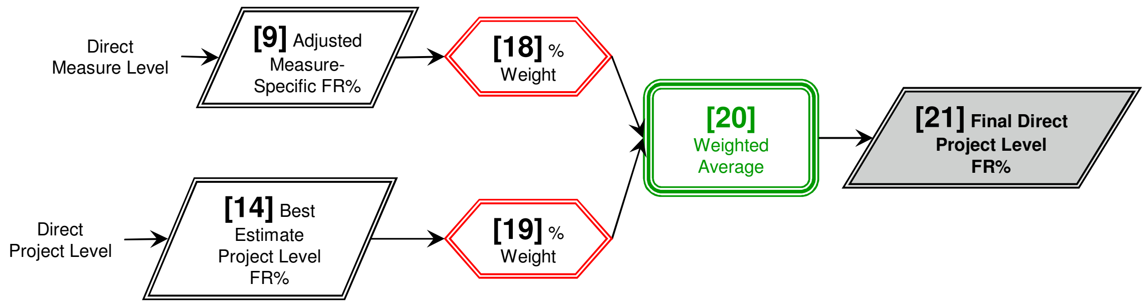
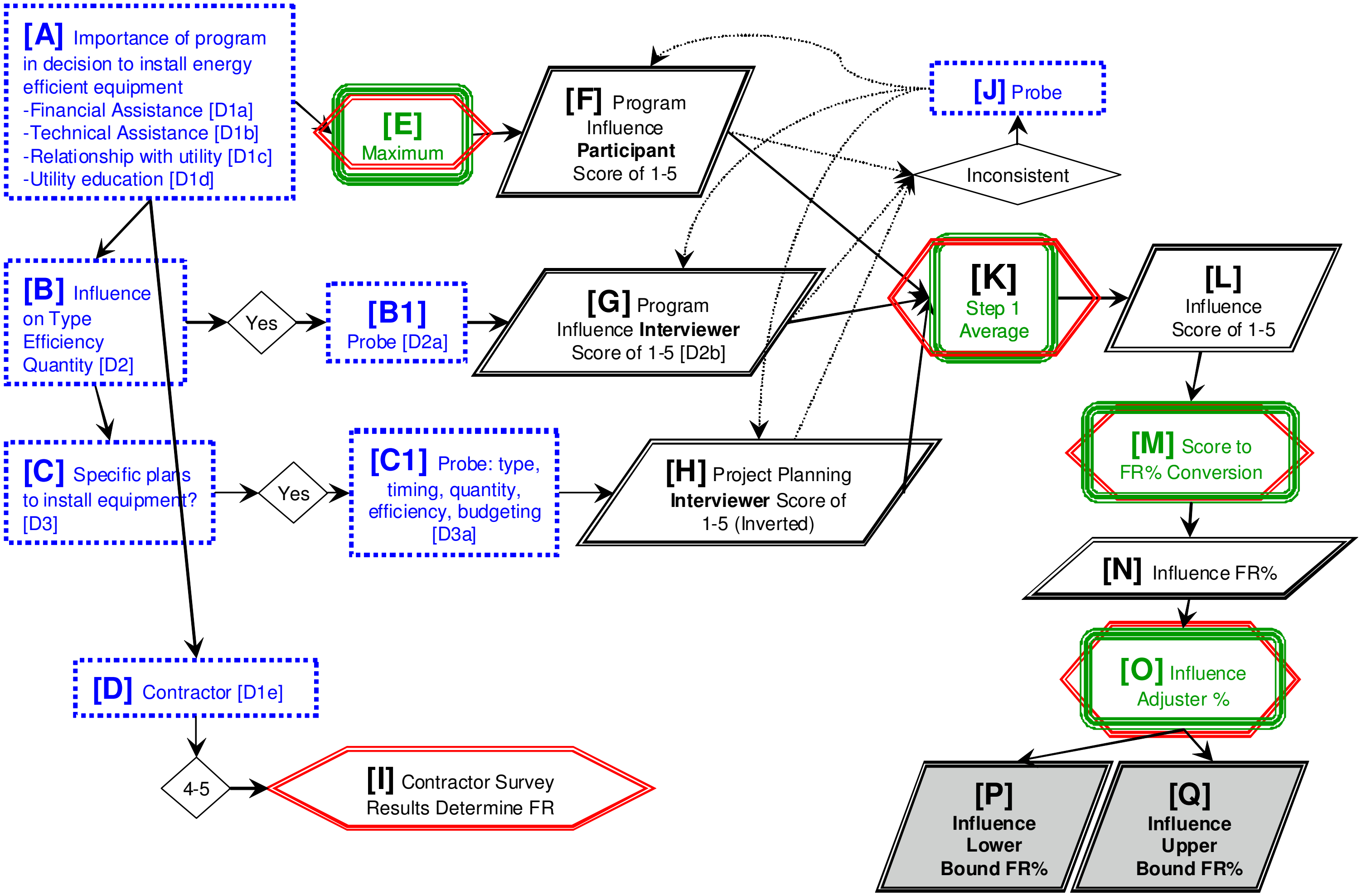


Figure 6. Free Ridership Analysis – Direct, Combined Project Level – Revised



Changes: Measure-specific gas savings values were not available so [9] fed straight through to [18].

Figure 7. Free Ridership Analysis – Program Influence, Project Level



Changes: Boxes [O], [P], and [Q] were deleted. See discussion on the following pages.

Figure 8. Free Ridership Analysis – Combined Direct and Program Influence Results - Original

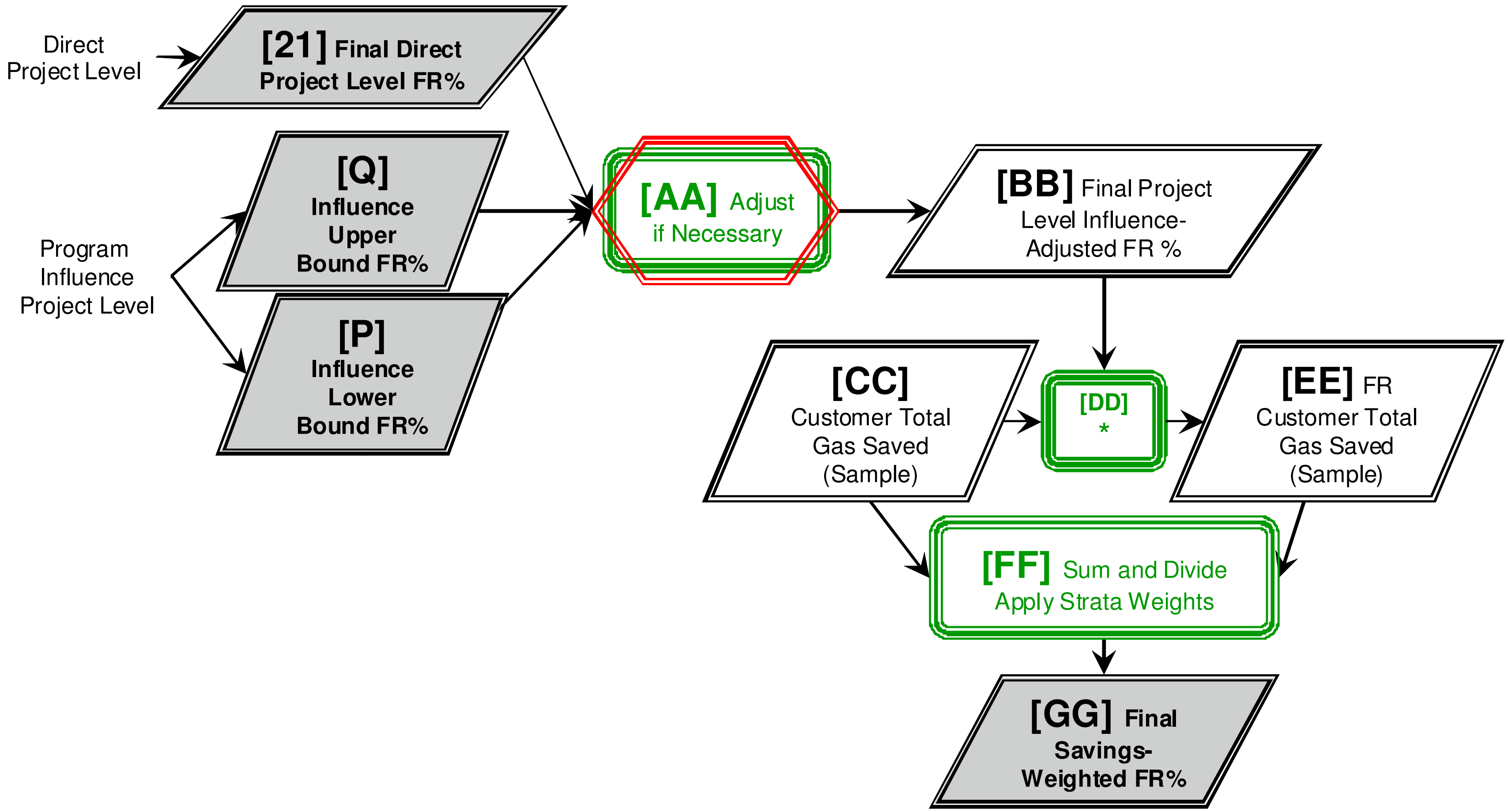
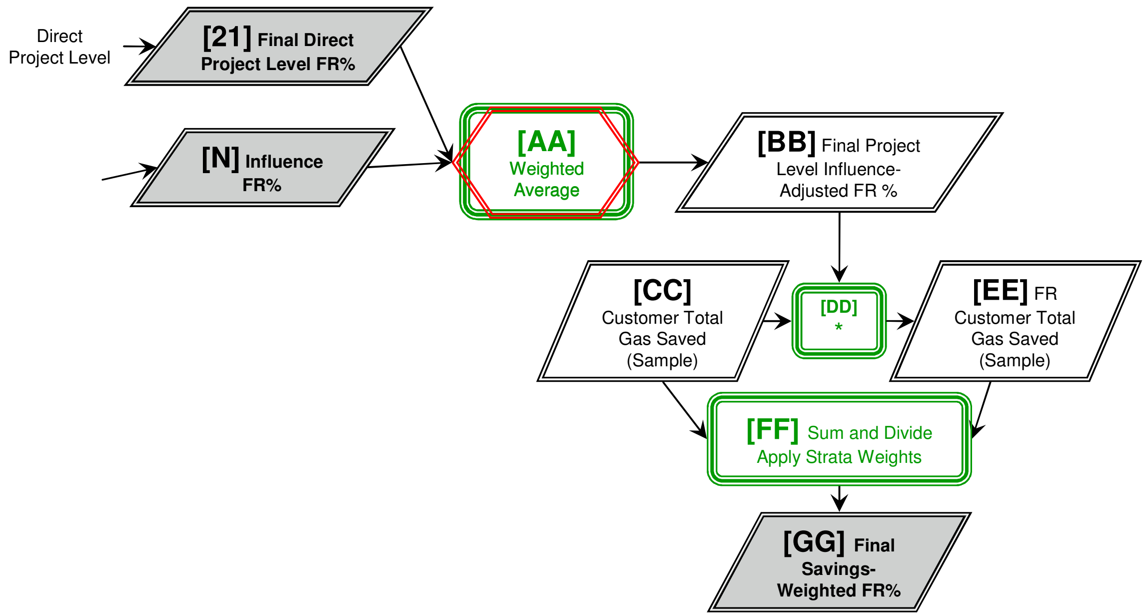


Figure 8. Free Ridership Analysis – Combined Direct and Program Influence Results - Revised



Changes: Because [21] was almost always significantly different from [N], the influence upper [Q] and lower bounds [P] had to be very wide to incorporate [21], which gave too much weight to [N]. It was decided that a more appropriate approach was to average [21] and [N].

Participant and Trade Ally Survey Sample Design

The budget for this study is designed to produce results at 90% confidence level at +/- 20% precision at the segment level with five segments per utility and 90% confidence level at +/- 10% precision at the utility level. The budget is based on the assumption that we will complete 17 surveys per segment per utility, covering a total of 170 projects. Since the total number of surveys that would be completed at 90/20 precision with 5 segments is more than that needed to produce 90/10 precision at the utility level, the budget should be sufficient to produce both 90/20 precision at the segment level and 90/10 precision at the utility level. Some extra surveys may be needed in certain segments to improve the fit of the sample to the utility-level population to produce 90/10 results.

We will on occasion complete more than one survey per project if we need to talk to both the end user and the contractor. The survey costs assume we will complete an average of 1.3 surveys per project.

Segments

Enbridge and Union agreed to the following definitions of the segments that should be included in the sample:

- Industrial
- Agriculture
- New Construction
- Commercial
- Multifamily (Multifamily is also referred to as "multi-residential".)

Enbridge provides design assistance and a holistic approach to all new construction projects in commercial and multifamily buildings. As a result, it includes new construction projects in those sectors in a "New Construction" category. For all other sectors, energy savings claimed typically refer only to mechanical upgrades related to the new facility and so are grouped with retrofit projects in their sector.[4]

Sample Size within Segments

It may be that the optimal sample distribution is not simply to do a random distribution from among the participants in each segment. There are two issues to consider. First the available population, second the size of individual projects relative to the population.

Sample compared to population size. It appears that there are enough participants in each segment to complete 17 surveys per segment with the exception of the Agriculture and New Construction segments for Union (Table 3). There are 18 individual agriculture customers and only five new construction customers. We will attempt to interview all Union participants in those segments (and will stop if we get 17 in agriculture). We can distribute the 12 completes that cannot be obtained in the Union new construction segment to other segments.

[4] Source: Judith Ramsay email 10/23/2007.

Table 3. Sample Size as Percent of Population

	Individual customers/ decision makers		17 Completes as % of Population	
	Union	Enbridge	Union	Enbridge
Industrial	67	76	25%	22%
Agriculture	18	32	**94%**	53%
Multi-family	29	187	59%	9%
New Construction	5	52	**340%**	33%
Building Retrofit	94	105	18%	16%

Source: Derived from spreadsheet sent by Christine Zivanov October 10, 2007.

If the population is not large, a small population correction factor is typically used to reduce the needed sample size,[5] e.g., if the population in a targeted group is 100, the sample size to achieve 90/10 precision is reduced to 40. For 90/20 precision, the small population correction factor comes into effect for populations of 170 or smaller, which covers all but one segment, Enbridge multifamily projects. The required sample size to reach 90/20 by segment, after applying the small population correction factor is shown in Table 4, which shows a total of 124 surveys. Given a budget based on 170 completes we could potentially distribute 46 surveys (170-124=46) to address other issues (we will return to this below).

Table 4. Sample Sizes Adjusted for Small Population

Segment	Utility	Population Size	Adjusted Sample Size
New Building	Union	5	4
Agriculture	Union	18	9
Multi-family	Union	29	11
Agriculture	Enbridge	32	12
New Building	Enbridge	52	13
Large Industrial	Union	67	14
Large Industrial	Enbridge	76	14
Building Retrofit	Union	94	15
Building Retrofit	Enbridge	105	15
Multi-family	Enbridge	187	17
Total			*124*

Source: Population size from spreadsheet sent by Christine Zivanov October 10, 2007.

Size of individual projects relative to the population. One common approach to sampling for DSM program evaluations is to stratify the sample to ensure that many of the participants with the highest energy savings are included. This reduces the variance among respondents within each stratum and results in a greater overall precision in estimating the share of energy savings that could be considered free

[5] When the sample size exceeds 1/10th of the population size, then the sample size is calculated as (Sample Size)/((Sample Size)/(Population Size)+1).

riders. This is the approach that will be taken for this analysis, basing the segmentation only on gas savings, without regard to water or electricity savings or the TRC.

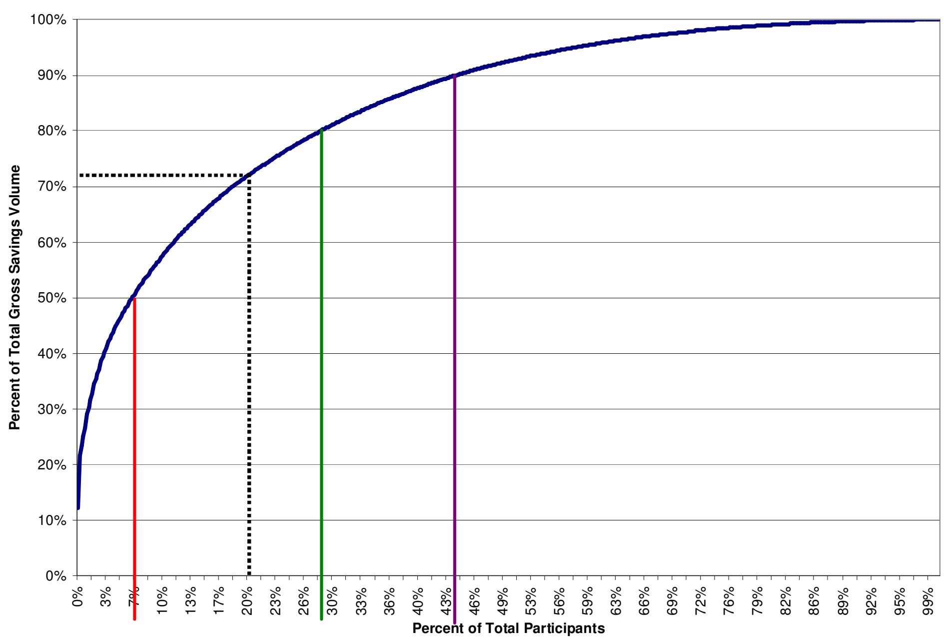
One half of the savings reported by Enbridge from the last quarter of 2006 and the first three quarters of 2007 was achieved by 6.4% of the participants, the largest 20% of projects represent 72% of the program savings, and the top 44% of participants represent 90% of the savings (Table 5 and Figure 9). Given this distribution, it seems appropriate to segment the sample by savings.

Table 5. Participants' Share of Savings – Enbridge

Percent of Participants	Percent of Gross m^3
6.4%	50%
20.0%	72%
22.8%	75%
28.2%	80%
44.0%	90%

Interpretation: 6.4 Percent of the participants account for 50% of the gross savings volume.
Source: Derived from spreadsheet sent by Judith Ramsay October 09, 2007.

Figure 9. Participants' Share of Savings – Enbridge



Source: Derived from spreadsheet sent by Judith Ramsay October 09, 2007.

One approach to segmenting the sample by savings would be to sample with certainty the customers responsible for the most savings within each segment. Table 6 shows the percent of segment savings for Enbridge projects of the five projects with the largest savings within each segment. In three of the segments, the top five projects represent over 40% of the savings. Since this represents a fairly large percent of the savings, this supports the decision to sample the top five projects in each segment for each utility with certainty and the remaining sample should be picked at random from the remainder.

Table 6. Percent of Savings from Top 5 Projects

	Total Gross m^3			Percent of Segment Total		
Segment	Top 5 Projects	Remainder	Total	Top 5 Projects	Remainder	Total
Industrial	24,066,050	26,646,410	50,712,460	47%	53%	100%
Agriculture	1,900,331	2,588,866	4,489,197	42%	58%	100%
Multifamily	1,917,380	21,570,252	23,487,632	8%	92%	100%
New Construction	1,023,733	3,061,981	4,085,714	25%	75%	100%
Commercial	5,771,444	8,124,495	13,895,939	42%	58%	100%
Total	34,678,938	61,992,004	96,670,942	36%	64%	100%

Source: Derived from spreadsheet sent by Judith Ramsay October 09, 2007.

PARTICIPANT AND TRADE ALLY SURVEY – SPILLOVER

This section will outline the survey and analysis approach for the participant survey, covering the spillover aspect. The spillover questions will be incorporated in the participants and trade ally surveys described above and the spillover analysis will be implemented in concert with the free ridership analysis.

Survey Overview

Spillover represents energy savings that are due to the program but not counted in program records. Spillover can be broken out in three ways:

- **Participant inside spillover** represents energy savings from other measures taken by participants at participating sites not included in the program but directly attributable to the influence of the program.
- **Participant outside spillover** represents energy savings from measures taken by participants at non-participating sites not included in the program but directly attributable to the influence of the program.
- **Non-participant spillover** represents energy savings from measures that were taken by non-participating customers but are directly attributable to the influence of the program. Non-participant spillover is sometimes called the "Free-Driver effect."[6]

Summit Blue will estimate **participant inside and outside spillover** through questions in the participant and trade ally surveys and through the Audit-Only Survey. Summit Blue will estimate nonparticipant spillover through the nonparticipant survey.

[6] See for example California Energy Efficiency Evaluation Protocols: Technical, Methodological and Reporting Requirements for Evaluation Professionals. TecMarket Works. Prepared for the California Public Utilities Commission. April 2006. Page 226.

Participant Inside Spillover

Respondents are asked whether their experience with the programs caused them to install additional energy efficient equipment at the site that did not go through the program. This establishes whether inside spillover exists. For those respondents reporting that additional measures were installed, they are asked to identify in which year(s) the measures were installed, and to describe how the program influenced their decisions to install additional energy efficient equipment at their facility. An additional question is asked to determine the ratio of the savings from these additional measures compared to the savings from the measures installed under the program. That is, they are asked the percent of savings as a multiple of the savings achieved under the program (**savings multiplier**). Finally, respondents are asked to estimate the share of the savings from these additional measures that can "reasonably be attributed to the influence" of the program **(net-to-gross percentage)**. The process of breaking the questions into incremental steps helps the respondent think through each part, and it allows the respondent to provide his or her expert judgment as a participant in the target market.

Participant Outside Spillover

Similar to inside spillover, respondents are asked first whether the influence of the program caused them to install any additional energy efficiency equipment, outside of the program, at other sites beyond what they would have done without their experience with the program. If they respond yes, they are asked several follow-up questions designed to provide an estimate of the level of savings from these actions that could be attributed to the program. These questions address the following:

- The number of non-program-funded facilities at which these extra installations occurred.
- How the program has influenced their decisions to install the high efficiency equipment at other facilities.
- The savings—per site—from the additional measures relative to the savings from the participating project being discussed in the interview.
- The share of the savings that can reasonably be attributed to the program's influence.

Using the Participant and Trade Ally Survey Responses to Estimate Spillover

Participant Inside Spillover

Inside spillover is zero for those without additional measures (or those who failed to answer all of the questions), and it is the product of the savings multiplier and the net-to-gross percentage for those with inside spillover. Similar to the free ridership analysis, individual spillover estimates are weighted both by relative energy savings for each respondent, as well as by sample stratification to determine an inside spillover value for the group as a whole.

Participant Outside Spillover

The savings as a percent of the in-project measure is multiplied by the share of savings attributed to the program to calculate the outside spillover value.[7] Similar to the free ridership analysis, individual spillover estimates are weighted both by relative energy savings for each respondent, as well as by sample stratification to determine an outside spillover value for the group as a whole.

AUDIT-ONLY SURVEY

This section will outline the survey, analysis approach, and sample design for the Audit-Only Participant survey.

Survey Overview

Participants who received an audit, implemented a recommended measure, but did not receive incentives through the program for that measure can be considered spillover. These kinds of participants would not be included in either the participant or nonparticipant surveys discussed above and below. We will implement a survey specifically with this population and focusing solely on spillover measures to provide an important additional estimate of program spillover.

The interviewer will begin by asking the respondent if they recall receiving the audit. If they do not, the interviewer will attempt to speak to someone else who might recall the audit.

The interviewer will ask the participant about each measure recommended in the audit. (Although we will limit this to the measures with the largest savings if there are more than 5 measures recommended.) The interviewer will examine whether the respondent remembers the recommendation and whether it has been installed and when. If the participant installed a measure, the interviewer will ask the following:

1. On a scale of 1 to 5 where 1 is “no influence” and 5 is “a great deal of influence”, how much influence did the audit have in your decision to implement this measure?

2. What share of the savings from this measure can reasonably be attributed to the influence of the program?

During the survey, the interviewer will fill in a matrix approximately like the following.

[7] A cap of five outside spillover projects per respondent is used to prevent outliers from skewing the results.

Table 7. Audit Survey Question Matrix

Recommended Measure Description	Recall recom-mended?	Measure installed?	% of Measures	% of Savings	When was it installed?	Influence of Program	Share of Savings
1. [Data]	Y/N	Y/N/DK	%	%	Month, Year	1 2 3 4 5	%
2. [Data]	Y/N	Y/N/DK	%	%	Month, Year	1 2 3 4 5	%
3. [Date]	Y/N	Y/N/DK	%	%	Month, Year	1 2 3 4 5	%
4. [Date]	Y/N	Y/N/DK	%	%	Month, Year	1 2 3 4 5	%
5. [Date]	Y/N	Y/N/DK	%	%	Month, Year	1 2 3 4 5	%

Using the Audit-Only Survey Responses to Estimate Spillover

The analysis of audit-related spillover savings will be fairly straightforward. The program tracking data will have measure-specific savings estimates from the audit. In general form, the participant-level spillover calculation will be:

Spillover Multiplier = (Influence of Program {converted to percentage} + Share of Savings)/2

Participant-level spillover = (Savings Estimate *{from sample}*) * (Spillover Multiplier) * (Percent of Items that were recommended that were installed)

This amounts to ***<averaging>*** the converted influence score with the answers to the share of savings question. Converting the influence of the program score to a percentage will be done using the scale shown in Table 8 below.

Table 8. Translate Influence Score to Free Ridership Percentage *<Assumptions>*

Average Influence Score	1.00	2.00	3.00	4.00	5.00
Influence Percentage	0%	25%	50%	75%	100%

Calculating program level savings will require weighting respondents and scaling up to the population.

Audit-Only Survey Sample Design

The sample will be taken from customers who had audits in 2005. This provides the optimal balance between providing enough time for the customers to have acted on the recommendations in the audit and ensuring that the audit is not so far in the past that respondents have trouble recalling details of the recommendations. Because the sample will be based on a single year, the result of the analysis can be expressed in spillover per year. Given that there have not been any significant changes in the program strategy, spillover calculated from a prior year ought to reasonably represent the probable spillover from the current year.

The costs of implementing the Audit-Only survey are based on these assumptions:

1. The survey would be done over the phone
2. Enbridge and Union provide the sample

3. Program tracking records provide estimates of savings for measures that get counted as spillover.
4. Completing 67 surveys for each utility to provide 90/10 precision at the utility level

Enbridge and Union will provide customer-level data from their program tracking systems that describes customers who have had audits in 2005 but have not implemented measures that appear in their program tracking systems. However, Union Gas was unable to find any companies who had an audit in 2005 and had not implemented one of the recommended measures through the program. As a result, no audit-only surveys were attempted with Union Gas customers. Based on the relatively limited sample available, Summit Blue will survey all available sample.

NONPARTICIPANT SPILLOVER SURVEY

This section will outline the survey, analysis approach, and sample design for the nonparticipant spillover survey.

Survey Overview

Summit Blue will estimate nonparticipant spillover using a survey targeted at nonparticipants only. The approach will be similar to participant spillover as follows:

- Whether spillover may exist. Using yes/no questions ask whether the respondent installed energy efficiency equipment.
- The amount of savings per spillover project. Asking respondents to estimate the energy savings associated with the implemented measures.
- The share of those savings that could be attributed to the influence of the program.

The approach to determine program influence will parallel that taken to determine free ridership – determining how much influence the program had on the decision to implement the measure.

The largest challenge in a nonparticipant spillover survey is identifying an appropriate sample and reaching a person within each company who can and will address the relevant issues. Using Enbridge and Union customer data we will identify a sample that would be reasonably close to the participant population then implement a phone survey in the following sequence:

1. Find someone knowledgeable about the replaced or modified equipment.
2. Aware of the program? If no, terminate.
3. Did the company participate in the program in the past 3 years? If yes, terminate.
4. Has the company modified or installed equipment that might fall under the program's incentives? (List target equipment.) If no, terminate. If yes, when?
5. Determine what effect, if any, the program had on their decision. (Same questions as in the Audit-Only survey.)

5A. On a scale of 1 to 5 where 1 is “no influence” and 5 is “a great deal of influence”, how much influence did the program have in your decision to install or modify your equipment?

5B. What share of the savings from this change can reasonably be attributed to the influence of the program?

5C. On a scale of 1 to 5 where 1 is “no influence” and 5 is “a great deal of influence”, how much influence did **your suppliers or contractors** have in your decision to install or modify your equipment?

5D. If ***<5A > 2 or 5B > 30%>*** then: “We want to have one of our engineers follow up with you to ask some technical questions. Will that be OK?

6. If 5D=Yes. Quantify the magnitude of savings. Summit Blue engineer calls to ask enough questions about the equipment to make an engineering estimate of the energy savings it produces.

Because a large number of companies may be screened out in the first four steps, it is most cost-effective to implement this kind of survey over the phone. The costs are driven more by locating a company and person able to get to step 5 than by the asking the questions that come in step 5. However, costs can also be significant in step 6, if detailed questions and engineering calculations are needed to calculate savings for each measure that was influenced by the program.

Using the Nonparticipant Survey Responses to Estimate Spillover

As described above, if the company indicates that it implemented measures that were influenced by the program, then a Summit Blue engineer will call to ask enough questions to estimate the measure’s energy savings. With that done, the calculation of spillover parallels that for the Audit-Only survey, as follows.

Nonparticipant spillover = (Engineering-based Savings Estimate) * (Spillover Multiplier *{calculated from survey}*)

The Multiplier is calculated in the same way as the Audit-Only multiplier.

Nonparticipant Sample Design

The project budget assumes that we will implement a minimum of 670 screening surveys across both utilities but cannot guarantee a specific number of respondents getting through to step 6. In theory, completing 67 screening surveys with companies who have made appropriate equipment purchases or changes that could have been influenced by the program would provide 90/10 precision for an estimate of whether spillover happened (again across both utilities). If the incidence of spillover is small, it would not provide a very robust estimate of the therm value of that spillover. We based the budget on an assumption that 10 screening calls are needed to complete 1 call through step 5, thus requiring 670 screening calls. If the 1/10 ratio is low, then we will spend relatively more money on engineering calls and reviews. If it is high, then we will complete relatively more screening surveys. We will complete as many screening calls and engineering reviews as the budget will allow.

The sample will be done at random after eliminating customers in the small commercial rate class. This will target the sample at the segment most likely to have been influenced by the program and allow a simple extrapolation to the population. Summit Blue staff will advise utility staff on the best approaches to drawing a random sample from their data.

OUTLINE OF FINAL REPORT

The following is a preliminary outline of the final report presented to start a dialog about how the report should be structured.

1. Executive Summary
    a) Top-Level Results
    b) Program-Wide Free Ridership
    c) Segment-Level Free Ridership
    d) Role of Prior Program Experience
    e) Spillover
    f) Net-to-Gross Ratio
2. Introduction
    a) Definitions
    b) Report Contents
3. History and Critique of Free Ridership Methodologies
4. Summary of Analysis Methodology
    a) Estimating Free Ridership
    b) Estimating Spillover
5. Sampling and Data Collection
6. Findings
    a) Free Ridership Results
        i) Direct Free Ridership Estimates
        ii) Program Influence Questions
        iii) Adjusted Free Ridership Estimates
        iv) Role of Prior Program Experience
    b) Spillover Results
    c) Net-to-Gross Ratio
7. Conclusions

Appendix A: Methodology Detail—Estimating Free Ridership and Spillover
Appendix B: Survey Instruments

Appendix B. Surveys

Contents

1. CUSTOM PROJECTS PARTICIPANT SURVEY

1.1 CONVENTIONS

- Bold text is spoken.
- Italics text is instructions for the interviewer.
- *{VIP}* indicates questions that are particularly important and represent specific boxes in the analysis flow chart.

1.2 SAMPLE DATA

(NOTE: Projects are the survey unit, so each project to be interviewed separately. Thus, use separate form for each Project, even if the same interviewee is associated with multiple projects)

Name_____________________________________ Interviewer Initials _________________________

Firm Name ________________________________ Survey Date ______________________________

Address __________________________________ Sample ID # ______________________________

Phone Number ____________________________ Project ID #_______________________________

Project Completion Date____________________

Equipment installed: ____
Channel Partner involved: ____
Program activity: ____

2.2. Project Briefing Information – Union Gas sales/marketing staff input:

2.2.1. Month/year of initial Union Gas involvement with the project or its precursors
2.2.1a Month_______
2.2.1b Year_______

2.2.2. General context of Union Gas relationship with customer:
a. Historical education effort with customer on efficiency opportunities & Union Gas programs (high, medium, low level of effort):

____

____

b. Facility energy audits performed (steam traps, boilers, etc)

____

____

c. Distribution and merchant services support provided (general credibility & relationship building)

____

____

d. Other (describe) ____

____

____

2.2.3. Services provided to customer in project-related contacts:

a. Gas bill histories (usage, cost) ____

b. Approximate number of project-related contacts with customer ____________________

c. General information on program ____

____

____

d. Project-specific technical information or analysis: technical/engineering, financial, vendor/technology alternatives, etc.

____

____

e. Project/technology recommendations____

____

____

f. Other (describe)____

____

____

ga. Low/medium/high intensity of support to customer generally

____

____

gb. Low/medium/high intensity of support to project specifically

____

____

h. Low/medium/high effect of on project's efficiency level

____

____

1.3 IDENTIFY CORRECT RESPONDENT

[Note: These questions may be covered on the phone while setting up an appointment.]

A1. **Are you the most appropriate person to talk to about the decision to install that equipment and about the selection of the specific energy efficiency equipment?**

1. YES Continue to Question A3

2. NO ➔ "May I ask who would be the best person to talk to?"
[obtain names and phone numbers] ______________________________
____
____
[Ask to speak with this person. Start again at the beginning.]
3. DO NOT REMEMBER PROJECT ➔ Ask Question A2

A2. Do you recall participating in <u>any</u> programs through Union Gas/Enbridge Gas Distribution in the past few years regarding this location?

1. YES

   A2A. Did the program involve assistance from Union Gas/Enbridge Gas Distribution in identifying energy efficient equipment or process changes and financing toward the initial capital costs?

   1. YES *Continue to Question A3*
   2. NO➔ "Can you provide me…" *[See text for "NO" above]*

2. NO ➔ "Can you provide me with a contact name and phone number for a person who might be familiar with the work that was done?" *[Get contact information and call this person; Start again at the beginning.]*

[If they express hesitation, use an appropriate combination of the following.]
Confidentiality. We are an independent research firm and will not report your individual responses in any way that would reveal your identity, as your response only will be presented in aggregate along with responses from other survey participants.
Security. Your responses will not affect your ability to participate in the program in the future.
Sales concern. I am not selling anything. I simply want to understand what factors were important to your company when deciding to install energy efficient equipment with assistance from this program.
Contact. If you would like to talk with someone about this effort from
–Union Gas, you can call your account manager.
–Enbridge Gas Distribution, the Enbridge Industrial contact is Peter Goldman at 416-495-6348, the Enbridge Commercial contact is Stefan Surdu at 416-495-5917, or you may contact your Energy Solutions Consultant.

1.4 Confirmation Of Equipment Installed

B1. Prior to calling, review program records for the project. In Table 1 below under "Program Records," check off each measure category for which energy efficient equipment was installed.

B2. Just to make sure that we're talking about the same project, I show that you installed *[list major equipment or equipment categories]*. **To your recollection, was all this equipment installed?**
[Check off each category for which respondent recalls installing equipment. If information is not available from program records, ask the respondent to recall what measures were undertaken.]

B3. Did Union Gas/Enbridge Gas Distribution provide financial assistance for installing this equipment?
[Ask of only those checked in B2. Check off each category for which respondent recalls that Union Gas/Enbridge Gas Distribution provided financial assistance.]

B3b. Approximately how much was the incentive as a percent of the total project cost?
[Ask of only those checked in B3.]

B4. Did you receive any technical assistance from Union Gas/Enbridge Gas Distribution staff with any of this equipment?
[Ask of only those checked in B2. Check off each category for which respondent recalls that Union Gas/Enbridge Gas Distribution provided technical assistance for the measure.]

Table 1. Equipment in program records and recalled by respondent

[Check if Yes]

Measure Category	**B1.** Program Records	**B2.** Respondent Recollection	**B3.** Union Gas/Enbridge Gas Financial Assistance	**B3b.** Incentive as % of Project Cost	**B4.** Union Gas/Enbridge Gas Distribution Technical Assistance	Notes/Caveats
a. Machine/Process	❒	❒	❒	%	❒	
b. HVAC (incl. furnaces, all boilers, A/Cs, chillers, EMS, etc.)	❒	❒	❒	%	❒	
c. Lighting	❒	❒	❒	%	❒	
d Controls (boiler controls, variable frequency drive controls	❒	❒	❒	%	❒	
e. Building envelope (incl. insulation, windows)	❒	❒	❒	%	❒	
f. Domestic hot water	❒	❒	❒	%	❒	
g. Refrigeration	❒	❒	❒	%	❒	
h. Agriculture	❒	❒	❒	%	❒	
i. Converted equipment from electricity to gas (fuel substitution)	❒	❒	❒	%	❒	
j. Other: _______________	❒	❒	❒	%	❒	

1.5 SET THE CONTEXT

C1. **Prior to the project being discussed, did your organization have a general policy regarding the energy efficiency specification of projects involving new construction and equipment retrofits, replacements or building remodeling generally?**
1. Yes 2. No -8. Do not know -9. Refused

C2. **[If yes] Did your policy target a specific standard of efficiency levels?**
1. Yes 2. No -8. Do not know -9. Refused

C2a. **[If yes] Can you specify what those efficiency levels are?**
-8. Do not know -9. Refused

C3. **Since the project, has your energy efficiency policy changed**
1. Yes 2. No -8. Do not know -9. Refused

C4. **[If Yes] How?**
____

C5. **Does your organization have specific criteria for selecting energy efficient equipment based on payback periods, life cycle costs, or internal rate of return?**
1. Yes 2. No -8. Do not know -9. Refused

C6. **[If C5=1 (yes)] Which?**
1. Simple payback period
2. Life-cycle cost analysis
3. Internal rate of return
4. Other [Record verbatim] C6B. ____
-8. Don't know
-9. Refused

C7. **[If C6=1 (simple payback period)] How many years or less must the project payback be?**
-8. Do not know -9. Refused

C8. **[If C6=2 (internal rate of return)] What is the minimum percent rate of return required for energy-efficiency related projects? [Record 10% as "10" not "0.10"]**
-8. Do not know -9. Refused

C9. **What was simple payback period for this project <u>prior</u> to any financial assistance from Enbridge/Union?**
-8. Do not know -9. Refused

C10. **What was simple payback period for this project <u>after</u> financial assistance from Enbridge/Union?** ***{VIP}***
-8. Do not know -9. Refused

C11. **[Note other relevant comments about how payback period figured in the decision process.]**
____

C12. **Do you recall receiving energy efficiency information and training in any of the following areas that was sponsored or delivered by Union Gas/Enbridge Gas Distribution?**
1. Yes 2. No -8. Do not know -9. Refused

C12a. General energy efficiency information
C12b. Energy audits
C12c. Technology seminars (including those co-sponsored with trades)
C12d. Program information
C12e. Specific project identification

1.6 FREE RIDERSHIP BATTERY

1.1.1 Program Influences

[Ask Questions in this section for all the equipment installed in aggregate.]

I'm going to ask a few more questions about the influence of Enbridge Gas Distribution/Union Gas on your decisions to install high efficiency equipment.

D1. On a scale of 1 to 5, where 1 = "not at all important" and 5 = "very important"… Please indicate how important each of the following aspects of your experience with [Enbridge/Union] were in your decision to install energy efficient equipment at your facility? {*VIP*}

D1a. Financial assistance	**1 2 3 4 5**	**DK**	**Refused**
D1b. Project technical assistance	**1 2 3 4 5**	**DK**	**Refused**
D1c. Your ongoing relationship with the utility *(Providing impartial advice and facilitating unbiased contacts, e.g., business partners)*	**1 2 3 4 5**	**DK**	**Refused**
D1d. Utility education activities *(e.g., case studies, best practice information, training, seminars, conferences, trade shows)*	**1 2 3 4 5**	**DK**	**Refused**
D1e. Advice and assistance from a contractor	**1 2 3 4 5**	**DK**	**Refused**

D1e1. [If D1e>3] Who was that contractor?

D1e2. [If D1e>3] May I have the name and phone number of your main contact there?

D2. Did the assistance you received from [Enbridge/Union] in any way influence the <u>type</u> or <u>efficiency level</u> of the equipment or the <u>amount</u> of high efficiency equipment you installed or process changes implemented?

1 Yes ➔ *Continue to Question D2a*
2 No (all the same equipment would have been installed at the same high efficiencies) ➔ *Skip to Question D3*
-8 Don't know ➔ *Skip to Question D3*
-9 Refused➔ *Skip to Question D3*

D2a. In what ways did the assistance you received from [Enbridge/Union] change your plans or in any other way influence your decision to install energy efficient equipment. Be sure to identify specific equipment.

____

D2b. [Based on response to D2a, fill in a "1 to 5"score indicating the extent to which the program influenced the decision to install energy efficient equipment. DO NOT ASK RESPONDENT DIRECTLY. "1" indicates that the program had no influence; "5" indicates that the program was the primary reason that energy efficient equipment was installed.]
{VIP}

(No program influence) 1 2 3 4 5 (Program was primary influence)

D3. Did your company have specific plans to install <u>any</u> of the *[list <u>all</u> relevant measure categories]* **equipment prior to your first contact with [Enbridge/Union] staff regarding this project?**

1 Yes ➔ *Continue to Question D3a*
2 No ➔ *Skip to Next Section*
-8 Don't know ➔ *Skip to Next Section*
-9 Refused➔ *Skip to Next Section*

D3a. Please describe any plans that you had to install the equipment prior to receiving assistance you received from [Enbridge/Union].
[Interviewer note: the goal here is to understand the plans that were in place before being influenced by program. Probe for equipment type, timing, quantity, and efficiency, as well as prior budgeting. Attempt to elicit responses that will provide answers for the "likelihood" or "share of savings" questions (E2a and E2b).]

D3b. *[Based on responses to D3a, fill in a "1 to 5"score indicating the extent to which respondent was already planning to install the energy efficient equipment. DO NOT ASK RESPONDENT DIRECTLY. "1" indicates that respondent had no plans at all; "5" indicates that respondent had documented plans and had budgeted for all of the efficient equipment.] {VIP}*

(No plans) 1 2 3 4 5 (Documented plans/budget)

1.1.2 Direct Decision Making Questions

[Ask the following questions <u>for each measure category</u> checked under Question B2 in Table 1 above. If previous open-ended questions have provided the necessary information, interviewer may skip the question/measure category. By the end of the interview, interviewer should be able to <u>populate Table 2</u> below with EITHER a "likelihood" OR a "share of equipment" OR both, for each relevant measure category.]

Now I'd like to try to quantify the impact of the [Enbridge/Union] assistance. I'd like you to think about the energy savings you achieved with the equipment you replaced. Some of the savings may have come from just replacing old equipment with <u>any</u> new equipment *[as appropriate: or replacing your existing process with a new process]***. And some of the savings may have come from the fact that the equipment you installed was more efficient than standard new equipment. I'd like you to think about the utility's influence on this last type of savings.**

First, let me ask about the ____________*[MEASURE CATEGORY]***.**

E1. If you had not received assistance you received from [Enbridge/Union] , would you have replaced your existing ___________ *[MEASURE CATEGORY]* or installed new equipment in the foreseeable future? *{VIP}*

[Note that these *do not* *have to be "energy efficient" equipment.]*

1 Yes ➔ *Continue to Question E1a*

2 No ➔ *ENTER 0% for the category in the Free Ridership Value column in Table 2 below (E2c) and move on to the next measure category.*

-8 Don't know ➔ Probe, perhaps using *Question E1a*

-9 Refused➔ *Skip to next measure category*

E1a. When would you likely have made these investments if you had not received assistance from [Enbridge/Union]? *[If clarification needed:]* (Within how many months or years of when you participated in the program?) *{VIP}*

E1aM. _____ Months

E1aY. _____ Years

-8 Don't know ➔ Probe, perhaps using *Question E1a*

-9 Refused➔ *Skip to next measure category*

- *Fill in only for categories for which equipment has been installed.*
- *Enter "0" years if equipment would have been installed in the same timeframe regardless of program participation.*
- *If respondent says, "…in a year or two," enter "1.5" years.*
- *Based on earlier responses, ask either the "likelihood" question below or the "share of equipment" question, whichever is more appropriate.*
- *For example, if respondent installed a single chiller, then the "likelihood" question may be most appropriate; if they installed multiple measures of various types/sizes, then the "share of equipment" may be more appropriate. Some respondents may be able to offer valid responses to both questions.*
- *If you are uncertain, ask both questions. If respondent can provide a response to each, then record both responses.*

E2a. *[Likelihood]* What is the likelihood that you would have installed the same or similar ___________ *[MEASURE CATEGORY]* of the same level of energy efficiency if it had not been for the assistance you received from [Enbridge/Union]? *{VIP}*

1 Definitely would NOT have installed equipment of the same level of energy efficiency

2 Definitely WOULD have installed equipment of the same level of energy efficiency anyway

3 MAY HAVE installed equipment of the same level of energy efficiency, even without the program

E2a2.About what percent likelihood? _____%

-8 Don't know

-9 Refused

E2b. *[Share of equipment]* (Or, if you might have installed some but not all of the ___________ *[MEASURE CATEGORY]* even without the assistance you received from [Enbridge/Union] , then…) what share of the ___________ *[MEASURE CATEGORY]* would you have installed anyway at the same level of energy efficiency? *{VIP}*

[If necessary, or if the flow of the interview dictates, you may derive this value by asking 1) the share of equipment that would have been installed (at any efficiency) and 2) the share of installed equipment that would have been high efficiency. The value in the table below for Question E2b would be the product of these two values.]

Table 2. Equipment

[Fill in EITHER the "likelihood" value OR the "share of equipment" value OR both values for each relevant measure category.
If respondents ask for the timeframe, use the timeframe specified above in Question E1a.
Then enter the appropriate free ridership value (E2c), which will be one of the following, depending on the nature of the project and the responses:

1) *The single value for "likelihood" or "share of equipment" if only one is entered;*
2) *If value provided for both, enter either Likelihood or Share value, whichever best represents the appropriate value*
3) *The product of the two, if appropriate (e.g., if there is a 50% likelihood that 75% of the equipment would have been installed, and respondent definitely wouldn't have done the final 25%)*

Measure Category	**E1. Would have installed in foreseeable future** *[Check no or yes]*		**E1a. Within ____ Years of participation** *[Enter # of years]*	**E2a. Likelihood that energy efficient equipment…**		**E2b. Share of energy efficient equipment that…**	**E2c.** *[Entered by interviewer]*
	2=No *FR=0%*	**1=Yes** (cont.)		**…would have been installed without the program**			**Free Ridership Value**
a.Machine/Process	❒	❒	Months Yrs	%	and/or	%	%
b. HVAC	❒	❒	Months Yrs	%	and/or	%	%
c. Controls							
d. Lighting	❒	❒	Months Yrs	%	and/or	%	%
e. Building envelope	❒	❒	Months Yrs	%	and/or	%	%
f. Domestic hot water	❒	❒	Months Yrs	%	and/or	%	%
g. Refrigeration	❒	❒	Months Yrs	%	and/or	%	%
h. Agriculture	❒	❒	Months Yrs	%	and/or	%	%
i. Fuel substitution	❒	❒	Months Yrs	%	and/or	%	%
j. Other:	❒	❒	Months Yrs	%	and/or	%	%

E2d. *[Additional notes/caveats (e.g., explaining how/why free ridership value was chosen, if necessary)]*

____

E3. Overall, <u>across all equipment</u>, that is the entire project, how much of these <u>extra energy savings</u> would have been achieved anyway, even if you had not received assistance from [Enbridge/Union]. Please provide a lower and upper bound, and then your best estimate. {VIP}

***[If needed for clarification:]* For example, 50% means that half of the extra savings from the energy efficient equipment would have been achieved anyway. Remember, I'm asking only about the extra savings from installing energy efficient equipment instead of standard equipment.**

E3A.Lower bound ➔ _____ % E3B. Upper bound ➔ _____ % E3C. Best estimate ➔ _____ %

1.7 PARTICIPANT INSIDE SPILLOVER

Now I want to ask about whether the assistance you received from [Enbridge/Union] has influenced you to install any other energy efficient equipment that did not receive financial support from [Enbridge/Union].
[For these questions, I'm talking about all your company's participation in the program, not just since October 2006.]

G1. **Did the assistance you got from [Enbridge/Union] in any way influence you to install additional energy efficient equipment** *at this site* **that did not get reported to the program** (i.e., *equipment that would not have been installed without the influence of the program)***?**
1 Yes➔ Continue to Question G2
2 No ➔ Skip to next section
-8 Don't know ➔ Skip to next section
-9 Refused➔ Skip to next section

G2. [*If G1 = "yes"]* **What year did you install this equipment?**

G3. *[If G1 = "yes"]* **Please briefly describe how the assistance you received from [Enbridge/Union] has influenced your decisions to install additional energy efficient equipment at your facility.**
[Identify the types of equipment affected.]

G4. **Would you estimate the energy savings from this extra equipment to be less than, similar to, or more than the savings from the energy efficient equipment from the original project?**
1 Less than the original project ➔
G4a. About what percentage of the savings from the original project?
____% *[Enter a number less than 100%]*
2 About the same savings
3 More than the original project ➔
G4b. About what percentage of the savings from the original project?
____% *[Enter a number greater than 100%]*
-8 Don't know
-9 Refused

G5. **What share of the savings from this extra equipment can reasonably be attributed to the influence of the assistance you received from [Enbridge/Union]?**
______% *[100% or less]*
-8 Don't know
-9 Refused
[Interviewer may be able to complete this based on response to G3, or at least use G3 to check for consistency. Probe if inconsistent to ensure that respondent is correctly interpreting the question.]

1.8 PARTICIPANT OUTSIDE SPILLOVER

H1. **Did the assistance you received from [Enbridge/Union] in any way influence you to install any additional energy efficient equipment *at other jobs or facilities in Union Gas/Enbridge Gas Distribution's Service Territory* beyond what you would have done otherwise?**
[Don't include projects that participated in another Union/Enbridge program.]
1 Yes ➔

H1a. How many other facilities were influenced (that did not participate in Union Gas/Enbridge Gas Distribution programs)? _________ (-8 Don't know, -9 Refused)

2 No ➔ Skip to next section
-8 Don't know ➔ Skip to next section
-9 Refused ➔ Skip to next section

H2. *[If H1 = "yes"]* **Please briefly describe how the assistance you received has influenced your decisions to install this equipment. (Probe to identify the types of equipment affected.)**

H3. On average, would you estimate the energy savings from these other non-program projects to be less than, similar to, or more than the savings from the energy efficient equipment from the program-supported that we've been discussing?
[E.g., if the same equipment was implemented in a facility twice as big, then savings would be 200%. Be sure to emphasize that this is savings "on average" not in aggregate across the many buildings that might be affected.]

1. Less than the Custom Projects project
   H3A. About what percentage of the savings from the Custom Projects project? ____% *[Enter a number less than 100%]*
2. About the same savings
3. More than the Custom Projects project
   H3B. About what percentage of the savings from the Custom Projects project? ____% *[Enter a number greater than 100%]*

-8 Don't know
-9 Refused

H4. What share of the savings from energy efficient equipment at these facilities can reasonably be attributed to the influence of the assistance you received from [Enbridge/Union]?
[Interviewer may be able to complete this based on response to H2, or at least use H2 to check for consistency. Probe if inconsistent to ensure that respondent is correctly interpreting the question.]
______% [100% or less]
-8 Don't know
-9 Refused

1.9 Firmographics

Z1. Does your company own or lease this building? :

1. Owner
2. Lease

-8. Don't know
-9. Refused

Z2. Approximately how large is the facility that received the efficiency improvements we have been talking about? (square meters)

1. Up to 5,000
2. 5,001 to 10,000
3. 10,001 to 15,000
4. 15,001 to 25,000
5. 25,001 to 50,000
6. 50,001 to 100,000
7. 100,001 to 200,000
8. 200,001 to 500,000
9. Over 500,000

-8 Do not know
-9 Refused

Z3. Is your company independent, or part of a larger organization?

1. Independent
2. Part of a larger company
3. Other Z3a. (specify) ________________________________

-8. Don't know
-9. Refused

Z4. How old is your facility?

-8 Don't know
-9 Refused

Z5. Does your building contain any manufacturing processes?

1. Yes 2. No -8. Do not know -9. Refused

Z6a. [If yes] What type of energy do they use?

1. Natural Gas
2. Electricity
3. Other

-8 Don't know
-9 Refused

Z6b. [If yes to Z5] Have you reviewed their energy usage?

1. Yes 2. No -8. Do not know -9. Refused

Z7. How many locations does your organization have in Ontario?

1. One	5. More than 20
2. 2 to 5	6. Currently Unoccupied
3. 6 to 10	-8. Don't know
4. 11 to 20	-9. Refused

Z8. Approximately how many full time employees or full time equivalents does your organization have at your locations in Ontario?

1. Fewer than 5	5. 50 to 99
2. 5 to 9	6. 100 to 249
3. 10 to 19	7. 250 or More
4. 20 to 49	-8 Do not know
	-9 Refused

Those are all the questions I had.

Z9. Do you have any final comments you would like to make?

____

____

Thank you very much for your time!

Z10. Record all additional or supporting comments here.

____

____

2. Custom Projects Trade Ally Survey

Business Partner (EGD) or Channel Partner (UG)

2.1 Conventions

- **Bold text is spoken.**
- *Italics text is instructions for the interviewer.*
- *{VIP}* indicates questions that are particularly important and represent specific boxes in the analysis flow chart.

2.2 Sample Data

(NOTE: Projects are the survey unit, so each project to be interviewed separately. Thus, use separate form for each Project, even if the same interviewee is associated with multiple projects)

Contact Name ____________________________ Interviewer Initials ________________________

Firm Name ______________________________ Survey Date _____________________________

Address _________________________________ Sample ID # _____________________________

Phone Number ___________________________ Project ID #______________________________

Project Completion Date___________________

Equipment installed: ____

Customer involved: ____

2.3 Information From Utility Staff and Records

3.1. Project Briefing Information – Union/EGD sales/marketing staff input:

3.1.1. Month/year of initial EGD/Union Gas involvement with the project or its precursors

3.1.1a Month_______

3.1.1b Year_______

3.1.2. General context of EGD/Union Gas relationship with Channel/Business Partner:

a. Historical education effort with customer on efficiency opportunities & Enbridge/Union Gas programs (high, medium, low level of effort):

____

____

b. Facility energy audits performed (steam traps, boilers, etc)

____

____

c. Distribution and merchant services support provided (general credibility & relationship building)

____

____

d. Other (describe)____

____

3.1.3. Services provided to Channel/Business Partner in project-related contacts:

a. Gas bill histories (usage, cost) ____

b. Approximate number of project-related contacts with customer ____________________

c. General information on program ____

____

d. Project-specific technical information or analysis: technical/engineering, financial , vendor/technology alternatives, etc.

____

____

e. Project/technology recommendations ____________________________________

____

f. Other (describe) ____

____

3.1.4. Channel/Business Partner involvement with customer project:

a. General context of Channel/Business Partner involvement with project or its precursors

____

____

b. Extent of Channel/Business Partner use of Union Gas program & other needed information, Union Gas technical services or other support

____

____

c. Type of service & information support given customer generally and project specifically by Channel/Business Partner (engineering/financial analysis of alternatives, project engineering, project construction, ongoing Maintenance/Repair/Operations support, other/describe)

____

____

d. **Low/medium/high intensity of support by Channel/Business Partner to customer generally and project specifically**

____

e. **Low/medium/high effect of on project's efficiency level**

____

2.4 PRELIMINARY CONCERNS

[If they express hesitation, use an appropriate combination of the following.]
Confidentiality. We are an independent research firm and will not report your individual responses in any way that would reveal your identity. Your response will only be presented in aggregate along with responses from other survey participants.
Security. Your responses will not affect your ability to participate in the program in the future. All responses are your opinion and there are no wrong answers.
Sales concern. I am not selling anything. I simply want to understand what factors were important to your company when deciding to install energy efficient equipment with assistance from this program.
Contact. For Union, the Channel Partners would have been notified by phone call or email from their Account Manager. If they have any questions, it is their Union Gas Account Manager they can call.
The Enbridge Industrial contact is Peter Goldman at 416-495-6348 or Stefan Surdu at 416-495-5917 or your Enbridge Energy Solutions Consultant/Union representative.

2.5 INTRODUCTION

A1. What is your primary line of business?

1. Consulting engineer
2. Manufacturer
3. Distributor or equipment sales
4. Installation contractor
5. Property manager
6. Other. A1b. Please specify. ____

2.6 CONFIRMATION OF EQUIPMENT INSTALLED

B1. Prior to the interview, review program records for the project or projects. In Table 1 below under "Program Records," check off each measure category for which energy efficient equipment was installed.

B2. Just to make sure that we're talking about the same project, I show that your company designed and specified/supplied/installed *[list major equipment or equipment categories]* at *[end use customer}*. **To your recollection, was all this work completed?**
[Check off each category for which respondent recalls installing equipment. If information is not available from program records, ask the respondent to recall what measures were undertaken.]

B3. Do you recall if Union Gas/Enbridge provided financial assistance for installing this equipment?
1. Yes 2. No -8. Do not know -9. Refused

[Ask of only those checked in B2. Check off each category for which respondent recalls that Union Gas/Enbridge provided financial assistance.]

B3a. *[If yes, for Union Only]* **Who received the incentive, your company or the customer?**
1. Your Company
2. The Customer
-8. Do not know
-9. Refused

B3b. **Approximately how much was the incentive as a percent of the total project cost?**
*[Ask of only those checked in B3.]*______________________________%
-8. Do not know
-9. Refused

[Ask of only those checked in B2. Check off each category for which respondent recalls that Union Gas/Enbridge provided technical assistance for the measure.]

B4. **Did your company receive any technical or marketing assistance from Union Gas/Enbridge staff?**
1. Yes   2. No   -8. Do not know   -9. Refused

B4a. ***[If Yes]*** **Please describe.**

____

____

B5. **Was the customer aware that Union/Enbridge was involved with the project?**
1. Yes   2. No   -8. Do not know   -9. Refused

Table 1. Equipment in program records and recalled by respondent

[Check if Yes]

Measure Category	**B1.** Program Records	**B2.** Respondent Recollection	**B3.** Union /Enbridge Financial Assistance	**B3a.** Trade ally received incentive	**B3b.** Incentive as % of Project Cost	**B4.** Union /Enbridge Technical or Marketing Assistance	Notes/Caveats
a. Machine/Process	❒	❒	❒	❒	%	❒	
b. HVAC (incl. furnaces, all boilers, A/Cs, chillers, EMS, etc.)	❒	❒	❒	❒	%	❒	
c. Lighting	❒	❒	❒	❒	%	❒	
d Controls (boiler controls, variable frequency drive controls	❒	❒	❒	❒	%	❒	
e. Building envelope (incl. insulation, windows)	❒	❒	❒	❒	%	❒	
f. Domestic hot water	❒	❒	❒	❒	%	❒	
g. Refrigeration	❒	❒	❒	❒	%	❒	
h. Agriculture	❒	❒	❒	❒	%	❒	
i. Converted equipment from electricity to gas (fuel substitution)	❒	❒	❒	❒	%	❒	
j. Other: ______________	❒	❒	❒	❒	%	❒	

2.7 Set the Context

C1. Do you recall receiving energy efficiency information and/or training in any of the following areas that was sponsored or delivered by Union Gas/Enbridge?

1. Yes 2. No -8. Do not know -9. Refused

		Yes	No	Do not know	Refused
C1a.	**General energy efficiency information**	❐	❐	❐	❐
C1b.	**Energy audits**	❐	❐	❐	❐
C1c.	**Technology seminars**	❐	❐	❐	❐
C1d.	**Program information**	❐	❐	❐	❐
C1e.	**Specific project identification**	❐	❐	❐	❐
C1f.	**Training or workshops**	❐	❐	❐	❐
C1g.	**Software e.g., Cumulative Sum of Differences (CUSUM)**	❐	❐	❐	❐
C1h.	**Lunch & Learns**	❐	❐	❐	❐

2.8 Free Ridership Battery

2.8.1 Program Influences

[Ask Questions in this section for all the equipment installed in aggregate.]

I'm going to ask a few more questions about the influence of Enbridge/Union Gas on your customer's decisions to install high efficiency equipment.

D1. On a scale of 1 to 5, where 1 = "not at all important" and 5 = "very important"… Please indicate how important each of the following aspects of your experience with [Enbridge/Union] were in the decision to install energy efficient equipment for your customer at this facility? *{VIP}*

D1a. Financial assistance 1 2 3 4 5 -8 DK -9 Refused

D1b. Project technical assistance 1 2 3 4 5 -8 DK -9 Refused

D1c. Your ongoing relationship with the utility 1 2 3 4 5 -8 DK -9 Refused

(Providing impartial advice and facilitating unbiased contacts, e.g., business partners)

D1d. Utility education activities 1 2 3 4 5 -8 DK -9 Refused

(e.g., case studies, best practice information, training, seminars, conferences, trade shows)

D1e. Marketing assistance 1 2 3 4 5 -8 DK -9 Refused

(e.g., lead generation, printed material)

D2. Did the assistance you received from [Enbridge/Union] in any way influence the <u>type</u> or <u>efficiency level</u> of the equipment, the <u>amount</u> of high efficiency equipment that was installed or efficient features that were added or process changes that were implemented?

1 Yes ➔ *Continue to Question D2a*

2 No (all the same equipment would have been installed at the same high efficiencies) ➔ *Skip to Question D3*

-8 Don't know ➔ *Skip to Question D3*

-9 Refused➔ *Skip to Question D3*

D2a. In what ways did the [Enbridge/Union] assistance change the plans or in any other way influence the decision to install energy efficient equipment? Be sure to identify specific equipment.
[Probe for whether the contractor added efficient features to make a more efficient system.]

____

____

____

D2b. ***[Based on response to D2a, fill in a "1 to 5"score indicating the extent to which the program influenced the decision to install energy efficient equipment. DO NOT ASK RESPONDENT DIRECTLY. "1" indicates that the program had no influence; "5" indicates that the program was the primary reason that energy efficient equipment was installed.]***
{VIP}

(No program influence) 1 2 3 4 5 (Program was primary influence)
-8 Don't know -9 Refused

D3. Did this customer have specific plans in place to install <u>any</u> of the *[list <u>all</u> relevant measure categories]* **equipment prior to contacting your company regarding this project?**
1 Yes ➔ *Continue to Question D3a*
2 No ➔ *Skip to Next Section*
-8 Don't know ➔ *Skip to Next Section*
-9 Refused➔ *Skip to Next Section*

D3a. Please describe the plans to install the equipment prior to contacting you.
[Interviewer note: the goal here is to understand the plans that were in place before being influenced by the trade ally. Had they already planned to install all the measures and at the same level of efficiency and with all the energy saving features? Probe for equipment type, timing, quantity, and efficiency, as well as prior budgeting. Attempt to elicit responses that will provide answers for the "likelihood" or "share of savings" questions (E2a and E2b).]

____

____

____

D3b. *[Based on responses to D3a, fill in a "1 to 5"score indicating the extent to which end user was already planning to install the energy efficient equipment prior to contact with the trade ally. DO NOT ASK RESPONDENT DIRECTLY. "1" indicates that respondent had no plans at all; "5" indicates that respondent had documented plans and had budgeted for all of the efficient equipment.]* ***{VIP}***

(No plans) 1 2 3 4 5 (Documented plans/budget)
-8 Don't know -9 Refused

D4. *[Enbridge only]* **Enbridge offers a higher incentive if three or more measures are implemented. Did this higher incentive figure in the decision process?**

1 Yes ➔ *Continue to Question D4a*
2 No ➔ *Skip to Next Section*
-8 Don't know ➔ *Skip to Next Section*
-9 Refused➔ *Skip to Next Section*

D4a. How?

____

____

____

D4b. *[Based on responses to D4a, fill in a "1 to 5"score indicating how much influence the higher incentive had on the decision. DO NOT ASK RESPONDENT DIRECTLY.] {VIP}*

(No influence) 1 2 3 4 5 (Critical Influence)
-8 Don't know -9 Refused

2.8.2 Direct Decision Making Questions

[Fill in Table 2 for most of these questions.]
[Ask the following questions for each measure category checked under Question B2 in Table 1 above. If previous open-ended questions have provided the necessary information, interviewer may skip the question/measure category. By the end of the interview, interviewer should be able to populate Table 2 below with EITHER a "likelihood" OR a "share of equipment" OR both, for each relevant measure category.]

Let me ask about the ____________*[MEASURE CATEGORY]***.**

E1. **Did the *[Enbridge/Union]* assistance in any way change the timing of the installation?**
1. Yes 2. No -8. Do not know -9. Refused

E1a. *[If Yes]* **Was the equipment installed earlier or later than first planned?**
1. Earlier
2. Later

E1b. ***[If Yes to E1]*** **When would it have been installed without the program assistance?** *{VIP}*

E1bM. ___ Month
E1bY. ___ Year
-7 Never -8. Do not know -9. Refused

Based on earlier responses, ask either the "likelihood" question below or the "share of equipment" question, whichever is more appropriate. For example, if respondent installed a single chiller, then the "likelihood" question may be most appropriate; if they installed multiple measures of various types/sizes, then the "share of equipment" may be more appropriate. Some respondents may be able to offer valid responses to both questions If you are uncertain, ask both questions. If respondent can provide a response to each, then record both responses.

E2a. ***[Likelihood]*** **What is the likelihood that you would have installed the same or similar ___________ *[MEASURE CATEGORY]* of the <u>same level of energy efficiency</u> or with the same features that affect the overall system efficiency if it had not been for the assistance from [Enbridge/Union]?**
{VIP}

1 Definitely would NOT have installed equipment of the same level of energy efficiency
2 Definitely WOULD have installed equipment of the same level of energy efficiency anyway
3 MAY HAVE installed equipment of the same level of energy efficiency, even without the program
E2a2.About what percent likelihood? _____%
-8 Don't know
-9 Refused

E2b. ***[Share of equipment]*** **What share of the ___________ *[MEASURE CATEGORY]* would you have installed anyway at the <u>same level of energy efficiency</u> if it had not been for the assistance from [Enbridge/Union]?** *{VIP}*

[If necessary, or if the flow of the interview dictates, you may derive this value by asking 1) the share of equipment that would have been installed (at any efficiency) and 2) the share of installed equipment that would have been high efficiency. The value in the table below for Question E2b would be the product of these two values.]

-8 Don't know
-9 Refused

Table 2. Equipment

[Fill in EITHER the "likelihood" value OR the "share of equipment" value OR both values for each relevant measure category.
If respondents ask for the timeframe, use the timeframe specified above in Question E1a.
Then enter the appropriate free ridership value (E2c), which will be one of the following, depending on the nature of the project and the responses:

1) *The single value for "likelihood" or "share of equipment" if only one is entered;*
2) *If value provided for both, enter either Likelihood or Share value, whichever best represents the appropriate value*
3) *The product of the two, if appropriate (e.g., if there is a 50% likelihood that 75% of the equipment would have been installed, and respondent definitely wouldn't have done the final 25%)*

Measure Category	E1. Change when the equipment was installed?	E1a. Forward or Slow	E1b. When would it have been installed?	E2a. Likelihood that energy efficient equipment… …would have been installed without the program		E2b. Share of energy efficient equipment that…	E2c. *[Entered by interviewer]* Free Ridership Value
a. Machine/Process	Y N DK R	F S	Months Yrs	%	and/or	%	%
b. HVAC (incl. furnaces, all boilers, A/Cs, chillers, EMS, etc.)	Y N DK R	F S	Months Yrs	%	and/or	%	%
c. Lighting	Y N DK R	F S					
d Controls (boiler controls, variable frequency drive controls	Y N DK R	F S	Months Yrs	%	and/or	%	%
e. Building envelope (incl. insulation, windows)	Y N DK R	F S	Months Yrs	%	and/or	%	%
f. Domestic hot water	Y N DK R	F S	Months Yrs	%	and/or	%	%
g. Refrigeration	Y N DK R	F S	Months Yrs	%	and/or	%	%
h. Agriculture	Y N DK R	F S	Months Yrs	%	and/or	%	%
i. Converted equipment from electricity to gas (fuel substitution)	Y N DK R	F S	Months Yrs	%	and/or	%	%
j. Other: ______________	Y N DK R	F S	Months Yrs	%	and/or	%	%

E2d. *[Additional notes/caveats (e.g., explaining how/why free ridership value was chosen, if necessary)]*

____

E3. Overall, across all equipment, that is the entire project, how much of these extra energy savings would have been achieved anyway, even without the assistance from [Enbridge/Union]. Please provide a lower and upper bound, and then your best estimate. {VIP}

***[If needed for clarification:]* For example, 50% means that half of the extra savings from the energy efficient equipment would have been achieved anyway. Remember, I'm asking only about the extra savings from installing energy efficient equipment instead of standard equipment.**

E3A. Lower bound ➔ _____ % E3B. Upper bound ➔ _____ % E3C. Best estimate ➔ _____ %

2.9 PARTICIPANT INSIDE SPILLOVER

G1. Did the assistance from [Enbridge/Union] in any way influence you to help the customer install additional energy efficient equipment *at the same site* that did not get reported to the program (i.e., *equipment that would not have been installed without the influence of the program)***?**

1 Yes➔ Continue to Question G2
2 No ➔ Skip to next section
-8 Don't know ➔ Skip to next section
-9 Refused➔ Skip to next section

G2. [*If G1 = "yes"]* **What year did this equipment get installed?**
-8 Don't know
-9 Refused

G3. *[If G1 = "yes"]* **Please briefly describe how the program assistance from [Enbridge/Union] influenced the decisions to install additional energy efficient equipment at the same site.**
[Identify the types of equipment affected.]

G4. Would you estimate the energy savings from this additional equipment to be less than, similar to, or more than the savings from the energy efficient equipment from the original project?
1 Less than the original project ➔
G4a. About what percentage of the savings from the original project?
____% [Enter a number less than 100%]
2 About the same savings
3 More than the original project ➔
G4b. About what percentage of the savings from the original project?
____% [Enter a number greater than 100%]
-8 Don't know
-9 Refused

G5. What share of the savings from this additional equipment can reasonably be attributed to the influence of the assistance from [Enbridge/Union]?
______% *[100% or less]*
-8 Don't know
-9 Refused

[Interviewer may be able to complete this based on response to G3, or at least use G3 to check for consistency. Probe if inconsistent to ensure that respondent is correctly interpreting the question.]

2.10 PARTICIPANT OUTSIDE SPILLOVER

H1. Did the assistance from [Enbridge/Union] in any way influence you to help the company to install any additional energy efficient equipment *<u>at other jobs or facilities in Union Gas/Enbridge's Service Territory</u>* beyond what they would have done otherwise?
[Don't include projects that participated in another Union/Enbridge program.]

1 Yes ➔

H1a. How many other facilities were influenced (that did not participate in Union Gas/Enbridge programs)? ___________________________ (-8 Don't know, -9 Refused)

2 No ➔ Skip to next section
-8 Don't know ➔ Skip to next section
-9 Refused ➔ Skip to next section

H2. *[If H1 = "yes"]* **Please briefly <u>describe how</u> the assistance has influenced the decisions to install this equipment. (Probe to identify the types of equipment affected.)**

____

____

H3. <u>On average</u>, would you estimate the energy savings from these other <u>non-program</u> projects to be <u>less than</u>, <u>similar to</u>, or <u>more than</u> the savings from the energy efficient equipment from the program-supported project that we've been discussing?
[E.g., if the same equipment was implemented in a facility twice as big, then savings would be 200%. Be sure to emphasize that this is savings "on average" not in aggregate across the many buildings that might be affected.]

1. Less than the Custom Projects project
   H3A. About what percentage of the savings from the Custom Projects project? ____% *[Enter a number <u>less than</u> 100%]*
2. About the same savings
3. More than the Custom Projects project
   H3B. About what percentage of the savings from the Custom Projects project? ____% *[Enter a number <u>greater than</u> 100%]*

-8 Don't know
-9 Refused

H4. What share of the savings from energy efficient equipment at these facilities can reasonably be attributed to the influence of the assistance from [Enbridge/Union]?
[Interviewer may be able to complete this based on response to H2, or at least use H2 to check for consistency. Probe if inconsistent to ensure that respondent is correctly interpreting the question.]
______% [100% or less]
-8 Don't know
-9 Refused

2.11 CLOSING

Those are all the questions I had.

Z9. Do you have any final comments you would like to make?

____

____

____

Thank you very much for your time!

Z10. Record all additional or supporting comments here.

____

____

____

2. CUSTOM PROJECTS AUDIT-ONLY SURVEY

2.1 CONVENTIONS

- Blue text is spoken.
- *Italics text is instructions for the interviewer.*
- Arial, bold font in brackets is skip instructions **[skip instructions]**
- Underlined in brackets are data from the sample: [<u>sample data</u>]

2.2 INTERVIEWER DATA

Interviewer ID
Survey Date
Survey Duration

2.3 SAMPLE DATA

Sample ID #
Contact Name
Contact Title
Contact Phone Number
Firm Name
Address
Company Phone Number
Audit Date
Recommended measure description (up to 5 per customer)
Recommended measure estimated gas savings (up to 5 per customer)

2.4 Recall Audit, Identify Respondent

[Enbridge] **According to our records, you had an energy or HVAC audit conducted by a third party professional that was co-funded by Enbridge Gas Distribution on [date].**

[Union] **According to our records, you had a boiler audit or feasibility study conducted with financial assistance provided by Union Gas on [date].**

1. **Do you recall receiving that audit?**
   1. Yes .... 2. No -8. Do not know
   .... -9. Refused

2. [If not Yes] **Can you suggest someone else at your company who might be familiar with the audit?**
   1. Yes .... 2. No -8. Do not know
   .... -9. Refused

   If yes, get name and phone. Ask to speak with this person. Start again at the beginning.

2.5 Measure-Specific Questions

[The interviewer will repeat these questions for each audit recommendations (limit of 5 recommendations).]

3. **The audit recommended that you implement [recommendation]. Do you recall that recommendation?**
   1. Yes .... 2. No -8. Do not know
   .... -9. Refused

4. **Has it been installed or implemented?**
   1. Yes .... 2. No 3. Partial
   .... 4. Caveat
   -8. Do not know .... -9. Refused

   Partial = Some of the recommended equipment was installed but not all.
   Caveat = Installed something related to the recommendation but not the exact thing recommended

[If Q4=3]

5. **What percent of the items recommended or equipment did you install?**

   Enter percents as whole numbers, thus 90% would be entered as "90" NOT "0.9".
   -8 Don't know .... -9 Refused

[If Q4=4]

6. **The audit estimated that this item [or the actual equipment] would save [savings] cubic meters of gas. What percent of that estimated savings do you think you achieved?**

   Enter percents as whole numbers, thus 90% would be entered as "90" NOT "0.9".
   -8 Don't know .... -9 Refused

[If not installed (Q4=2, -8, -9)]

6A. **Why have you not implemented this recommendation yet?**
   1. We plan to but have not yet
   2. Do not have the money
   3. We do not have that equipment any more
   4. Other
      6AOther. **[Capture verbatim]**

   -8 Don't know
   -9 Refused

[If not installed (Q4=2, -8, -9), skip to the next recommendation. If last recommendation, skip to the next section.]

7. **When was it installed?**

Record month and year installed

-8 Don't know.. -9 Refused

8. **On a scale of 1 to 5 where 1 is "no influence" and 5 is "a great deal of influence", how much influence did the audit have in your decision to implement this item?**

1 2 3 4 5 .... -8 Don't know -9 Refused

9. **What share of the savings from this item can reasonably be attributed to the influence of the audit?**

Enter percents as whole numbers, thus 90% would be entered as "90" NOT "0.9".

-8 Don't know.. -9 Refused

2.6 Firmographics

Now I have just a few questions about your company.

Z1. Approximately how large is the facility that received the audit? (square feet)?

1. Up to 5,000
2. 5,001 to 10,000
3. 10,001 to 15,000
4. 15,001 to 25,000
5. 25,001 to 50,000
6. 50,001 to 100,000
7. 100,001 to 200,000
8. 200,001 to 500,000
9. Over 500,000

-8 Do not know

-9 Refused

Z2. Is the facility you work in independent, or part of a larger organization?

1. Independent
2. Part of a larger company
3. Other

Z3Other. [Capture verbatim]

-8. Don't know

-9. Refused

Z3. Approximately how many full time employees or full time equivalents does your organization have at your locations in Ontario?

1. Fewer than 5
2. 5 to 9
3. 10 to 19
4. 20 to 49
5. 50 to 99
6. 100 to 249
7. 250 or More

-8 Do not know

-9 Refused

Those are all the questions I had. Thank you very much for your time!

3. CUSTOM PROJECTS NONPARTICIPANT SPILLOVER SURVEY

3.1 CONVENTIONS

- Blue text is spoken.
- Italics text is instructions for the interviewer.
- Arial, bold font in brackets is skip instructions: **[skip instructions]**
- Underlined in brackets are data from the sample: [sample data]

3.2 INTERVIEWER DATA

Interviewer ID
Survey Date
Survey Duration

3.3 SAMPLE DATA

Sample ID # (Per Sample File)
Contact Name
Contact Title
Contact Phone Number
Firm Name
Address
Company Phone Number
Dwtp Code Desc (Per Sample File)
Utility (Enbridge / Union Gas – Per Sample File)

3.4 QUALIFY RESPONDENT, EXPLAIN PURPOSE

Find someone knowledgeable about the company's buildings and equipment.

Q1. May I speak with the plant engineer or facilities manager?

1 Yes **[CONTINUE WITH INTRODUCTION]**
-8 Do Not Know **[PROMPT WITH DESCRIPTION OF APPROPRIATE CONTACT]**
-9 Refused **[THANK AND TERMINATE]**

DESCRIPTION OF APPROPRIATE CONTACT (If necessary):

I would like to speak with someone who is accountable for energy efficiency or who is responsible for your building's operation and is knowledgeable about your company's energy-using equipment, like space and water heating, ventilation, and industrial processes.

INTRODUCTION - Once you have the person on the phone (or if needed to find the person) say:

I am calling on behalf of [Enbridge/Union Gas] to ask some questions about your plant or building operation and equipment to help [Enbridge/Union Gas] improve their energy efficiency programs.

If necessary:

Confidentiality: **We will not report your individual answers to [Enbridge/Union Gas]. We only report results aggregated across all the respondents.**

Record

Q2. Name

Q3. Phone number

3.5 PARTICIPATION SCREENING

P1. Have you heard of [Enbridge/Union Gas'] energy efficiency program?

1 Yes **[SKIP TO P3]**
2 No
-8 Don't Know
-9 Refused

P2. The energy efficiency program is designed to provide incentives and technical assistance for implementing projects that save energy. Does that sound familiar?

1 Yes
2 No **[THANK AND TERMINATE]**
-8 Don't Know **[THANK AND TERMINATE]**
-9 Refused **[THANK AND TERMINATE]**

P3. Have you received financial incentives through the program to make energy efficiency improvements or conduct an energy audit?

1 Yes **[THANK AND TERMINATE]**
2 No
-8 Don't Know
-9 Refused

P4. Have you had contact with [<u>Enbridge/Union Gas'</u>] energy efficiency program through a trade show, attending a workshop or receiving a publication?

1 Yes
2 No
-8 Don't Know
-9 Refused

3.6 EQUIPMENT SCREENING

S1. Have you modified or installed any of the following types of equipment since the beginning of 2005?
Read each option.

Equipment	Yes	No	Don't Know	Refused
a. Space Heating	1	2	-8	-9
b. Water Heating	1	2	-8	-9
c. Steam generation	1	2	-8	-9
d. Other kind of heating	1	2	-8	-9
e. Ventilation	1	2	-8	-9
f. Industrial process improvements	1	2	-8	-9
g. Building controls	1	2	-8	-9

[IF 'NO, DK or RF' TO <u>ALL</u> IN S1, THANK AND TERMINATE]

[FOR EACH 'YES' IN S1 ASK]

S2. When did you make that change?
Record month and year.

Equipment	Month	Year	Don't Know	Refused
a. Space Heating	-- --	-- -- -- --	-8	-9
b. Water Heating	-- --	-- -- -- --	-8	-9
c. Steam generation	-- --	-- -- -- --	-8	-9
d. Other kind of heating	-- --	-- -- -- --	-8	-9
e. Ventilation	-- --	-- -- -- --	-8	-9
f. Industrial process improvements	-- --	-- -- -- --	-8	-9
g. Building controls	-- --	-- -- -- --	-8	-9

3.7 PROGRAM INFLUENCE

[FOR EACH 'YES' IN S1 ASK]

G1. On a scale of 1 to 5 where 1 is "no influence" and 5 is "a great deal of influence", how much influence did the [Enbridge/Union Gas] energy efficiency program have in your decision to install or modify your [Equipment]?

Equipment	No Influence				Great Deal of Influence	Don't Know	Refused
a. Space Heating	1	2	3	4	5	-8	-9
b. Water Heating	1	2	3	4	5	-8	-9
c. Steam generation	1	2	3	4	5	-8	-9
d. Other kind of heating	1	2	3	4	5	-8	-9
e. Ventilation	1	2	3	4	5	-8	-9
f. Industrial process improvements	1	2	3	4	5	-8	-9
g. Building controls	1	2	3	4	5	-8	-9

[FOR EACH 'YES' IN S1 ASK]

G2. What share of the savings from this change can reasonably be attributed to the influence of the [Enbridge/Union Gas] energy efficiency program?

Enter percents as whole numbers, thus 90% would be entered as "90" NOT "0.9".

Equipment	**%**	**Don't Know**	**Refused**
a. Space Heating	-- -- --	-8	-9
b. Water Heating	-- -- --	-8	-9
c. Steam generation	-- -- --	-8	-9
d. Other kind of heating	-- -- --	-8	-9
e. Ventilation	-- -- --	-8	-9
f. Industrial process improvements	-- -- --	-8	-9
g. Building controls	-- -- --	-8	-9

[FOR EACH 'YES' IN S1 ASK]

G3. On a scale of 1 to 5 where 1 is "no influence" and 5 is "a great deal of influence", how much influence did your suppliers or contractors have in your decision to install or modify your [Equipment]?

Equipment	**No Influence**				**Great Deal of Influence**	**Don't Know**	**Refused**
a. Space Heating	1	2	3	4	5	-8	-9
b. Water Heating	1	2	3	4	5	-8	-9
c. Steam generation	1	2	3	4	5	-8	-9
d. Other kind of heating	1	2	3	4	5	-8	-9
e. Ventilation	1	2	3	4	5	-8	-9
f. Industrial process improvements	1	2	3	4	5	-8	-9
g. Building controls	1	2	3	4	5	-8	-9

3.8 FOLLOW-UP CALL OK?

[IF P4 > 2 OR P5 > 30% FOR ANY MEASURE FROM S1 THEN CONTINUE. ELSE, TERMINATE]

F1. We want to have one of our engineers ask you some technical questions about the equipment changes you made. Will that be OK?

1 Yes **[VERIFY/COLLECT CONTACT INFORMATION]**
2 No **[THANK AND TERMINATE]**
-8 Don't Know **[THANK AND TERMINATE]**
-9 Refused **[THANK AND TERMINATE]**

May I verify your:

F2. Name ______________________________ [PRE-FILL WITH INFO FROM Q2]
F3. Phone number ______________________________ [PRE-FILL WITH INFO FROM Q3]
F4. Email Address ______________________________

Those are all the questions I had. Thank you very much for your time!

STEAM TRAP RESEARCH SUMMARY

Assumption	Measure Life of Steam Traps	
Recommendation	Increase Measure Life from 3 years to 13 years	
Authors	Terry Whitehead, P. Eng, EGD Manager of DSM Standards Pirapa Tharmalingam EGD Senior Load Research Analyst	Robert Griffin, P.Eng. EGD DSM Industrial Sales
Research Completed	November, 2007	

BACKGROUND

Steam traps are automatic valves that release condensed steam (*water)* from a steam system while preventing the loss of steam vapour. They also remove non-condensable gases from the steam system. Steam traps are designed to maintain steam energy efficiency for performing specific tasks such as heating a building or maintaining heat for process use. Once steam has transferred heat through a process and becomes hot water, it is removed by the trap from the steam side as condensate and returned to the boiler via condensate return lines. Alternatively, the condensate is discharged, simply wasting water and energy.

In the Settlement Agreement for the Enbridge Gas Distribution 2003 DSM Program, a steam trap measure life of 3 years was agreed on between the parties (RP-2002-0133, Ex. N1, Tab 1, Sch.1, Pg. 64).

Since the introduction of the "steam trap audit program" at Enbridge in 1998, 216 audits have been completed through third parties, providing a significant amount of data that has enabled Enbridge to statistically establish the average operating life of a steam trap.

RESEARCH DESCRIPTION

Enbridge has conducted 216 steam trap surveys (to the end of 2005) through the Industry Partners Spirax Sarco and Preston Phipps. These surveys were completed over a period of about 7 years.

The general finding in the vast majority of cases of the 216 surveys done to the end of 2005 was that the traps were quite old and poorly maintained on average.

The results of the surveys were as follows:

- 216 surveys
- 41,124 traps tested
- 16.3% of traps leaking
- 7.7% of traps blocked
- Total defect rate: 24.0%

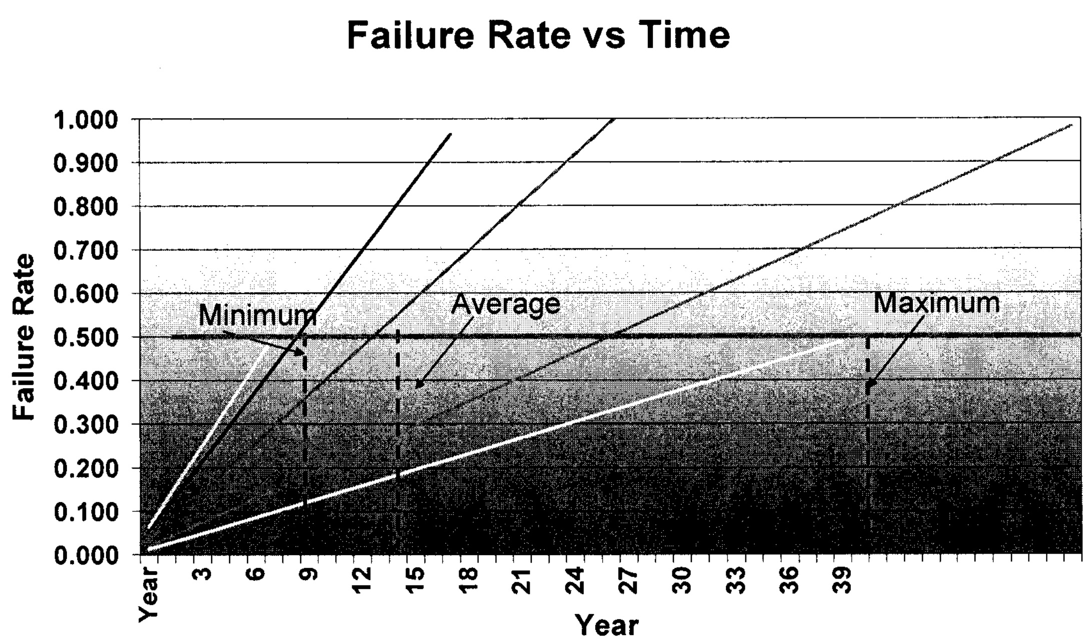
Of the 216 steam trap audits, four sites provided multiple audits over many years of inspecting the same steam traps. This information was used to develop a statistical evaluation of the life span of a steam trap. At these sites the steam traps were tagged during the first audit which allowed subsequent audits to track specific steam traps. To complete a life analysis the steam traps which were replaced or repaired during the first audit provide a base year for the equipment.

Each of the sites provided two audits of the same steam traps. The base year varied from 2001 to 2004, and the follow-up study year was either 2 years, or 4 years apart. The total number of leaking traps was separated. It was understood that the four customer sites did not repair or replace any of the steam traps between the two audit years, therefore this data provides reasonable life operation of the steam traps that were replaced in the base year.

RESULTS

Using the data it is possible to conclude the "average" years it takes for 50% of the units to fail. A linear approximation methodology was used to extrapolate average yearly failure rates of the units for each customer. Then an average yearly failure of all customers was calculated.

Some time between year 13 and 14, 50% of the sample would have failed if the linearly approximated trend were to be continued into the future. Based on the data, the minimum expected life span would be 8 years and the maximum would be 41 years. This analysis provides strong support for the "average life" of 13 years.



RECOMMENDATION

Adopt a measure life of 13 years for steam traps.

AIR DOOR RESEARCH SUMMARY

Assumption	Gas and electricity savings related to Air Door Installation for Small Commercial Customers	
Recommendation	Gas savings for single door installation: 2,118 m^3 Electricity savings for single door installation: 172 kWh Gas savings for double door installation: 4,508m^3 Electricity savings for double door installation: 1,023 kWh	
Authors	Bill Chihata , EGD Program Manager	Mark Armstrong P.Eng. AGVIRO Inc.
Research Completed	December, 2007	

BACKGROUND

Enbridge Gas Distribution is working towards the development of an Air Door Program designed to provide small business owners with the opportunity to save on energy costs by reducing natural gas and electricity consumption.

Every day, businesses lose vast amounts of heated or air-conditioned air every time their doors are opened. Air doors give business owners improved control over their building's internal temperature, resulting in increased energy efficiency and savings.

In order to determine an appropriate average saving per air door, an analysis was done that compared the energy savings findings from the Air Curtain Installation and Performance Report with the results of an air door calculator that was developed by AGVIRO Inc., an Ontario consulting and design engineering company providing services in the areas of indoor air quality, mechanical design and energy efficiency.

RESEARCH DESCRIPTION

For this research, savings calculations were developed using two different methods and the results compared to provide the recommended savings assumption:

1. Monitored savings results from a restaurant installation in the EGD franchise area (Air Curtain Installation and Performance Study) were applied to the 2006 pre installation consumption of 2007 air door customers and the results averaged to develop prescriptive savings value per installation.
2. Savings for each 2007 project were estimated using a savings calculator which develops engineering estimates of savings based on site conditions and the results averaged to develop a prescriptive savings value.

RESULTS

1. Monitored results applied to the population

Monitored results from the restaurant installation showed that a 3% energy savings can be achieved with the use of a single air door on a pedestrian entrance way. The 3% value was applied to the 2006 annual consumption of those 2007 customers that have installed a single air door and have a full year of pre-installation consumption. For those customers that installed a double door, a 6% energy savings was applied. Since the air doors were installed in restaurants, savings were calculated on total energy consumption. In restaurant applications the base load (from both water heating and cooking) is generally much greater than the space heating load. Further, the base load of cooking contributes in part to meeting the space heating load in winter due to the size and usage of the cooking equipment. For these reasons it is not possible to isolate the space heating consumption from total consumption for restaurant applications.

The results are separated into two groups – single door installations and double door installations. The average natural gas savings calculated on 3% of annual consumption for a single door and 6% for a double door was 2,473m^3 and 10,506m^3 respectively.

2. Estimated Savings using the Air Door Calculator

The Air Door Calculator was developed by Agviro for Enbridge. The software tool calculates gas and electricity savings for air door installations. Inputs to the calculator include:

- Door size and location
- Seasonal and daily operating schedules for the opening
- Building heating and cooling loads
- Heat loss through the opening
- ASHRAE suggested values for air curtain effectiveness.

Using this software, savings were calculated individually for each of the 16 air door installations in 2007 and the results averaged.

The average savings found using the calculator was 2,118m^3 gas savings for a single door and 4,508m^3 for a double door and 172 kWh and 1, 023 kWh electricity savings due to reduced heating and cooling load.

RECOMMENDATION

The Air Door Calculator develops energy savings related only to the building's heating and cooling loads and site conditions. Therefore it is recommended that the following prescriptive savings based on results from the Air Door Calculator of 16 sites be adopted.

Prescriptive Savings for single door installation:

Gas	2,118m^3
Electricity	172kWh

Prescriptive Savings for double door installation

Gas	4,508 m^3
Electricity	1,023 kWh

Understanding Cost-Effectiveness of Energy Efficiency Programs:

Best Practices, Technical Methods, and Emerging Issues for Policy-Makers

A RESOURCE OF THE NATIONAL ACTION PLAN FOR ENERGY EFFICIENCY

NOVEMBER 2008

About This Document

This paper, *Understanding Cost-Effectiveness of Energy Efficiency Programs*, is provided to assist utility regulators, gas and electric utilities, and others in meeting the 10 implementation goals of the National Action Plan for Energy Efficiency's Vision to achieve all cost-effective energy efficiency by 2025.

This paper reviews the issues and approaches involved in considering and adopting cost-effectiveness tests for energy efficiency, including discussing each perspective represented by the five standard cost-effectiveness tests and clarifying key terms.

The intended audience for the paper is any stakeholder interested in learning more about how to evaluate energy efficiency through the use of cost-effectiveness tests. All stakeholders, including public utility commissions, city councils, and utilities, can use this paper to understand the key issues and terminology, as well as the various perspectives each cost-effectiveness test provides, and how the cost-effectiveness tests can be implemented to capture additional energy efficiency.

Understanding Cost-Effectiveness of Energy Efficiency Programs:

Best Practices, Technical Methods, and Emerging Issues for Policy-Makers

A RESOURCE OF THE NATIONAL ACTION PLAN FOR ENERGY EFFICIENCY

NOVEMBER 2008

The Leadership Group of the National Action Plan for Energy Efficiency is committed to taking action to increase investment in cost-effective energy efficiency. *Understanding Cost-Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods, and Emerging Issues for Policy-Makers* was developed under the guidance of and with input from the Leadership Group. The document does not necessarily represent a consensus view and does not represent an endorsement by the organizations of Leadership Group members.

Understanding Cost-Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods, and Emerging Issues for Policy-Makers is a product of the National Action Plan for Energy Efficiency and does not reflect the views, policies, or otherwise of the federal government. The role of the U.S. Department of Energy and U.S. Environmental Protection Agency is limited to facilitation of the Action Plan.

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List of Abbreviations and Acronyms

AEO	Annual Energy Outlook
Btu	British thermal unit
CCGT	combined cycle gas turbine
CDM	conservation and demand management
CEC	California Energy Commission
CFL	compact fluorescent light bulb
CO_2	carbon dioxide
DCR	debt-coverage ratio
DOE	U.S. Department of Energy
DR	demand response
DSM	demand-side management
EPA	U.S. Environmental Protection Agency
GHG	greenhouse gas
HP	horsepower
HVAC	heating, ventilation, and air conditioning
ICAP	installed capacity
IOU	investor-owned utility
IRP	integrated resource planning
kW	kilowatt
kWh	kilowatt-hour
LNG	liquefied natural gas
LSE	load serving entity
MMBtu	million Btu
MW	megawatt
MWh	megawatt-hour
NEBs	non-energy benefits
NO_x	nitrogen oxides
NPV	net present value
NTG	net-to-gross ratio
NWPCC	Northwest Power and Conservation Council
NYSERDA	New York State Energy Research and Development Authority
PACT	program administrator cost test (same as UCT)
PCT	participant cost test
PSE	Puget Sound Energy
RIM	ratepayer impact measure test
ROE	return on equity
RPS	renewable portfolio standard
SCE	Southern California Edison
SCT	societal cost test
SEER	Seasonal Energy Efficiency Ratio
SO_x	sulfur oxides
T&D	transmission and distribution
TOU	time of use
TRC	total resource cost test
TWh	terawatt-hour
UCAP	unforced capacity
UCT	utility cost test (same as PACT)
VOC	volatile organic compound
WACC	weighted average cost of capital

Acknowledgements

This technical issue paper, *Understanding Cost-Effectiveness of Energy Efficiency Programs,* is a key product of the Year Three Work Plan for the National Action Plan for Energy Efficiency. This work plan was developed based on Action Plan Leadership Group discussions and feedback expressed during and in response to the January 7, 2008, Leadership Group Meeting and the February 2008 Initial Draft Work Plan. A full list of Leadership Group members is provided in Appendix A.

With direction and comment by the Action Plan Leadership Group, the paper's development was led by Snuller Price, Energy and Environmental Economics, Inc., under contract to the U.S. Environmental Protection Agency (EPA). Additional preparation was performed by Eric Cutter and Rebecca Ghanadan of Energy and Environmental Economics, Inc.

Rich Sedano and Brenda Hausauer of the Regulatory Assistance Project supplied information on the use of cost-effectiveness tests by states and provided their expertise during the review and editing of the paper. Alison Silverstein also provided expertise during the review and editing of the paper.

EPA and the U.S. Department of Energy (DOE) facilitate the National Action Plan for Energy Efficiency. Key staff include Larry Mansueti (DOE Office of Electricity Delivery and Energy Reliability), Dan Beckley (DOE Office of Energy Efficiency and Renewable Energy), and Kathleen Hogan, Katrina Pielli, and Stacy Angel (EPA Climate Protection Partnership Division).

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Executive Summary

This paper, Understanding Cost-Effectiveness of Energy Efficiency Programs, reviews the issues and approaches involved in considering and adopting cost-effectiveness tests for energy efficiency, including discussing each perspective represented by the five standard cost-effectiveness tests and clarifying key terms. This paper is provided to assist organizations in meeting the 10 implementation goals of the National Action Plan for Energy Efficiency's Vision to achieve all cost-effective energy efficiency by 2025.

Improving energy efficiency in our homes, businesses, schools, governments, and industries—which consume more than 70 percent of the natural gas and electricity used in the country—is one of the most constructive, cost-effective ways to address the challenges of high energy prices, energy security and independence, air pollution, and global climate change. Despite these benefits and the success of energy efficiency programs in some regions of the country, energy efficiency remains critically underutilized in the nation's energy portfolio. It is time to take advantage of more than two decades of experience with successful energy efficiency programs, broaden and expand these efforts, and capture the savings that energy efficiency offers. Understanding energy efficiency cost-effectiveness tests and the various stakeholder perspectives each test represents is key to establishing the policy framework to capture these benefits.

This paper has been developed to help parties pursue the key policy recommendations and implementation goals of the National Action Plan for Energy Efficiency. The Action Plan was released in July 2006 as a call to action to bring diverse stakeholders together at the national, regional, state, or utility level, as appropriate, and foster the discussions, decision-making, and commitments necessary to take investment in energy efficiency to a new level. This paper directly supports the National Action Plan's Vision for 2025 implementation goal three, which encourages state agencies along with key stakeholders to establish cost-effectiveness tests for energy efficiency. This goal highlights the policy step to establish a process to examine how to define cost-effective energy efficiency practices that capture the long-term resource value of energy efficiency.

Evaluating the cost-effectiveness of energy efficiency is essential to identifying how much of our country's potential for energy efficiency resources will be captured. Based on studies, energy efficiency resources may be able to meet 50 percent or more of the expected load growth by 2025 (National Action Plan for Energy Efficiency, 2008). Defining cost-effectiveness helps energy efficiency compete with the broad range of other resource options in order for energy efficiency to get the attention and funding necessary to succeed.

In its simplest form, energy efficiency cost-effectiveness is measured by comparing the benefits of an investment with the costs. Five key cost-effectiveness tests have, with minor updates, been used for over 20 years as the principal approaches for energy efficiency program evaluation. These five cost-effectiveness tests are the participant cost test (PCT), the utility/program administrator cost test (PACT), the ratepayer impact measure test (RIM), the total resource cost test (TRC), and the societal cost test (SCT).

The key points from this paper include:

- There is no single best test for evaluating the cost-effectiveness of energy efficiency.

- Each of the cost-effectiveness tests provides different information about the impacts of energy efficiency programs from distinct vantage points in the energy system. Together, multiple tests provide a comprehensive approach.

- Jurisdictions seeking to increase efficiency implementation may choose to emphasize the PACT, which compares energy efficiency as a utility investment on a par with other resources.

- The most common primary measurement of energy efficiency cost-effectiveness is the TRC, followed closely by the SCT. A positive TRC result indicates that the program will produce a net reduction in energy costs in the utility service territory over the lifetime of the program. The distributional tests (PCT, PACT, and RIM) are then used to indicate how different stakeholders are affected. Historically, reliance on the RIM test has limited energy efficiency investment, as it is the most restrictive of the five cost-effectiveness tests.

There are a number of choices in developing the costs and benefits of energy efficiency that can significantly affect the cost-effectiveness results. Several major choices available to utilities, analysts, and policy-makers are described below.

- **Where in the process to apply the cost-effectiveness tests:** The choice of where to apply each cost-effectiveness test has a significant impact on the ultimate set of measures offered to customers. In general, there are three places to evaluate the cost-effectiveness test: at the "measure" level, the "program" level, and the "portfolio" level. Applying cost-effectiveness tests at the program or portfolio levels allows some non-cost-effective measures or programs to be offered as long as their shortfall is more than offset by cost-effective measures and programs.

- **Which benefits to include:** There are two main categories of avoided costs: energy-related and capacity-related. Energy-related avoided costs refer to market prices of energy, fuel costs, natural gas commodity prices, and other variable costs. Capacity-related avoided costs refer to infrastructure investments such as power plants, transmission and distribution lines, and pipelines. From an environmental point of view, saving energy reduces air emissions, including greenhouse gases (GHGs). Within each of these categories, policy-makers must decide which specific benefits are sufficiently known and quantifiable to be included in the cost-effectiveness evaluation.

- **Net present value and discount rates:** A significant driver of overall cost-effectiveness of energy efficiency is the discount rate assumption used to calculate the net present value (NPV) of the annual costs and benefits. Since costs typically occur upfront and savings occur over time, the lower the discount rate the more likely the cost-effectiveness result is to be positive. As each cost-effectiveness test portrays a specific stakeholder's view, each cost-effectiveness test should use the discount rate associated with its perspective. For a household, the consumer lending rate is used, since this is the debt cost that a private individual would pay to finance an energy efficiency investment. For a business firm, the discount rate is the firm's weighted average cost of capital, typically in the 10 to 12 percent range. However, commercial and industrial customers often demand payback periods of two years or less, implying a discount rate well in excess of 20 percent. The PACT, RIM, and TRC should reflect the utility weighted average cost of capital. The social discount rate (typically the lowest rate) should be used for the SCT to reflect the benefit to society over the long term.

- **Net-to-gross ratio (NTG):** The NTG can be a significant driver in the results of TRC, PACT, RIM, and SCT. The NTG adjusts the impacts of the programs so that they only reflect those energy efficiency gains that are the result of the energy efficiency program. Therefore, the NTG deducts energy savings that would have been achieved without the efficiency program (e.g., "free-riders") and increases savings for any "spillover" effect that occurs as an indirect result of the program. Since the NTG attempts to measure what customers would have done in the absence of the energy efficiency program, it can be difficult to determine precisely.

- **Non-energy benefits (NEBs):** Energy efficiency measures often have additional benefits (and costs) beyond energy savings, such as improved comfort, productivity, health, convenience and aesthetics. However, these benefits can be difficult to quantify. Some jurisdictions choose to include NEBs and costs in some of the cost-effectiveness tests, often focusing on specific issues emphasized in state policy.

- **GHG emissions:** There is increasing interest in valuing the energy efficiency's effect on reducing GHG emissions in the cost-effectiveness tests. The first step is to determine the quantity of avoided carbon dioxide (CO_2) emissions from the efficiency program. Once the amount of CO_2 reductions has been determined, its economic value can be calculated and added to the net benefits of the energy efficiency measures used to achieve the reductions. Currently, some jurisdictions use an explicit monetary CO_2 value in cost-benefit calculations and some do not.

- **Renewable portfolio standards (RPS):** The interdependence between energy efficiency and RPS goals is an emerging issue in energy efficiency. Unlike supply-side investments, energy efficiency, by reducing load, can reduce the amount of renewable energy that must be procured pursuant to RPS targets. This reduces RPS compliance cost, which is a benefit that should be considered in energy efficiency cost-effectiveness evaluation.

1: Introduction

Improving the energy efficiency of homes, businesses, schools, governments, and industries—which consume more than 70 percent of the natural gas and electricity used in the United States—is one of the most constructive, cost-effective ways to address the challenges of high energy prices, energy security and independence, air pollution, and global climate change. Mining this efficiency could help us meet on the order of 50 percent or more of the expected growth in U.S. consumption of electricity and natural gas in the coming decades, yielding many billions of dollars in saved energy bills and avoiding significant emissions of greenhouse gases and other air pollutants.[1]

Recognizing this large opportunity, more than 60 leading organizations representing diverse stakeholders from across the country joined together to develop the National Action Plan for Energy Efficiency. The Action Plan identifies many of the key barriers contributing to underinvestment in energy efficiency; outlines five policy recommendations for achieving all cost-effective energy efficiency; and offers a wealth of resources and tools for parties to advance these recommendations, including a Vision for 2025. As of November 2008, over 120 organizations have endorsed the Action Plan recommendations and made public commitments to implement them in their areas. Establishing cost-effectiveness tests for energy efficiency investments is key to making the Action Plan a reality.

1.1 Background on Cost-effectiveness Tests

The question of how to define the cost-effectiveness of energy efficiency investments is a critical issue to address when advancing energy efficiency as a key resource in meeting future energy needs. How cost-effectiveness is defined substantially affects how much of our nation's efficiency potential will be accessed and whether consumers will benefit from the lower energy costs and environmental impacts that would result. The decisions on how to define cost-effectiveness or which tests to use are largely made by state utility commissions and their utilities, and with critical input from consumers and other stakeholders. This paper is provided to help facilitate these discussions.

Cost-effectiveness in its simplest form is a measure of whether an investment's benefits exceed its costs. Key differences among the cost-effectiveness tests that are currently used include the following:

- **The stakeholder perspective of the test.** Is it from the perspective of an energy efficiency program participant, the organization offering the energy efficiency program, a non-participating ratepayer, or society in general? Each of these perspectives represents a valid viewpoint and has a role in assessing energy efficiency programs.

- **The key elements included in the costs and the benefits.** Do they reflect avoided energy use, incentives for energy efficiency, avoided need for new generation and new transmission and distribution, and avoided environmental impacts?

- **The baseline against which the cost and benefits are measured.** What costs and benefits would have been realized absent investment in energy efficiency?

The five cost-effectiveness tests commonly used across the country are listed below:

- Participant cost test (PCT).
- Program administrator cost test (PACT).[2]
- Ratepayer impact measure test (RIM).
- Total resource cost test (TRC).
- Societal cost test (SCT).

These cost-effectiveness tests are used differently in different states. Some states require all of the tests, some require no specific tests, and others designate a primary test. Table 1-1 provides a quick overview of which tests are used in which states. Chapter 5 presents more information and guidelines on the use of the cost-effectiveness tests by the states.

Table 1-1. Cost-Effectiveness Tests in Use by Different States as Primary or Secondary Consideration

PCT	PACT	RIM	TRC	SCT
AR, FL, GA, HI, IA, IN, MN, VA	AT, CA, **CT**, HI, IA, IN, MN, NO, NV, OR, **UT**, VA, **TX**	AR, DC, **FL**, GA, HI, IA, IN, KS, MN, NH, VA	AR, **CA**, CO, CT, DE, FL, GA, HI, IL, IN, KS, **MA**, MN, **MO**, MT, **NH**, **NM**, NY, UT, VA	**AZ**, CO, GA, HI, IA, IN, MW, **ME**, **MN**, MT, NV, OR, VA, **VT**, **WI**

Source: Regulatory Assistance Project (RAP) analysis.

Note: Boldface indicates the primary cost-effectiveness test used by each state.

1.2 About the Paper

This paper examines the five standard cost-effectiveness tests that are regularly used to assess the cost-effectiveness of energy efficiency, the perspectives each test represents, and how states are currently using the tests. It also discusses how the tests can be used to provide a more comprehensive picture of the cost-effectiveness of energy efficiency as a resource. Use of a single cost-effectiveness test as a primary cost-effectiveness test may lead to an efficiency portfolio that does not balance the benefits and costs between stakeholder perspectives. Overall, using all five cost-effectiveness tests provides a more comprehensive picture than using any one test alone.

Paper Objective

After reading this paper, the reader should be able to understand each the perspective represented by each of the five standard cost tests, understand that all five tests provide a more comprehensive picture than any one test alone, have clarity around key terms and definitions, and use this information to shape how the cost-effectiveness of energy efficiency programs is treated.

This paper was prepared in response to a need identified by the Action Plan Leadership Group (see Appendix A) for a practical discussion of the key considerations and technical terms involved in defining cost-effectiveness and establishing which cost-effectiveness tests to use in developing an energy efficiency program portfolio. The Leadership Group offers this reference to program designers and policy-makers who are involved in adopting and implementing cost-effectiveness tests for evaluating efficiency investments.

This paper supports the *National Action Plan for Energy Efficiency Vision for 2025: A Framework for Change* (National Action Plan for Energy Efficiency, 2008). This Vision establishes a long-term aspirational goal to achieve all cost-effective energy efficiency by 2025 and outlines 10 goals for implementing the Leadership Group's recommendations (see Figure 1-1). This paper directly supports the Vision's third implementation goal, which encourages states and key stakeholders to establish cost-effectiveness tests for energy efficiency. This goal encourages applicable state agencies, along with key stakeholders, to establish a process to examine how to define cost-effective energy efficiency practices that capture the long-term resource value of energy efficiency.

Figure 1-1. Ten Implementation Goals of the *National Action Plan for Energy Efficiency Vision for 2025: A Framework for Change*

Goal One:	Establishing Cost-Effective Energy Efficiency as a High-Priority
Goal Two:	Developing Processes to Align Utility and Other Program Administrator Incentives Such That Efficiency and Supply Resources Are on a Level Playing Field
Goal Three:	Establishing Cost-Effectiveness Tests
Goal Four:	Establishing Evaluation, Measurement, and Verification Mechanisms
Goal Five:	Establishing Effective Energy Efficiency Delivery Mechanisms
Goal Six:	Developing State Policies to Ensure Robust Energy Efficiency Practices
Goal Seven:	Aligning Customer Pricing and Incentives to Encourage Investment in Energy Efficiency
Goal Eight:	Establishing State of the Art Billing Systems
Goal Nine:	Implementing State of the Art Efficiency Information Sharing and Delivery Systems
Goal Ten:	Implementing Advanced Technologies

1.3 Structure of the Paper

This paper walks the reader through the basics of cost-effectiveness tests and the perspectives they represent, issues in determining the costs and benefits to include in the cost-effectiveness tests, emerging issues, how states are currently using cost-effectiveness tests, and guidelines for policy-makers.

The key chapters of the paper are the following:

- **Chapter 2.** This chapter discusses the five standard cost-effectiveness tests and their application in four utility best practice programs.

- **Chapter 3.** This chapter briefly describes the interpretation of each test and presents a calculation of each cost-effectiveness test using an example residential program from Southern California Edison.

- **Chapter 4.** This chapter presents the key factors and issues in the determination of an energy efficiency program's cost-effectiveness. It also discusses key emerging issues that are shaping energy efficiency programs, including the impact greenhouse gas (GHG) reduction targets and renewable portfolio standards (RPS) may have on energy efficiency programs.

- **Chapter 5.** This chapter gives guidelines and examples for policy-makers to consider when choosing which cost-effectiveness test(s) to emphasize, and summarizes of the use of the cost-effectiveness tests in each state.

- **Chapter 6.** This chapter describes the calculation of each cost-effectiveness test in detail, as well as the key considerations when reviewing and using cost-effectiveness tests and the pros and cons of each test in relation to increased efficiency investment.

- **Appendix C.** This chapter gives further detail on the four example programs included in Chapter 2. It also describes how the cost-effectiveness test results were calculated for each program.

1.4 Development of the Paper

Understanding Cost-Effectiveness of Energy Efficiency Programs is a product of the Year Three Work Plan for the National Action Plan for Energy Efficiency. With direction and comment by the Action Plan Leadership Group (see Appendix A for a list of group members), the paper's development was led by Snuller Price, Eric Cutter, and Rebecca Ghanadan of Energy and Environmental Economics, Inc., under contract to the U.S. Environmental Protection Agency and the U.S. Department of Energy. Chapter 5 was authored by Rich Sedano and Brenda Hausauer of the Regulatory Assistance Project, under contract to the U.S. Department of Energy.

1.5 Notes

[1] See the *National Action Plan for Energy Efficiency Vision for 2025: A Framework for Change* (National Action Plan for Energy Efficiency, 2008).

[2] The program administrator cost test, or PACT, was originally named the utility cost test (UCT). As program management has expanded to government agencies, nonprofit groups, and other parties, the term "program administrator cost test" has come into use, but the computations are the same. This document refers to the UCT/PACT as the "PACT" for simplicity. See Section 6.2 for more information on the test.

2: Getting Started: Overview of the Cost-Effectiveness Tests

This chapter provides a brief overview of the cost-effectiveness tests used to evaluate energy efficiency measures and programs. All the cost-effectiveness tests use the same fundamental approach in comparing costs and benefits. However, each test is designed to address different questions regarding the cost-effectiveness of energy efficiency programs.

2.1 Structure of the Cost-Effectiveness Tests

Each of the tests provides a different kind of information about the impacts of energy efficiency programs from different vantage points in the energy system. On its own, each test provides a single stakeholder perspective. Together, multiple tests provide a comprehensive approach for asking: Is the program effective overall? Is it balanced? Are some costs or incentives too high or too low? What is the effect on rates? What adjustments are needed to improve the alignment? Each test contributes one of the aspects necessary to understanding these questions and answering them.

The basic structure of each cost-effectiveness test involves a calculation of the total benefits and the total costs in dollar terms from a certain vantage point to determine whether or not the overall benefits exceed the costs. A test is positive if the benefit-to-cost ratio is greater than one, and negative if it is less than one. Results are reported either in net present value (NPV) dollars (method by difference) or as a ratio (i.e., benefits/costs). Table 2-1 outlines the basic approach underlying cost-effectiveness tests.

Table 2-1. Basic Approach for Calculating and Representing Cost-Effectiveness Tests

Net Benefits (Difference)	Net Benefits$_a$ (dollars)	=	NPV ∑ benefits$_a$ (dollars) - NPV ∑ costs$_a$ (dollars)
Benefit-Cost Ratio	Benefit-Cost Ratio$_a$	=	$\dfrac{\text{NPV} \sum \text{benefits}_a \text{ (dollars)}}{\text{NPV} \sum \text{costs}_a \text{ (dollars)}}$

Source: Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects.

Note: “NPV” refers to the net present value of benefits and costs. See Section 4.6.

> Cost-effectiveness test results compare relative benefits and costs from different perspectives. A benefit-cost ratio above 1 means the program has positive net benefits. A benefit-cost ratio below 1 means the costs exceed the benefits. A first step in analyzing programs is to see which cost-effectiveness tests are produce results above or below 1.

2.2 The Five Cost-Effectiveness Tests and Their Origins

Currently, five key tests are used to compare the costs and benefits of energy efficiency and demand response programs. These tests all originated in California. In 1974, the Warren Alquist Act established the California Energy Commission (CEC) and specified cost-effectiveness as a leading resource planning principle. In 1983, California's *Standard Practice for Cost-Benefit Analysis of Conservation and Load Management Programs* manual developed five cost-effectiveness tests for evaluating energy efficiency programs. These approaches, with minor updates, continue to be used today and are the principal approaches used for evaluating energy efficiency programs across the United States.[1]

Table 2-2 summarizes the five tests in terms of the questions they help answer and the key elements of the comparison.

Table 2-2. The Five Principal Cost-Effectiveness Tests Used in Energy Efficiency

Test	Acronym	Key Question Answered	Summary Approach
Participant cost test	PCT	Will the participants benefit over the measure life?	Comparison of costs and benefits of the customer installing the measure
Program administrator cost test	PACT	Will utility bills increase?	Comparison of program administrator costs to supply-side resource costs
Ratepayer impact measure	RIM	Will utility rates increase?	Comparison of administrator costs and utility bill reductions to supply-side resource costs
Total resource cost test	TRC	Will the total costs of energy in the utility service territory decrease?	Comparison of program administrator and customer costs to utility resource savings
Societal cost test	SCT	Is the utility, state, or nation better off as a whole?	Comparison of society's costs of energy efficiency to resource savings and non-cash costs and benefits

Source: Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects.

2.3 Cost-Effectiveness Test Results in Best Practice Programs

Illustrating cost-effectiveness test calculations, Table 2-3 shows benefit-cost ratio results from four successful energy efficiency programs from across the country.[2] The Southern California Edison (SCE) Residential Energy Efficiency Incentive Program provides customer incentives for efficient lighting and appliances. Avista's results are for its Regular Income Portfolio, which includes a variety of programs targeted to residential users. Puget Sound Energy's Commercial/Industrial Retrofit Program encourages commercial customers to install cost- and energy-efficient equipment, adopt energy-efficient designs, and use energy-efficient operations at their facilities. Finally, the National Grid's MassSAVE residential program provides residential in-home audits and incentives for comprehensive whole-house improvements.

All the programs presented have been determined to be cost-effective by the relevant utilities[3] and regulators. Nevertheless, the results of the five cost-effectiveness tests vary significantly for each program. Furthermore, the result of each cost-effectiveness test across the four programs is also quite different. (Puget Sound Energy is the only utility for which all five cost-effectiveness tests are positive.) The test results show a range of values that reflect the program designs and the individual choices made by the program administrators and policy-makers for their evaluation. As later chapters discuss, both the individual tests *and* the relationships between test results offer useful information for assessing programs.

Table 2-3. Summary of Cost-effectiveness Test Results for Four Energy Efficiency Programs

Test	Southern California Edison Residential Energy Efficiency Incentive Program	Avista Regular Income Portfolio	Puget Sound Energy Commercial/ Industrial Retrofit Program	National Grid MassSAVE Residential
	Benefit-Cost Ratio			
PCT	7.14	3.47	1.72	8.81
PACT	9.91	4.18	4.19	2.64
RIM	0.63	0.85	1.15	0.54
TRC	4.21	2.26	1.90	1.73
SCT	4.21	2.26	1.90	1.75

Source: E3 analysis; see Appendix C.

Note: The calculation of each cost-effectiveness test varies slightly by jurisdiction. See Appendix C for more details.

The choice of cost-effectiveness test depends on the policy goals and circumstances of a given program and state. Multiple tests yield a more comprehensive assessment than any test on its own.

2.4 Notes

1 The California standard practice manual was first developed in February 1983. It was later revised and updated in 1987–88 and 2001; a Correction Memo was issued in 2007. The 2001 California SPM and 2007 Correction Memo can be found at <http://www.cpuc.ca.gov/PUC/energy/electric/Energy+Efficiency/EM+and+V/>.

2 The cost-effectiveness test results of each program are described further in Appendix C.

3 "Utility" refers to any organization that delivers electric and gas utility services to end users, including investor-owned, cooperatively owned, and publicly owned utilities.

3: Cost-Effectiveness Test Review—Interpreting the Results

This chapter discusses the benefit and cost components included in each cost-effectiveness test, and profiles how a residential lighting and appliance incentive program fares under each test. It also provides an overview of important considerations when using cost-effectiveness tests.

Overall, the results of all five cost-effectiveness tests provide a more comprehensive picture than the use of any one test alone. The TRC and SCT cost tests help to answer whether energy efficiency is cost-effective overall. The PCT, PACT, and RIM help to answer whether the selection of measures and design of the program is balanced from participant, utility, and non-participant perspectives respectively. Looking at the cost-effectiveness tests together helps to characterize the attributes of a program or measure to enable decision making, to determine whether some measures or programs are too costly, whether some costs or incentives are too high or too low, and what adjustments need to be made to improve distribution of costs and benefits among stakeholders. The scope of the benefit and cost components included in each test is summarized in Table 3-1 and Table 3-2.

The broad categories of costs and benefits included in each cost-effectiveness test are consistent across all regions and applications. However, the specific components included in each test may vary across different regions, market structures, and utility types. Transmission and distribution investment may be considered deferrable through energy efficiency in some areas and not in others. Likewise, the TRC and SCT may consider just natural gas or electricity resource savings in some cases, but also include co-benefits of other savings streams (such as water and fuel oil) in others. Considerations regarding the application of each cost-effectiveness test and which cost and benefit components to include are the subject of Chapter 5.

3.1 Example: Southern California Edison Residential Energy Efficiency Program

The Southern California Edison (SCE) Residential Energy Efficiency Incentive Program provides customer incentives for efficient lighting and appliances (not including HVAC). It is part of a statewide mass market efficiency program that coordinates marketing and outreach efforts. This section summarizes how to calculate cost-effectiveness for each cost-effectiveness test using the SCE Residential Energy Efficiency Incentive Program as an example. Calculations for three additional programs from other utilities are evaluated in Appendix C.

Table 3-1. Summary of Benefits and Costs Included in Each Cost-Effectiveness Test

Test	Benefits	Costs
PCT	*Benefits and costs from the perspective of the customer installing the measure*	
	▪ Incentive payments ▪ Bill savings ▪ Applicable tax credits or incentives	▪ Incremental equipment costs ▪ Incremental installation costs
PACT	*Perspective of utility, government agency, or third party implementing the program*	
	▪ Energy-related costs avoided by the utility ▪ Capacity-related costs avoided by the utility, including generation, transmission, and distribution	▪ Program overhead costs ▪ Utility/program administrator incentive costs ▪ Utility/program administrator installation costs
RIM	*Impact of efficiency measure on non-participating ratepayers overall*	
	▪ Energy-related costs avoided by the utility ▪ Capacity-related costs avoided by the utility, including generation, transmission, and distribution	▪ Program overhead costs ▪ Utility/program administrator incentive costs ▪ Utility/program administrator installation costs ▪ Lost revenue due to reduced energy bills
TRC	*Benefits and costs from the perspective of all utility customers (participants and non-participants) in the utility service territory*	
	▪ Energy-related costs avoided by the utility ▪ Capacity-related costs avoided by the utility, including generation, transmission, and distribution ▪ Additional resource savings (i.e., gas and water if utility is electric) ▪ Monetized environmental and non-energy benefits (see Section 4.9) ▪ Applicable tax credits (see Section 6.4)	▪ Program overhead costs ▪ Program installation costs ▪ Incremental measure costs (whether paid by the customer or utility)
SCT	*Benefits and costs to all in the utility service territory, state, or nation as a whole*	
	▪ Energy-related costs avoided by the utility ▪ Capacity-related costs avoided by the utility, including generation, transmission, and distribution ▪ Additional resource savings (i.e., gas and water if utility is electric) ▪ Non-monetized benefits (and costs) such as cleaner air or health impacts	▪ Program overhead costs ▪ Program installation costs ▪ Incremental measure costs (whether paid by the customer or utility)

Source: Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects.

Table 3-2. Summary of Benefits and Costs Included in Each Cost-Effectiveness Test

Component	PCT	PACT	RIM	TRC	SCT
Energy- and capacity-related avoided costs		Benefit	Benefit	Benefit	Benefit
Additional resource savings				Benefit	Benefit
Non-monetized benefits					Benefit
Incremental equipment and installation costs	Cost			Cost	
Program overhead costs		Cost	Cost	Cost	Cost
Incentive payments	Benefit	Cost	Cost		
Bill savings	Benefit		Cost		

Source: Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects.

Note: Incentive payments include any equipment and installation costs paid by the program administrator.

3.1.1 Overview of the Program

The SCE Residential Energy Efficiency Incentive Program resulted in costs of:

- $3.5 million in administration and marketing for SCE.
- $15.5 million in customer incentives, direct installation, and upstream payments combined for SCE.
- $41.1 million in measure installation costs for customers (before incentives).

The reduced energy consumption achieved as a result of the program resulted in:

- $188 million in avoided cost savings to the utility.
- $278 million in bill savings to the customers (and reduced revenue to SCE).
- Reduced nitrogen oxides (NO_x), PM_{10},[1] and carbon dioxide (CO_2) emissions.

The costs and savings are presented on a “net” basis, after the application of the net-to-gross ratio (NTG). The determination of the NTG is described in Section 4.7. The benefits and costs of the SCE program are presented in Table 3-3 and Table 3-4. Together, these two tables provide the key parameters for employing individual cost-effectiveness tests, as well as the calculations leading to each test are discussed in turn.

Table 3-3. SCE Residential Energy Efficiency Incentive Program Benefits

Net Benefit Inputs		
Resource savings	**Units**	**$**
Energy (MWh)	2,795,290	$ 187,904,906
Peak demand (kW)	55,067	—
Total resource savings		**$ 187,904,906**
Participant bill savings		**$ 278,187,587**
Emission savings	**Tons**	
NO_x	421,633	
PM_{10}	203,065	
CO_2	1,576,374	

Source: E3 analysis; see Appendix C.

Table 3-4. SCE Residential Energy Efficiency Incentive Program Costs

Cost Inputs	
Program overhead	
Program administration	$ 898,548
Marketing and outreach	$ 559,503
Rebate processing	$ 1,044,539
Other	$ 992,029
Total program administration	**$ 3,494,619**
Program incentives	
Rebates and incentives	$ 1,269,393
Direct installation costs	$ 564,027
Upstream payments	$ 13,624,460
Total incentives	**$ 15,457,880**
Total program costs	**$ 18,952,499**
Net measure equipment and installation	**$ 41,102,993**

Source: E3 analysis; see Appendix C.

3.1.2 Cost-Effectiveness Test Results Overview

The results of each of the five cost-effectiveness tests for 2006 (based on the information in the fourth quarter 2006 SCE filing) are presented in Table 3-5[2] A first level assessment shows that the SCE program is very cost-effective for the participant (PCT), the utility (PACT), and the region as a whole (TRC). The program will reduce average energy bills, and a RIM below 1.0 suggests that the program will increase customer rates. Greater detail on the application of each of these cost-effectiveness tests is provided below.

Table 3-5. Summary of Cost-Effectiveness Test Results ($Million)

Test	Cost	Benefits	Ratio	Result
PCT	$41	$294	7.14	Bill savings are more than seven times greater than customer costs.
PACT	$19	$188	9.91	The value of saved energy is nearly 10 times greater than the program cost.
RIM	$297	$188	0.63	The reduced revenue and program cost is greater than utility savings.
TRC	$45	$188	4.21	Overall benefits are four times greater than the total costs.
SCT	$45	$188	4.21	Same as the TRC, as no additional benefits are currently included in the SCT in California.

Source: E3 analysis; see Appendix C.

3.1.3 Calculating the PCT

The PCT assesses the costs and benefits from the perspective of the customer installing the measure. Overall, customers received $294 million in benefits (derived from utility program incentives and bill savings from reduced energy use). The incremental costs to customers were $41 million. This yields an overall net benefit of $252 million and a benefit-cost ratio of 7.14. The PCT shows that bill savings are seven times customer costs—a cost-effective program for the participant. PCT calculation terms from the SCE program data are presented in Table 3-6.

Table 3-6. Participant Cost Test for SCE Residential Energy Efficiency Program

PCT Calculations		
	Benefits	**Costs**
Program overhead		
Program incentives	$ 15,457,880	
Measure costs		$ 41,102,993
Energy savings		
Bill savings	$ 278,187,587	
Monetized emissions		
Non-energy benefits		
Total	**$ 293,645,466**	**$ 41,102,993**
Net benefit	**$252,542,473**	
Benefit-cost ratio	**7.1**	

Source: E3 analysis; see Appendix C.

3.1.4 Calculating the PACT

The PACT calculates the costs and benefits of the program from the perspective of SCE as the utility implementing the program. SCE's avoided costs of energy are $188 million (energy savings). Overhead and incentive costs to SCE are $19 million. These figures yield an overall net benefit of $169 million and a benefit-to-cost ratio of 9.91. The PACT result shows that the value of saved energy is nearly 10 times greater than the program cost: high cost-effectiveness from the perspective of the utility's administration of the program. Table 3-7 shows the breakdown of costs and benefits yielding the positive PACT result.

Table 3-7. Program Administrator Cost Test for SCE Residential Efficiency Program

PACT Calculations		
	Benefits	**Costs**
Program overhead		$ 3,494,619
Program incentives		$ 15,457,880
Measure costs		
Energy savings (net)	$ 187,904,906	
Bill savings		
Monetized emissions (net)	$ 0	
Non-energy benefits		
Total	**$ 187,904,906**	**$ 18,952,499**
Net benefit	**$168,952,407**	
Benefit-cost ratio	**9.91**	

Source: E3 analysis; see Appendix C.

3.1.5 Calculating the RIM

The RIM examines the potential impact the energy efficiency program has on rates overall. The net benefits are the avoided cost of energy (same as PACT). The net costs include the overhead and incentive costs (same as PACT), but also include utility lost revenues from customer bill savings. The result of the SCE program is a loss of $109 million and a benefit-to-cost ratio of 0.63. This result suggests that, all other things being equal, the hypothetical impact of the program on rates would be for rates to increase. However, in practice, non-participants are unaffected until rates are adjusted through a rate case or a decoupling mechanism. In the long term, energy efficiency may reduce the capacity needs of the system; this can lead to either higher or lower rates to non-participants depending on the level of capital costs saved. Energy efficiency can be a lower-cost investment than other supply-side resources to meet customer demand, thereby keeping rates lower than they otherwise would be. (This is discussed in more detail in Section 3.2.2.) Thus it is important to recognize the RIM as examining the potential impacts on rates, but also recognizing that a negative RIM does not necessarily mean that rates will actually increase. Section 6.3 discusses impacts over time in greater detail. Table 3-8 breaks down the costs and benefits included in the RIM.

Table 3-8. Ratepayer Impact Measure for SCE Residential Energy Efficiency Program

RIM Calculations		
	Benefits	**Costs**
Program overhead		$ 3,494,619
Program incentives		$ 15,457,880
Measure costs		
Energy savings (net)	$ 187,904,906	
Bill savings (net)		$ 278,187,587
Monetized emissions (net)	$ 0	
Non-energy benefits		
Total	**$ 187,904,906**	**$ 297,140,085**
Net benefit	**($109,235,180)**	
Benefit-cost ratio	**0.63**	

Source: E3 analysis; see Appendix C.

3.1.6 Calculating the TRC

The TRC reflects the total benefits and costs to all customers (participants and non-participants) in the SCE service territory. The key difference between the TRC and the PACT is that the former does not include program incentives, which are considered zero net transfers in a regional perspective (i.e., costs to the utility and benefits to the customers). Instead, the TRC includes the net measure costs of $41 million. Net benefits in the TRC are the avoided costs of energy, $188 million. The regional perspective yields an overall benefit of $143 million and a benefit-to-cost ratio of 4.21. In California, the TRC includes an adder that internalizes the benefits of avoiding the emission of NO_x, CO_2, sulfur oxides (SO_x), and volatile organic compounds (VOCs). The adder is incorporated into energy savings (and not broken out as a separate category).[3] In many jurisdictions, the avoided costs are based on a market price that is presumed to implicitly include emissions permit costs and an explicit calculation of permit costs for regulated emissions is not made. The TRC shows that overall benefits are four times greater than total costs (a lower benefits-to-cost ratio than the PACT and PCT, but still positive overall). Table 3-9 shows the costs and benefits included in the TRC calculation.

Table 3-9. Total Resource Cost Test for SCE Residential Energy Efficiency Program

TRC Calculations		
	Benefits	**Costs**
Program overhead		$ 3,494,619
Program incentives		
Measure costs (net)		$ 41,102,993
Energy savings (net)	$ 187,904,906	
Bill savings		
Monetized emissions (net)	(included in energy savings above)	
Non-energy benefits		
Total	**$ 187,904,906**	**$ 44,597,612**
Net benefit	**$143,307,294**	
Benefit-cost ratio	**4.21**	

Source: E3 analysis; see Appendix C.

3.1.7 Calculating the SCT

In California, the avoided costs of emissions are included directly in energy savings. These benefits are included in both TRC and SCT values, and as a result, their test outputs are the same (see Table 3-10).

Table 3-10. Societal Cost Test for SCE Residential Energy Efficiency Program

SCT Calculations		
	Benefits	**Costs**
Program overhead		$ 3,494,619
Program incentives		
Measure costs (net)		$ 41,102,993
Energy savings (net)	$ 187,904,906	
Bill savings		
Monetized emissions (net)	(included in energy savings above)	
Non-energy benefits (net)	$ 0	
Total	**$ 187,904,906**	**$ 44,597,612**
Net benefit	**$143,307,294**	
Benefit-cost ratio	**4.21**	

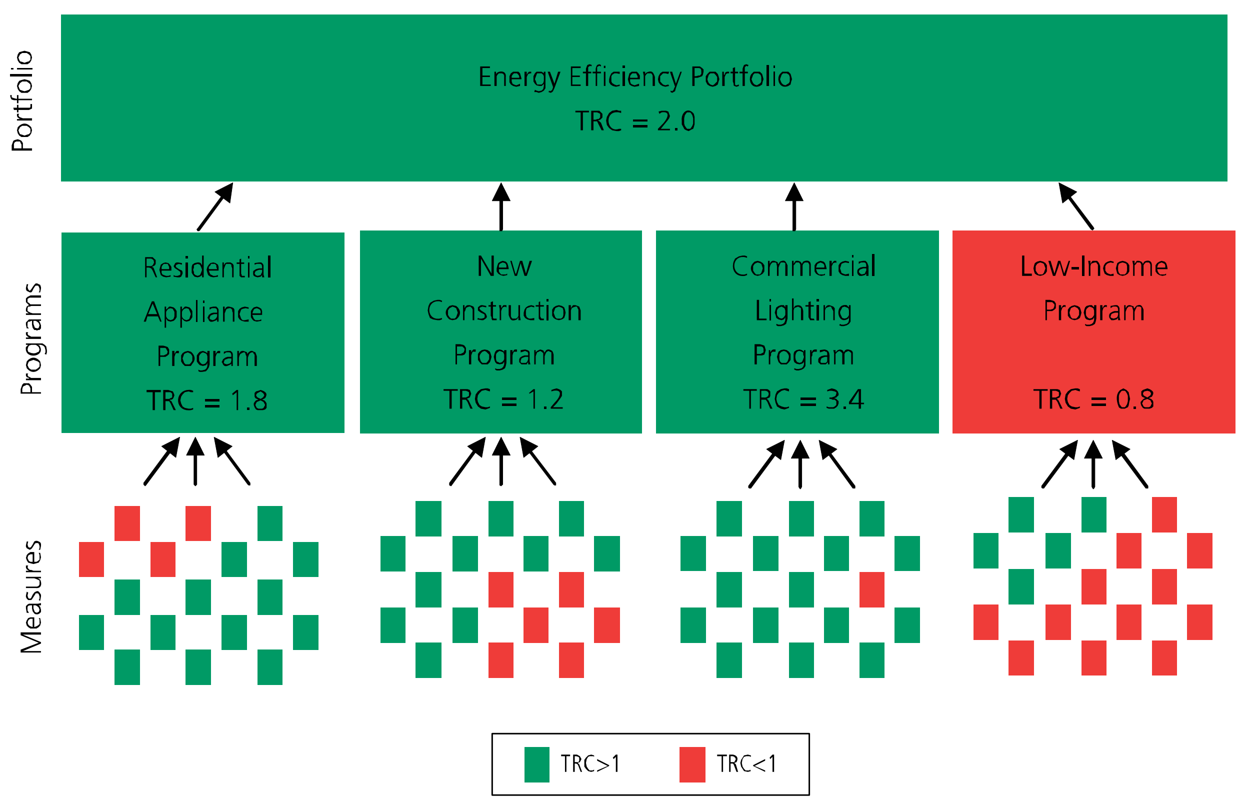
Source: E3 analysis; see Appendix C.

3.2 Considerations When Using Cost-Effectiveness Tests

3.2.1 Application of Cost-Effectiveness Tests

Cost-effectiveness tests can be applied at different points in the design of the energy efficiency portfolio, and the choice of when to apply each cost-effectiveness test has a significant impact on the ultimate set of measures offered to customers. In general, there are three places to evaluate the cost-effectiveness test: the "measure" level, the "program" level, and at the "portfolio" level. Evaluating cost-effectiveness at the measure level means that each individual component of a utility program must be cost-effective. Evaluation at the utility program level means that collectively the measures under a program must be cost-effective, but some measures can be uneconomical if there are other measures that more than make up for them. Evaluating cost-effectiveness at the portfolio level means that all of the programs taken together must be cost-effective, but individual programs can be positive or negative. Figure 3-1 illustrates a hypothetical portfolio in which cost-effectiveness is evaluated at the portfolio level, allowing some measures and programs that are not cost-effective even as the overall portfolio remains positive. If cost-effectiveness were evaluated at a measure level, those measures in red—the low-income program—could be eliminated as not cost-effective and would not be offered to customers.

Figure 3-1. Hypothetical Cost-Effectiveness at Measure, Program, and Portfolio Levels



Applying cost-effectiveness tests at the measure level is the most restrictive. With this approach, the analyst or policy-maker is explicitly or implicitly emphasizing the cost-effectiveness rather than the total energy savings of the efficiency portfolio. In contrast, applying cost-effectiveness tests at the portfolio level allows utilities greater flexibility to experiment with different strategies and technologies and results in greater overall energy savings, though at the expense of a less cost-effective portfolio overall. California applies the cost-effectiveness tests at the portfolio level specifically to allow and encourage the implementation of emerging technology and market transformation programs that promote important policy goals but do not themselves pass the TRC or PCT.

Strictly applying cost-effectiveness at the measure or even the program level can often result in the need for specific exceptions. At the measure level, variations in climate, building vintage, building type and end use may affect the cost-effectiveness of a measure. For marketing clarity, a rebate might be provided service-territory-wide even if some eligible climate zones and customer types are not cost-effective since differentiating among customer types may complicate the advertising message and make the program less effective (the program designers make sure the measure is cost-effective overall). At the program level, some programs—such as low-income programs—generally need higher incentive levels and marketing focus and may not be cost-effective, but are desired in the overall portfolio for social equity and other policy reasons. Similarly, some programs, such as those for emerging technologies or Home Performance with ENERGY STAR, ramp up slowly over time and typically do not achieve cost-effectiveness within the first three years, but do provide energy efficiency benefits. Also, the program and portfolio approaches make it easier to include supporting programs such as informational campaigns that raise overall awareness and complement other programs, but may not be cost-effective on a stand-alone basis.

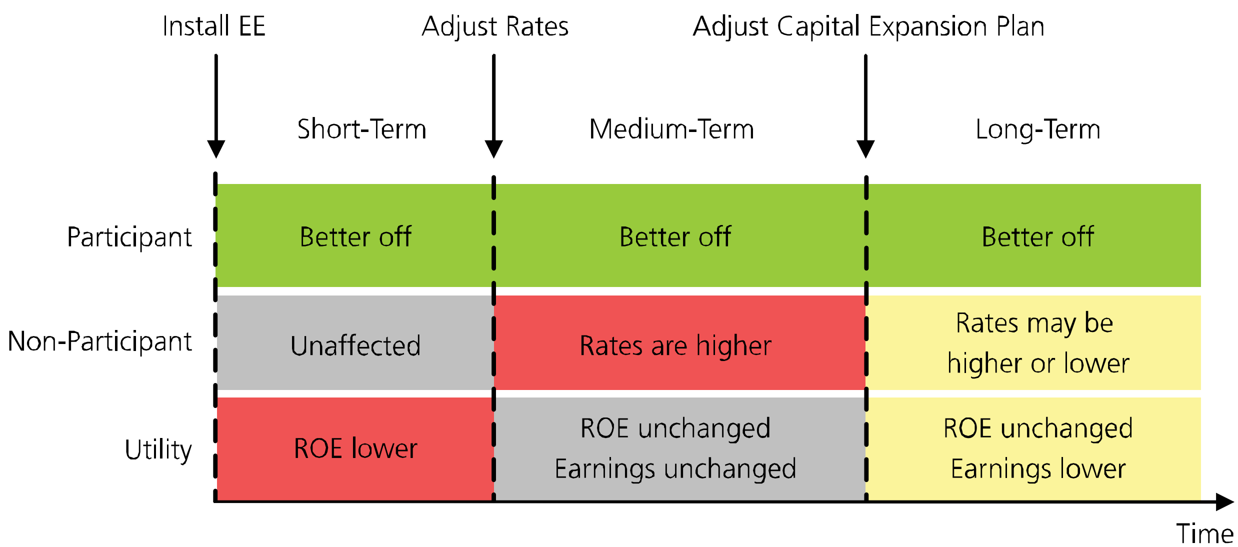
Summing up the benefits of multiple measures at the program level may require some adjustment for what are known as "interactive effects" between related measures. Interactive effects occur when multiple measures installed together affect each other's impacts. When measures affect the same end use, their combined effect when implemented together may be less than the sum of each measure's individually estimated impact. An insulation and air conditioning measure may each save 500 kilowatt-hours (kWh) individually, but less than 1,000 kWh when installed together. Alternatively, some measures may have additional benefits when other end uses are also present (i.e., "interactive effects"). For example, replacing incandescent bulbs with compact fluorescent light bulbs (CFLs) also reduces cooling loads in buildings with air conditioning.

3.2.2 Impacts Over Time of the Distribution Tests

Cost-effectiveness tests are evaluated on a life-cycle basis; however, they do not show the way impacts vary or adjust over time. As a result, it is important to recognize the ways in which program impacts may vary over time in order to properly interpret cost-effectiveness test results. For example, the RIM estimates the impact of the energy efficiency program on non-participants. Yet non-participants are actually unaffected until rates are adjusted through a rate case or a decoupling mechanism. Figure 3-2 illustrates the distributional impacts on the participant, non-participant, and utility over time in the common test-result case where energy efficiency has a PCT above 1 and a RIM below 1.[4]

Consider three time periods from the point at which the energy efficiency measure is first installed: the short term, medium term, and long term. The short term is defined as the period between installing the energy efficiency and adjusting the rate levels. The medium term begins once rates are adjusted and lasts until the change in energy efficiency results in an adjustment to the capital plan. The long term begins once the capital expansion plan has been changed.

Figure 3-2. Timeline of Distributional Impacts When PCT > 1 and RIM < 1



From a participant perspective, because the PCT is above 1.0, the participant is better off once an investment in energy efficiency is made, as the utility bill is lower than it would have been throughout the time horizon. In the short term, the non-participant is indifferent since rates have not been adjusted.[5] However, because the RIM is below 1.0, the utility is saving less than the drop in revenue from the participant and will therefore have lower return on equity (ROE), or debt-coverage ratio (DCR) for a public utility, compared to the case without energy efficiency. Note that for utilities with decoupling mechanisms or annual fuel cost adjustments, some or all of the rate impact may be felt before the next regular rate case cycle.

In the medium term, rates will be increased to hit the target ROE or DCR and the utility will be indifferent to the energy efficiency. This rate increase, however, affects the non-participating customers who have the same consumption as they otherwise would have, but now face higher rates. Finally, in the long term, energy efficiency may reduce the capacity needs of the system, as the capital expansion requirements of the utility are reduced. The long-term rate impact will depend on the level of fixed capital costs included in the avoided costs to value the energy savings. If the avoided costs include the long-term capacity cost savings realized through energy efficiency, a RIM ratio below 1.0 would indicate that rates will be higher in the long term. In many cases, however, avoided costs are based primarily on market prices, which tend to represent a short-term view. Thus, it may be that energy efficiency will meet load growth at a lower cost than that of alternative utility investments, and rates will be lower than they otherwise would have been even if the RIM ratio is below 1.0. To the extent that less capital is needed, earnings will be lower for the utility since the utility will be smaller relative to the no-efficiency case. However, ROE or DCR will be unchanged in the long term since rates will be adjusted periodically based on the target ROE or DCR.

3.3 Notes

[1] PM10 is particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers.

[2] Calculations of the cost tests were made by the paper's authors using a simplified analysis tool. This serves to illustrate the concepts, but may not match exactly what each utility has reported based on their own analysis.

[3] The inclusion of the environmental adder in the TRC is an effort to directly internalize the externalities of environmental impacts into California's primary cost test, which is the TRC (see Section 5.1.1).

[4] More detailed analysis of impacts over time can be evaluated with the National Action Plan for Energy Efficiency's Energy Efficiency Benefits Calculator, using a set of assumptions that can be modified to fit a particular utility. See <http://www.epa.gov/cleanenergy/energy-programs/napee/resources/calculator.html>.

[5] If the load forecasts used in rate-making are adjusted to reflect projected efficiency savings, rates may increase in the short term as well.

4: Key Drivers in the Cost-Effectiveness Calculation

In addition to the cost-effectiveness tests themselves, there are a number of choices in developing the costs and benefits that can significantly affect the cost-effectiveness results. This chapter describes some of the major choices available to analysts and policy-makers; it is a resource and reference for identifying and better understanding the variations in possible terms and approaches and developing a more robust understanding of possible evaluation techniques and their trade-offs. Because energy efficiency programs vary in different energy sectors and have different embedded savings and cost values, the variations on these terms are considerable. Thus, this chapter cannot be a step-by-step guide of all possible conditions.

Issues covered in this chapter include:

- Which benefits to include in each cost-effectiveness test.
- Whether to emphasize accuracy or transparency.
- Which methodology to use to forecast future benefits of energy and capacity savings.
- What time period to consider when assessing costs and benefits.
- Whether to determine demand- and supply-side resource requirements in the same analysis (true "integrated resource planning").
- Whether to use a public, non-proprietary data set to develop the benefits, or rely on proprietary forecasts and estimates.
- Which discount rates to use in NPV analysis.
- Whether to incorporate non-energy benefits (NEBs) and costs in the calculation.
- What NTG to use.
- Whether to include CO_2 emissions reductions in the analysis.
- Whether to include RPS procurement costs in the analysis.

Ultimately, the types of costs, benefits, and methodology used depend on the policy goals. This chapter outlines the key terms that will need to be addressed in weighing and evaluating efficiency programs. It also provides a discussion of key factors in applying cost-effectiveness test terms.

4.1 Framework for Cost-Effectiveness Evaluation

The typical approach for quantifying the benefits of energy efficiency is to forecast long-term "avoided costs," defined as costs that would have been spent if the energy efficiency savings measure had not been put in place. For example, if an electric distribution utility expects to purchase energy at a cost of $70 per megawatt-hour (MWh) on behalf of customers, then $70/MWh is the value of reduced purchases from energy efficiency. In addition, the utility may not have to purchase as much system capacity (ICAP or UCAP),[1] make as many upgrades to distribution or transmission systems, buy as many emissions offsets, or incur as many other costs. All such cost savings resulting from efficiency are directly counted as "avoided cost" benefits. In addition to the directly counted benefits, the state regulatory commission or governing councils may request that the utility account for indirect cost savings that are not priced by the market (e.g., reduced CO_2 emissions). For additional information on avoided costs, refer to the National Action Plan's *Guide to Resource Planning with Energy Efficiency* (National Action Plan for Energy Efficiency, 2007b [Chapter 2]).

4.2 Choosing Which Benefits to Include

There are two main categories of avoided costs: energy-related and capacity-related avoided costs. Energy-related avoided costs involve market prices of energy, losses, natural gas commodity prices, and other benefits associated with energy production such as reduced air emissions and water usage. Capacity-related avoided costs involve infrastructure investments such as power plants, transmission and distribution lines, pipelines, and liquefied natural gas (LNG) terminals. Environmental benefits make up a third category of benefits that are frequently included in avoided costs. Saving energy reduces air emissions including GHGs, and saving capacity addresses land use and siting issues such as new transmission corridors and power plants.

Table 4-1 lists the range of avoided cost components that may be included in avoided cost benefits calculations for electricity and natural gas energy efficiency programs. The most commonly included components (and which comprise the majority of avoided costs) for electric utilities are both energy and capacity. Natural gas utilities will typically include energy and may or may not include the capacity savings.[2] Depending on the utility and the focus of the state regulatory commission or governing council, others may also be included.

Table 4-1. Universe of Energy and Capacity Benefits for Electricity and Natural Gas

Electricity Energy Efficiency	
Energy Savings	**Capacity Savings**
Market purchases or fuel and operation and maintenance costs	Capacity purchases or generator construction
System losses	System losses (peak load)
Ancillary services related to energy	Transmission facilities
Energy market price reductions	Distribution facilities
Co-benefits in water, natural gas, fuel oil, etc.	Ancillary services related to capacity
Air emissions	Capacity market price reductions
Hedging costs	Land use
Natural Gas Energy Efficiency	
Energy Savings	**Capacity Savings**
Market purchases at city gate	Extraction facilities
Losses	Pipelines
Air emissions	Cold weather action/pressurization activities
Market price reductions	Storage facilities
Co-benefits in water, natural gas, fuel oil, etc.	LNG terminals
Hedging costs	

Note: More detail on each of these components can be found in Chapter 3 of the Action Plan's *Guide to Resource Planning with Energy Efficiency* (National Action Plan for Energy Efficiency, 2007b).

Most states select a subset to analyze from within this “universe” of benefits when evaluating energy efficiency. No state considers them all. The most important factor in choosing the components is to inform the decisions on energy efficiency given the policy backdrop and situation of the state. As an example of how calculations may be adopted to specific conditions, California chose to include market price reduction effects in evaluating energy efficiency programs during the California Energy Crisis. Similarly, large capital projects such as LNG terminals or power plants, or a focus on GHGs or local environment, might lead to emphasizing these components over others. There may be diminishing value to detailed analysis of small components of the avoided cost that will not change the fundamental decisions.

4.3 Level of Complexity When Forecasting Avoided Costs

Within the avoided cost framework, there are many ways to estimate the benefits. The approach may be as simple as estimating the fixed and variable costs of displaced generation and using them as the avoided costs (as is done in Texas). An alternative approach is to use a more sophisticated integrated resource planning (IRP) approach that simultaneously evaluates both supply- and demand-side investments. This IRP analysis may include a simulation of the utility system with representation of all of the generation, transmission constraints, and loads over time (for example, see the Northwest Power Planning and Conservation Council 5th Power Plan[3] or PacifiCorp Integrated Resource Planning[4]). This requires a much more complex set of analysis tools, but provides more information on the right timing, desired quantity, and value of energy efficiency with respect to the existing utility system and its expected future loads.

In general, more sophisticated and accurate estimates of benefits are better. However, other considerations include the following:

- **Availability of resources** needed to complete the analysis and stakeholders’ review before adoption may be a problem in states without intervener compensation.

- **Time taken to complete** the analysis with sophisticated IRP approaches could delay implementation of energy efficiency. The regulatory landscape in many states is littered with IRP proceedings that are contentious and have taken years to complete.

- **Transparency of the approach** to a broad set of stakeholders is also valued and may be easier to achieve without sophisticated models to achieve broader support.

4.4 Forecasts of Avoided Costs

Depending on the utility type and market structure in a region, there are a number of methodology options for developing avoided natural gas and electricity costs. The first approach is to use forward and futures market data, which are publicly available and transparent to all stakeholders. However, energy efficiency is likely to have a life longer than available market prices, and a supplemental approach will also be needed to estimate long-term costs.

The second approach is to use public or private long-run forecast of electricity and natural gas costs, such as those produced by the Department of Energy’s Energy Information Agency and many state agencies (utilities participating in wholesale markets will also have proprietary forward market forecasts to inform trading activities).

The third approach is to develop simple long run estimates of future electricity value by choosing a typical “marginal resource” such as a combined cycle natural gas plant and forecasting its variable costs into the future. A more sophisticated variation would be to incorporate production simulation modeling of the electricity system into this analysis. Overall, it is important to understand the underlying assumptions of the forecasting approach and assess whether or not these assumptions are appropriate for the intended purpose. Table 4-2 summarizes avoided costs approaches by utility type and each is described in more detail below.

Table 4-2. Approaches to Valuing Avoided Energy and Capacity Costs by Utility Type

Utility Type	Near-Term Analysis (i.e., Market Data Available)	Long-Term Analysis (i.e., No Market Data Available)
Distribution electric or natural gas utility	Current forward market prices of energy and capacity	Long-term forecast of market prices of energy and capacity
Electric vertically integrated utility	Current forward market prices of energy and capacity *or* Expected production cost of electricity and value of deferring generation projects	Long-term forecast of market prices of energy and capacity *or* Expected production cost of electricity and value of deferring generation projects

4.4.1 Market Data

For utilities that are tightly integrated into the wholesale energy market, forward market prices provide a good basis for establishing avoided costs. If the utility is buying electricity, energy efficiency reduces the need to purchase electricity. If the utility can sell excess electricity, energy savings enables additional sales, resulting in incremental revenue. In either case, the market price is the per kWh value of energy efficiency. Forward market electricity prices are publicly available through services such as Platt’s “Megawatt Daily,” which surveys wholesale electricity brokers. This data is typically available extending three or four years into the future depending on the market.

The market price is also a good approach for natural gas utilities. The NYMEX futures market for natural gas provides market prices as far as 12 years in advance by month.[5] The market currently has active trading daily over the next three to five years. The NYMEX market also includes basis swaps that provide the price difference between Henry Hub and most delivery points in the United States.[6] Some analysts hesitate to use market data such as NYMEX beyond the period of active trading for fear that low volume of trading creates liquidity problems and prices that are not meaningful. While more liquid markets provide more rigor in the prices, the less liquid long-term markets are still available for trading and are therefore unbiased estimates of future market prices and may still be the best source of data.

Market prices provide a relatively simple, transparent, and readily accessible basis for quantifying avoided costs. On the other hand, market prices tend to be influenced primarily by current market conditions and variable operating costs, particularly in the near term. Market prices alone may not adequately represent long-term and/or fixed operating costs. The production simulation and proxy plant approaches described below provide alternative approaches that address long-term fixed costs.

4.4.2 Production Simulation Models

For self-resourced electric utilities that do not have wholesale market access or actively trade electricity, a "production simulation" forecast may be the best approach to forecast energy costs. A production simulation model is a software tool that performs system dispatch decisions to serve load at least cost, subject to constraints of transmission system, air permitting, and other operational parameters. The operating cost of the "marginal unit" in each hour or time period is used to establish the avoided cost of energy. The downside of production simulation models is that they are complex, rely on sophisticated algorithms that can appear as a "black box" to stakeholders, and have to be updated when market prices of inputs such as natural gas change. In addition, these types of models can have difficulty predicting market prices since the marginal energy cost is based on production cost, rather than supply and demand interactions in a competitive electricity market. If production simulation produces prices that differ from those actually seen in the market, energy efficiency can end up facing a cost hurdle that differs from the hurdles faced by supply-side resources. Long-term natural gas forecasts also often rely on production simulation to model regional supply, demand, and transportation dynamics and estimate the equilibrium market prices.

4.4.3 Long-Run Marginal Cost and the "Proxy Plant"

Developing a "proxy plant" is an alternative to production simulation approaches and may be used when market data is not available or appropriate. Under this approach, a fixed hypothetical plant is used as a proxy for the resources that will be built to meet incremental load.[7] Selecting the proxy-plant, the construction costs, financial assumptions, and operating characteristics are all assessed from its characteristics. As an example, the variable costs of a combined cycle natural gas plant may be used as a proxy for energy costs. The annual fixed cost of a combustion turbine may be used as a proxy for capacity costs. Several methods can be used to allocate fixed costs, adjust the variable operating costs, or otherwise shape the costs of the plant(s) across different time-of-use (TOU) periods. These methods include applying market price or system load shapes, loss of load probabilities, or marginal heat rates to vary prices by TOU. Another commonly used method is the peaker methodology, which uses an allocation of the capacity costs associated with peaking resources (typically combustion turbines) and the marginal system energy cost by hour (system lambda) to estimate avoided electricity costs in each hour or TOU period. These costs are then used to estimate the costs of the energy and capacity in the avoided costs calculations. The proxy plant approach is more transparent and understandable to many stakeholders (particularly in comparison to production simulation). The proxy plant approach may be used in conjunction with market data, to estimate costs for the periods beyond the time horizons when existing market data are available.

4.4.4 Proprietary and Public Forecasts

The easiest approach for a utility to develop long-term avoided costs may be to use its own internal forecast of market prices. This approach provides estimates of avoided cost that are closely linked to the utility operations. However, the methodology may be confidential since utilities involved in procuring electricity or natural gas on the market may not to reveal their expectations of future prices publicly. Therefore, the use of internal forecasts can significantly limit the stakeholder review process for evaluation of energy efficiency programs.

Public forecasts of avoided costs may also be used to develop a more open process for energy efficiency evaluation and planning. California, Texas, the Northwest Power Planning Council, Ontario, and others use a non-proprietary methodology. An open process allows non-utility stakeholders to evaluate and comment on the methodology, thereby increasing the confidence that the analysis is fair. This approach also makes it possible for energy efficiency contractors to evaluate the cost-effectiveness of proposed energy efficiency upgrades. Unfortunately, this open process may diverge from internal forecasts and introduce some discrepancy between the publicly adopted numbers and those actually used by utilities in resource planning and procurement decisions. States balance these concerns and generally commit to one path or the other.

Policy-makers may also rely on existing publicly available forecasts of electricity or natural gas. The most universal source of forecasts is the Annual Energy Outlook (AEO), provided by the Department of Energy's Energy Information Agency.[8] This public forecast provides regional long-term forecasts of electricity and natural gas. In addition to the AEO, state energy agencies or regional groups may provide their own independent forecasts, which may include sensitivity analysis. Some parties, however, view publicly developed forecasts with some skepticism, as they may be seen as being overly influenced by political considerations or the compromises necessary to gain wide support in a public process.

4.4.5 Risk Analysis

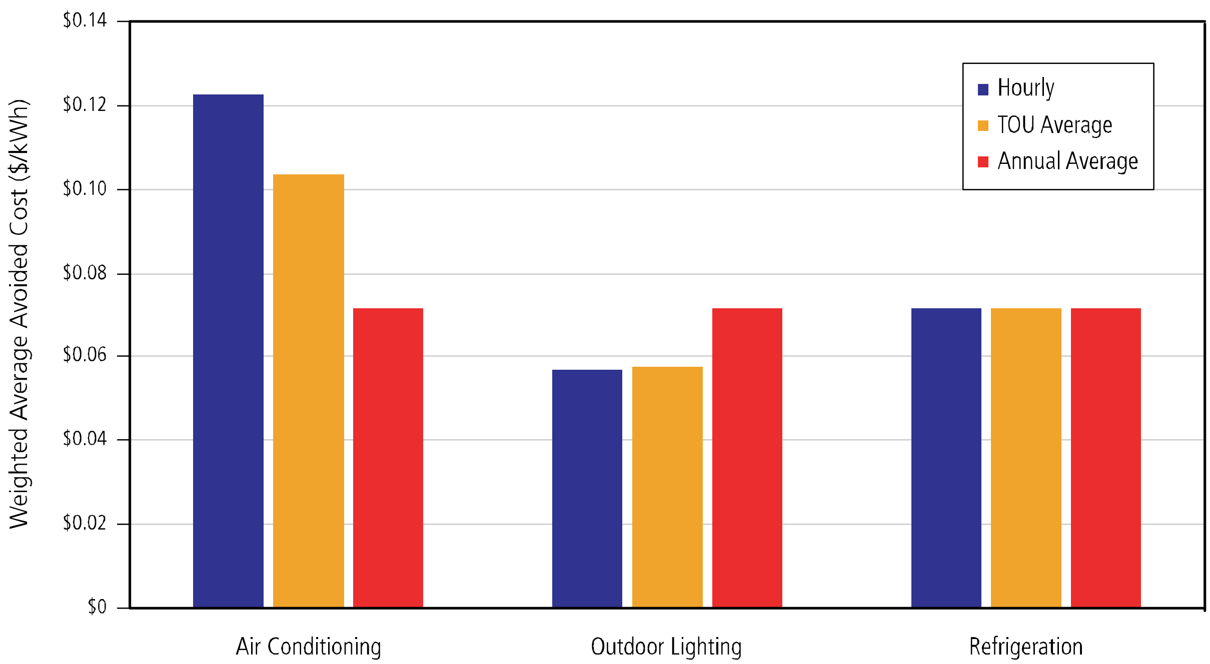
Electricity and natural gas prices are quite volatile and subject to cyclical ups and downs. In reducing load, energy efficiency also reduces a utility's exposure to fluctuating market prices. This provides an option or hedge value that can be quantified with risk analysis, but which is omitted when a single forecast of avoided costs is used.

Increasingly, utilities have used scenario and risk analysis to assess the benefits of different investment options under a range of future scenarios. One of the simpler approaches is to compare the cost-effectiveness results under multiple scenarios, using a high, expected, and low energy price forecast for example. More advanced techniques, such as Monte Carlo simulation, may be used to evaluate the performance of various resource plans under a wide range of possible outcomes.

4.5 Area- and Time-Specific Marginal Costs

For all of the forecasting approaches for avoided costs, the analyst must decide the level of disaggregation by area and time used in developing the forecasts. The marginal costs of electricity can vary significantly hour to hour and both electricity and natural gas prices vary by area and time of year. Similarly, the load reductions provided by energy efficiency measures also vary by season and time of day. Figure 4-1 shows the differences that can result when using hourly, TOU, and annual average avoided costs for different end uses, based on a study of air conditioning, outdoor lighting, and refrigeration end uses in California. The significance of using either TOU or average annual costs is highly dependent on the end use and demand/cost characteristics of the region in question. In California, the decision to use hourly avoided costs was made in order to appropriately value air conditioning energy efficiency.[9] This approach almost doubles the value of air conditioning measures relative to a flat annual average assessment of avoided cost (~$0.12/kWh vs. ~$0.07). In the case of other end uses, such as outdoor lighting efficiency, there is very little difference between hourly and TOU costs for end uses that operate evenly within a 24-hour period (e.g., refrigeration), there is no difference in method.

Figure 4-1. Implication of Time-of-Use on Avoided Costs



Source: California Proceeding on Avoided Costs of Energy Efficiency; R.04-04-025.

Another consideration of time-dependent avoided cost analysis is the need to correctly evaluate the tradeoffs between different types of energy efficiency measures. Hourly avoided costs are highly detailed, capturing the cost variance within and across major time periods. Annual average costs ignore the timing of energy savings. In the example above, using an annual average method, CFLs and outdoor lighting efficiency would receive the same value as air conditioning energy efficiency, while in actuality air conditioning energy efficiency is much more valuable to the system overall because it reduces the peak load significantly. The use of hourly avoided costs in this case reveals the large potential avoided cost value of air conditioning savings relative to other efficiency measures.

4.6 Net Present Value and Discount Rates

A significant driver of overall cost-effectiveness of energy efficiency is the discount rate assumption. Each cost-effectiveness test compares the NPV of the annual costs and benefits over the life of an efficiency measure or program. Typically, energy efficiency measures require an upfront investment, while the energy savings and maintenance costs accrue over several years. The calculation of the NPV requires a discount rate assumption, which can be different for the stakeholder perspective of each cost-effectiveness test.

As each perspective portrays a specific stakeholder's view, each perspective comes with its own discount rate. The five cost-effectiveness tests are listed in Table 4-3, along with the appropriate discount rate and an illustrative value. Using the appropriate discount rate is essential for correctly calculating the net benefits of an investment in energy efficiency.

Table 4-3. The Use of Discount Rates in Cost-Effectiveness Tests

Tests and Perspective	Discount Rate Used	Illustrative Value	Present Value of $1 a Year for 20 Years*	Today's Value of the $1 Received in Year 20
PCT	Participant's discount rate	10%	$8.51	$0.15
RIM	Utility WACC	8.5%	$9.46	$0.20
PACT	Utility WACC	8.5%	$9.46	$0.20
TRC	Utility WACC	8.5%	$9.46	$0.20
SCT	Social discount rate	5%	$12.46	$0.38

Source: Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects.

* This value is the same as not having to purchase $1 of electricity per year for 20 years.

Three kinds of discount rates are used, depending on which test is being calculated. For the PCT, the discount rate of an individual or business is used. For a household, this is taken to be the consumer lending rate, since this is the debt cost that a private individual would pay to finance an energy efficiency investment. It is typically the highest discount rate used in the cost-effectiveness tests. However, since there are potentially many different participants, with very different borrowing rates, it can be difficult to choose a single appropriate discount rate. Based on the current consumer loan market environment, a typical value may be in the 8 to 10 percent range (though a credit card rate might be much higher). For a business firm, the discount rate is the firm's weighted average cost of capital (WACC). In today's capital market environment, a typical value would be in the 10 to 12 percent range—though it can be as high as 20 percent, depending on the firm's credit worthiness and debt-equity structure. Businesses may also assume higher discount rates if they perceive several attractive investment opportunities as competing for their limited capital dollars. Commercial and industrial customers can have payback thresholds of two years or less, implying a discount rate well in excess of 20 percent.

For the SCT, the social discount rate is used. The social discount rate reflects the benefit to society over the long term, and takes into account the reduced risk of an investment that is spread across all of society, such as the entire state or region. This is typically the lowest discount rate. For example, California uses a 3 percent real discount rate (~5 percent nominal) in evaluating the cost-effectiveness of the Title 24 Building Standards.

Finally, for the TRC, RIM, or PACT, the utility's average cost of borrowing is typically used as the discount rate. This discount rate is typically called the WACC and takes into account the debt and equity costs and the proportion of financing obtained from each. The WACC is typically between the participant discount rate and the social discount rate. For example, California currently uses 8.6 percent in evaluating the investor-owned utility energy efficiency programs.

Using these illustrative values for each cost-effectiveness test, the third column of Table 4-3 shows the value of receiving $1 per year for 20 years from each perspective. This is analogous to the value of not having to purchase $1 of electricity per year. From a participant perspective assuming a 10 percent discount rate, this stream is worth $8.51; from a utility perspective, it is worth $9.46; and from a societal perspective, it is worth $12.46. The effect of the discount rate increases over time. The value today of the $1 received in the 20th year ranges from $0.15 from the participant perspective to $0.38 in the societal perspective, more than twice as much. Since the present value of a benefit decreases more over time with higher discount rates, the choice of discount rate has a greater impact on energy efficiency measures with longer expected useful lives.

4.7 Establishing the Net-to-Gross Ratio

A key requirement for cost benefit analysis is estimating the NTG. The NTG adjusts the cost-effectiveness results so that they only reflect those energy efficiency gains that are attributed to, and are the direct result of, the energy efficiency program in question. It gives evaluators an estimate of savings achieved as a direct result of program expenditures by removing savings that would have occurred even absent a conservation program. Establishing the NTG is critical to understanding overall program success and identifying ways to improve program performance. For more information on NTG in the context of efficiency program evaluation, see Chapter 5 of the National Action Plan for Energy Efficiency's *Model Energy Efficiency Program Impact Evaluation Guide* (National Action Plan for Energy Efficiency, 2007c).

Gross energy impacts are the changes in energy consumption and/or demand that result directly from program-related actions taken by energy consumers that are exposed to the program. Estimates of gross energy impacts always involve a comparison of changes in energy use over time among customers who installed measures versus some baseline level of usage.

Net energy impacts are the percentage of the gross energy impact that is attributable to the program. The NTG reduces gross energy savings estimates to reflect three types of adjustments:

- Deduction of energy savings that would have been achieved even without a conservation program.
- Deduction of energy savings that are not actually achieved in real world implementation.
- Addition of energy savings that occur as an indirect result of the conservation program.

Key factors addressed through the NTG are:

- **Free riders.** A number of customers take advantage of rebates or cost savings available through conservation programs even though they would have installed the efficient equipment on their own. Such customers are commonly referred to as "free riders."
- **Installation rate.** In many cases the customer does not ultimately install the equipment. In other cases, efficient equipment that is installed as part of an energy conservation program is later bypassed or removed by the customer. This is common for CFL programs.

- **Persistence/failure.** A certain percentage of installed equipment can be expected to fail or be replaced before the end of its useful life. Such early failure reduces the achieved savings as compared to pre-installation savings estimates.

- **Rebound effect.** Some conservation measures may result in savings during certain periods, but increase energy use before or after the period in which the savings occur. In addition, customers may use efficiency equipment more often due to actual or perceived savings.

- **Take-back effect.** A number of customers will use the reduction in bills/energy to increase their plug load or comfort by adjusting thermostat temperatures.

- **Spillover.** Spillover is the opposite of the free rider effect: customers that adopt efficiency measures because they are influenced by program-related information and marketing efforts, though they do not actually participate in the program.

4.8 Codes and Standards

Another way to encourage energy efficiency is to adopt increasingly strict codes and standards for energy use in buildings and appliances. This process is occurring in parallel with energy efficiency programs in most states, as each approach has its advantages and disadvantages. Codes and standards can be adopted for the state as a whole and do not demand the same level of state or utility funding as incentive programs. They do, on the other hand, impose regulatory and compliance costs on businesses and residents. Codes and standards generally involve a more complicated and potentially contentious legislative process than utility energy efficiency programs overseen by regulatory agencies. They also present enforcement challenges; local planning departments often do not have the staff, budget, or expertise to focus on state regulations related to energy use.

Increasingly strict codes and standards effectively raise the baseline that efficiency measures are compared against over time. This will reduce the energy savings and net benefits of efficiency measures, either by reducing the estimated savings or increasing the NTG.

4.9 Non-Energy Benefits and Costs

Conservation measures often have additional benefits beyond energy savings. These benefits include improved comfort, health, convenience, and aesthetics and are often referred to as non-energy effects (to include costs as well as benefits) or NEBs. None of the five cost-effectiveness tests explicitly recognizes changes in NEBs. Unless specifically cited, databases and studies generally exclude NEBs.

Examples of NEBs include:

- **From the customer perspective,** increased comfort, air quality, and convenience. For example, a demand response event that turns off air conditioning can reduce comfort and be a “cost” to the customer. Conversely, participants who gain improved heating and insulation can experience increased comfort, gaining an overall benefit.

- **From the utility perspective,** NEBs have been shown to reduce the number of shut-off notices issued or bill complaints received, particularly in low-income communities.

- **From a societal perspective,** efficiency programs can provide regional benefits in increased community health and improved aesthetics. On a larger scale, energy efficiency also reduces reliance on imported energy sources and provides national security benefits.

Studies attempting to estimate the value of NEBs are limited. Such studies often rely on participant surveys, which are designed to indicate their willingness to pay for NEBs or comparative valuation of various NEBs. Other studies rely on statistical analysis of survey data to estimate or "reveal" participant preferences toward NEBs. Both survey and statistical methods have significant limitations, and it is difficult to account for changing preferences across different income levels, cultural backgrounds, and household types. When values are not available, the judgment of regulators or program managers may be used. Examples of accounting for NEBs include decreasing costs or increasing benefits by a fixed percentage in the cost-effectiveness tests. To date, more emphasis has been placed on including NEBs than on non-energy costs. Nevertheless, as NEBs are incorporated in cost-effectiveness evaluation, non-energy costs should be evaluated on an equivalent basis. Examples of non-energy costs include reduced convenience and increased disposal or recycling costs.

4.10 Incentive Mechanisms

An area of growing interest in the application of cost-effectiveness tests is in establishing incentive mechanisms for utility efficiency programs. There exist two natural disincentives for utilities to invest in energy efficiency programs. First, energy efficiency reduces sales, which puts upward pressure on rates and can affect utility earnings. Second, utilities make money through a return on their capital investments or rate base. The financial disincentives for utilities are discussed thoroughly in the National Action Plan for Energy Efficiency's paper *Aligning Utility Incentives with Energy Efficiency Investment* (National Action Plan for Energy Efficiency, 2007a).

To address the reduced earnings from energy efficiency, states are increasingly exploring incentive mechanisms that allow a utility to earn a return on energy efficiency expenditures similar to the return on invested capital. The intent is to give the utility an equal (or greater) financial incentive to invest in energy efficiency as compared to traditional utility infrastructure.

The cost-effectiveness test results are increasingly being used as a metric to measure the incentive payment to the utility, based on the performance of the energy efficiency program. However, as discussed previously, no single cost-effectiveness test captures all of the goals of the efficiency program. Therefore, some states, such as California, have developed "weighting" approaches that combine the results of the cost-effectiveness tests. California has established a Performance Earnings Basis that is based on two-thirds of the TRC portfolio net benefits result and one-third of the PACT portfolio net benefits result. An incentive is then paid based on the utilities' combined results using this metric if the utilities' portfolio of savings meets or exceeds the utility commission's established energy savings goals.

When the cost-effectiveness tests are used in the payment of shareholder incentives, there will be additional scrutiny on the input assumptions and key drivers in the calculation. With this additional pressure, transparency and stakeholder review of the methodology becomes more important. Finally, the cost-effectiveness tests' use and their weights must be considered with care to align the utility objectives with the goals of the energy efficiency policy.

4.11 Greenhouse Gas Emissions

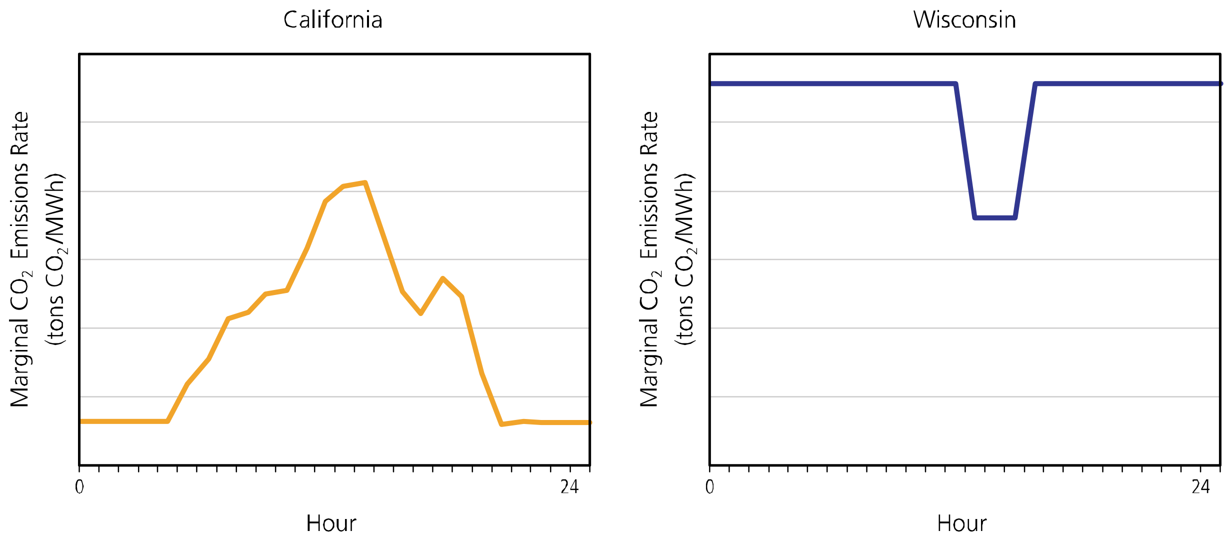
Another factor to consider when determining the cost-effectiveness of an energy efficiency program is how to value the program's effect on GHG emissions. The first step is to determine the quantity of avoided CO_2 emissions from the efficiency program. Once that quantity has been determined, its economic value can be calculated and added to the net benefits of the energy efficiency measures used to achieve the reductions. Currently, some jurisdictions use an explicit monetary CO_2 value in cost-benefit calculations, and some do not. California includes a forecast of GHG values in the avoided costs used to perform the cost-effectiveness tests and Oregon requires that future GHG compliance costs be explicitly considered in utility resource planning. Several utilities, including Idaho Power, PacifiCorp, and Public Service Company of Colorado, include GHG emissions and costs when evaluating supply- and demand-side options, including energy efficiency, in their IRP process.

The GHG emissions emitted through the end use of natural gas and heating oil are driven by the carbon content of the fuel and do not vary significantly by region or time of use. The GHG profiles of electricity generation do differ greatly by technology, fuel mix, and region. A very rough estimate of GHG emissions savings from energy efficiency can be obtained by multiplying the kWh saved by an average emission factor. Alternatively, it can be estimated based upon a weighted average of the heat rates and emission factors for the different types of generators in a utility's generation mix. Such "back of the envelope" methods are useful for agency staff and others who wish to quickly check that results from more sophisticated methods are approximately accurate.

A formal cost-effectiveness evaluation uses marginal emission rates that more accurately reflect the change in emissions due to energy efficiency and have an hourly profile that varies by region. For states in which natural gas is both a base load and peaking fuel, marginal emissions will be higher during peak hours because of the lower thermal efficiency of peaking plants, and therefore energy efficiency measures that focus their kWh savings on-peak will have the highest avoided GHG emissions per kWh saved. However, in states in which coal is the dominant fuel, off-peak marginal emission rates may actually be higher than on-peak if the off-peak generation is coal and on-peak generation is natural gas. Figure 4-2 illustrates this difference, comparing reported marginal emission rates for California and Wisconsin.

To date, monetary values for GHG emissions have been drawn primarily from studies and journal articles and applied in regulatory programs. While there is widespread agreement that GHG reduction policies are likely to impose some cost on CO_2 emissions, achieving consensus on a specific $/ton price for the electricity sector is challenging. As Congress and individual states consider specific GHG legislation, a number of the policy considerations that will affect the CO_2 price remain in flux.

Figure 4-2. Comparison of Marginal CO_2 Emission Rates for a Summer Day in California and Wisconsin



Source: Erickson et al. (2004).

Note: The on-peak marginal emissions rate of each state is set by natural gas peaking units. The off-peak rates are quite different, reflecting the dominance of coal base load generation in Wisconsin and natural gas combined cycle in California.

4.12 Renewable Portfolio Standards

An emerging topic in energy efficiency cost-effectiveness is how to treat the interdependence between energy efficiency and RPS. RPS goals are typically established state by state as a percentage of retail loads in a future target year (e.g., 20 percent renewable energy purchases by 2020). Unlike supply-side investments, energy efficiency, by reducing load, can reduce the amount of renewable energy that must be procured pursuant to RPS targets, thereby reducing RPS compliance cost.

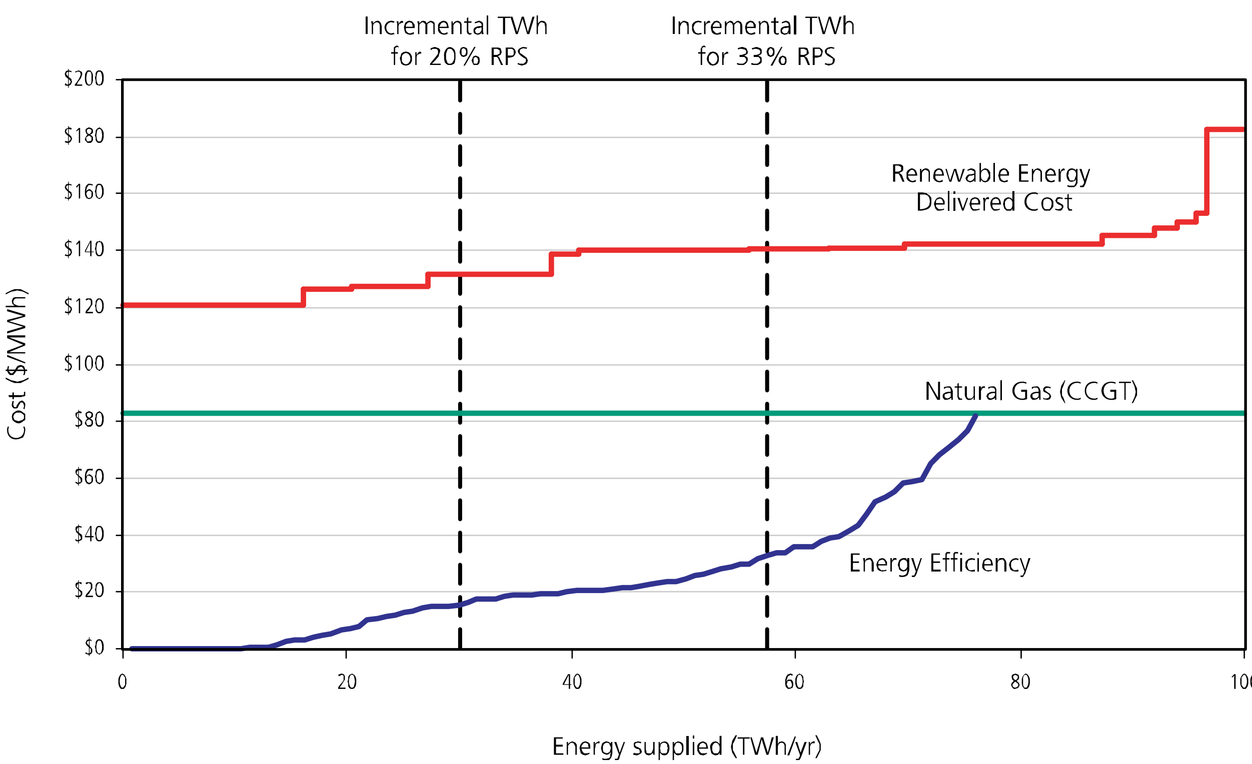
Some renewable technologies can provide energy at costs close to that of conventional generation. However, for many states, the marginal cost of complying with state RPS goals will be set either by more expensive technologies or by distant resources with significant transmission costs. When the cost of renewable energy needed to meet RPS goals is significantly higher than the avoided cost for conventional generation, energy efficiency provides additional savings by reducing RPS compliance costs.

The additional RPS-related savings from energy efficiency for California are illustrated in Figure 4-3. In California, as in many regions, the least-cost conventional base-load resource is combined cycle gas turbine (CCGT), shown here with a cost of $82/MWh. The avoided costs against which energy efficiency has historically been evaluated are based on such conventional generation. This has limited the promotion of energy efficiency to technologies with costs below $80/MWh. In practice, given limited budgets and staff, utilities have focused primarily on technologies with costs of $40/MWh or below.

In comparison, the estimated cost of renewable energy needed to meet California's 20 percent RPS standard is over $130/MWh. So for every 1,000 MWh saved by energy efficiency, the utilities avoid the purchase 800 MWh of conventional generation at $82/MWh and 200 MWh of renewable generation at $130/MWh. Thus the RPS standard increases the cost of avoided energy purchases from $82/MWh to $92/MWh ($82/MWh + [130/MWh - $82/MWh] × 20%).

Utilities in California have begun to incorporate the higher cost of renewable generation in their internal evaluation of load reduction strategies. However, as in most jurisdictions, the cost of meeting RPS targets has not yet been formally included in the adopted avoided cost forecasts against which energy efficiency programs are officially evaluated.

Figure 4-3. Natural Gas, Energy Efficiency, and Renewable Supply Curves for California



Source: Mahone et al. (2008).

4.13 Defining Incremental Cost

In order to apply the avoided cost approach in evaluating benefits of energy efficiency cost-effectiveness, the analyst must also determine the incremental cost of the measures. Energy efficiency portfolio costs are easier to evaluate than benefits, since they are directly observable and auditable. For example, marketing costs, measurement and evaluation costs, incentive costs, and administration costs all have established budgets. The exception to this is in estimating the incremental measure cost. This is a necessary input for the TRC, SCT, and PCT calculations.

For each of these tests, the appropriate cost to use is the cost of the energy efficiency device in excess of what the customer would otherwise have made. Therefore, the incremental measure costs must be evaluated with respect to a baseline. For example, a program that provides an incentive to a customer to upgrade to a high-efficiency refrigerator would use the premium of that refrigerator over the base model that would otherwise have been purchased.

Establishing the appropriate baseline depends on the type of measure. In cases where the customer would not have otherwise made a purchase, for example the early replacement of a working refrigerator, the appropriate baseline is zero expenditure.[10] In this case, the incremental cost is the full cost of the new high-efficiency unit. The four basic measure decision types are described in Table 4-4 along with different names often used for each decision type.

Table 4-4. Defining Customer Decision Types Targeted by Energy Efficiency Measures

Decision Type	Definition	Example
New New construction Lost opportunity	Encourages builders and developers to install energy efficiency measures that go above and beyond building standards at the time of construction	Utility offers certification or award to builder of new homes that meet or exceed targets for the efficient use of energy.
Replacement Failure replacement Natural replacement Replace on burnout	Customer is in the market for a new appliance because their existing appliance has worn out or otherwise needs replacing. Measure encourages customer to purchase and install efficient instead of standard appliance.	The utility provides a rebate that encourages the customer to purchase a more expensive, but more efficient and longer-lasting CFL bulb instead of an incandescent bulb.
Retrofit Early replacement	Customer's existing appliance is working with several years of useful life remaining. Measure encourages customer to replace and dispose of old appliance with a new, more efficient one.	The utility provides a rebate toward the purchase of a new, more efficient refrigerator upon the removal of an older, but still working refrigerator.
Retire	Customer is encouraged to remove, but not replace existing fixture.	The utility pays for the removal and disposal of older but still working "second" refrigerators (e.g., in the garage) that customer can conveniently do without.

Table 4-5 summarizes the calculation of measure costs for each of the decision types described above. In the table, "efficient device" refers to the equipment that replaces an existing, less-efficient piece of equipment. "Standard device" refers to the equipment that would be used in industry standard practice to replace an existing device. "Old device" refers to the existing equipment to be replaced.

Table 4-5. Defining Costs and Impacts of Energy Efficiency Measures

Type of Measure	Measure Cost ($/Unit)	Impact Measurement (kWh/Unit and kW/Unit)
New New construction Lost opportunity	Cost of efficient device **minus** cost of standard device *(Incremental)*	Consumption of standard device **minus** consumption of efficient device
Replacement Failure replacement Natural replacement Replace on burnout	Cost of efficient device **minus** cost of standard device *(Incremental)*	Consumption of standard device **minus** consumption of efficient device
Retrofit Early replacement *(Simple)*	Cost of efficient device **plus** installation costs *(Full)*	Consumption of old device **minus** consumption of efficient device
Retrofit Early replacement *(Advanced)**	Cost of efficient device **minus** cost of standard device **plus** remaining present value	*During remaining life of old device:* Consumption of old device **minus** consumption of efficient device *After remaining life of old device:* Consumption of standard device **minus** consumption of efficient device
Retire	Cost of removing old device	Consumption of old device

* The advanced retrofit case is essentially a combination of the simple retrofit treatment (for the time period during which the existing measure would have otherwise remained in service) and the failure replacement treatment for the years after the existing device would have been replaced. "Present Value" indicates that the early replacement costs should be discounted to reflect the time value of money associated with the installation of the efficient device compared to the installation of the standard device that would have occurred at a later date.

4.14 Notes

[1] Installed capacity (ICAP), or unforced capacity (UCAP) in some markets, is an obligation of the electric utility (load serving entity, or LSE) to purchase sufficient capacity to maintain system reliability. The amount of ICAP an LSE must typically procure is equal to its forecasted peak load plus a reserve margin. Therefore, reduction in peak load due to energy efficiency reduces the ICAP obligation.

[2] The ability to store natural gas, and to manage the gas system to serve peak demand periods by varying the pressure, reduces the share of gas costs associated with capacity relative to electricity.

[3] See <http://www.nwcouncil.org/energy/powerplan/5/Default.htm>.

[4] See <http://www.pacificorp.com/Navigation/Navigation23807.html>.

[5] See <http://www.nymex.com/ng_fut_csf.aspx> for current market prices at Henry Hub.

[6] See <http://www.nymex.com/cp_produc.aspx> for available basis swap products.

[7] The specifications may be developed by the utility or developed through a regulatory process with stakeholder input.

[8] Forecasts are available at <res://ieframe.dll/tabswelcome.htm>.
See <http://www.eia.doe.gov/oiaf/aeo/> for the latest edition of the Annual Energy Outlook.

[9] See <http://www.ethree.com/CPUC/E3_Avoided_Costs_Final.pdf> for a detailed description of the development of avoided costs in California.

[10] A simplifying assumption of zero as the baseline expenditure is often used, even though the equipment may have a limited remaining useful life and need replacement in a few years. Table 4-5 presents a more detailed calculation that can be used for early replacement programs.

5: Guidelines for Policy-Makers

A common misperception is that there is a "best" perspective for evaluating the cost-effectiveness of energy efficiency. On the contrary, no single test is more or less appropriate for a given jurisdiction. A useful analogy for the value of the five cost-effectiveness tests is the way doctors use multiple diagnostics to assess the overall health of a patient: each test reflects different aspects of the patient's health. This chapter describes how individual states use each of the five cost-effectiveness tests and why states might choose to emphasize some tests over others. Four hypothetical situations are presented to illustrate how states may emphasize particular tests in pursuit of specific policy goals.

5.1 Emphasizing Cost-Effectiveness Tests

Nationwide, the most common primary measurement of energy efficiency cost-effectiveness is the TRC, followed closely by the SCT. A positive TRC result indicates that the program will, over its lifetime, produce a net reduction in energy costs in the utility service territory. A positive SCT result indicates that the region (the utility, the state, or the United States) will be better off on the whole. Table 5-1 shows the distribution of primary cost-effectiveness tests used by state.

Table 5-1. Primary Cost-Effectiveness Test Used by Different States

PCT	PACT	RIM	TRC	SCT	Unspecified
	CT, TX, UT	FL	CA, MA, MO, NH, NM,	AZ, ME, MN, VT, WI	AR, CO, DC, DE, GA, HI, IA, ID, IL, IN, KS, KY, MD, MT, NC, ND, NJ, NV, OK, OR, PA, RI, SC, VA, WA, WY

Source: Regulatory Assistance Project (RAP) analysis.

Cost-effectiveness overall as analyzed by the TRC and SCT is not necessarily the only important aspect to evaluate when designing an energy efficiency portfolio. Even if benefits outweigh costs, some stakeholders can be net winners and others net losers. Therefore, many states also include one or more of the distributional tests to evaluate cost-effectiveness from individual vantage points. Using the results of the distribution tests, the energy efficiency measures and programs offered, their incentive levels, and other elements in the portfolio design can be balanced to provide a reasonable distribution of costs and benefits among stakeholders. Table 5-2 shows the distribution of cost-effectiveness tests used by states for either the primary or secondary consideration.

Table 5-2. Cost-Effectiveness Tests in Use by Different States as Primary or Secondary Consideration

PCT	PACT	RIM	TRC	SCT
AR, FL, GA, HI, IA, IN, MN, VA	AT, CA, CT, HI, IA, IN, MN, NO, NV, OR, UT, VA, TX	AR, DC, FL, GA, HI, IA, IN, KS, MN, NH, VA	AR, CA, CO, CT, DE, FL, GA, HI, IL, IN, KS, MA, MN, MO, MT, NH, NM, NY, UT, VA	AZ, CO, GA, HI, IA, IN, MW, MN, MT, NV, OR, VA, VT, WI

Source: Regulatory Assistance Project (RAP) analysis.

Using the PCT. The PCT provides two key pieces of information helpful in program design: at the measure level it provides some sense of the potential adoption rate, and it can help in setting the appropriate incentive level so as not to provide too small or too unnecessarily large an incentive. Setting the incentive levels is part art and part science. The goal is to get the most participation with the least cost. There is a balance between the PCT results with the PACT and RIM results. The higher the incentive, the higher the PCT benefit cost ratio and the lower the PACT and RIM benefit-cost ratio.

Using the PACT. The PACT provides an indication of how the energy efficiency program compares with supply-side investments. This is used to balance the incentive levels with the PCT. A poor PACT may also result from a low NTG, if, for example, a large number of customers would make the efficiency investment without the program. A poor PACT might also suggest that large incentives are required to induce sufficient adoption of a particular measure.

"You get what you measure"

When selecting cost-effectiveness tests to use as metrics for portfolio, remember the saying, "you get what you measure." If a single distributional test is used as a primary cost-effectiveness test, the portfolio may not balance benefits and costs between stakeholders. This is particularly true as utility incentive mechanisms are introduced that rely on cost-effectiveness results. Overall the results of all five cost tests provide a more comprehensive picture than any one test alone.

Using the RIM. The RIM as a primary consideration test is not as common as the other two distributional tests. If used, it is typically a secondary consideration test done on a portfolio basis to evaluate relative impacts of the overall energy efficiency program on rates. The results will provide a high-level understanding of the likely pressure on rates attributable to the energy efficiency portfolio. A RIM value below 1.0 can be acceptable if a state chooses to accept the rate effect in exchange for resource and other benefits. Efficiency measures with a RIM value below 1.0 can nevertheless represent the least-cost resource for a utility, depending on the time period and long-term fixed costs included in the avoided costs.

5.1.1 Use of Cost-Effectiveness Tests by State

Table 5-3 shows how states use cost-effectiveness tests. Many states use multiple cost-effectiveness tests to provide a more complete picture of energy efficiency cost-effectiveness. Eighteen states use two or more cost-effectiveness tests for some aspect of efficiency evaluation; four of those require all five tests. For example, Hawaii requires that all five tests be included in the analysis of supply and demand options in utility IRPs. Indiana uses all five tests to screen demand-side management (DSM) programs. Minnesota uses all five tests, but considers the SCT to be the most important. Many other states use two or three tests with different weights assigned to each test, or with separate tests being used for separate parts of the process. Several states have adopted formal and in some cases unique modifications to the standard forms of the tests.

The choice of tests and their applications reveal the priorities of the states and the perspectives of their regulatory commissions—the extent to which energy efficiency is considered a resource or the extent to which rates dominate policy implementation of energy efficiency. Some commissions like having a clear formula, using only one or two tests with threshold values to establish program scope.

The following are several examples of the types of decisions regulatory commissions have made regarding cost-effectiveness tests:

- In Colorado, a 2004 settlement with Xcel Energy required the TRC. A 2007 statute requires the use of a variation of the SCT that includes the utility's avoided costs, the valuation of avoided emissions, and NEBs as determined by the regulatory commission.

- Connecticut uses the PACT to screen individual DSM programs and the TRC to evaluate the total benefit of conservation and load management programs and to determine performance incentives.

- In the District of Columbia, the RIM is used for DSM programs. Those which have a cost-benefit ratio of 0.8 and 1.0 may be evaluated for other benefits, including long-term savings, market transformation, peak savings, and societal benefits.

- Iowa requires utilities to analyze DSM programs using the SCT, RIM, PACT, and PCT. According to statute, if the utility uses a test other than the SCT to determine the cost-effectiveness of energy efficiency programs and plans, it must describe and justify its use of the alternative test.

- In Montana, the SCT and TRC are used for the traditionally regulated utility that prepares IRPs. Neither test is required for the utility that conducts portfolio management, although statute specifies that the RIM should not be used.

- Utah requires that DSM programs meet the TRC and PACT in IRP. For supply and demand resources, the primary test is the PACT, calculated under a variety of scenarios; other tests may also be considered.

- California weighs the results of two of the cost-effectiveness tests, TRC and PACT, in this program screening process. California adopted a "Dual-Test" that uses the PACT to ensure that utilities are not over spending on incentives for programs that pass the TRC. The recently adopted shareholder incentive mechanisms use a weighting of two-thirds of the TRC portfolio net benefits result and one-third of the PACT portfolio net benefits result. An incentive is then paid based on the utility's combined results using this metric if the utility's portfolio of savings meets or exceeds the Commission's established energy savings goals.

Table 5-3. Use of Cost-Effectiveness Tests by States

State	Requires All	Primary Test	TRC	SCT	PCT	PACT	RIM	Other	Non Specific
AK									•
AL									•
AR			•		•	•	•		
AZ*		SCT		•					
CA		TRC	•			•			
CO			•	•					
CT		PACT	•			•			
DC							•	•	
DE*			•						
FL		RIM	•		•		•		
GA			•	•	•		•		
HI	•		•	•	•	•	•		
IA				•	•	•	•		
ID†			•	•	•	•			
IL			•						
IN	•		•	•	•	•	•		
KS*			•				•		
KY									•
LA									•
MA		TRC	•						
MD*									•
ME		SCT		•					
MI									•
MN	•	SCT	•	•	•	•	•		
MO		TRC	•			•			
MS									•
MT			•	•					
NC									•
ND									•
NE									•
NH		TRC	•				•		
NJ								•	
NM		TRC	•						
NV				•		•		•	
NY		TRC	•						
OH									•
OK									•
OR*				•		•			
PA									•
RI								•	
SC									•
SD									•
UT		PACT	•			•			
VA	•		•	•	•	•	•		
VT		SCT		•					
TN									•
TX		PACT				•			
WA								•	
WI		SCT		•					
WV									•
WY									•

* Proposed or not yet codified in statute/Commission Order.

† Allows any or all tests, though the RIM may not be used as primary or limiting cost-effectiveness test.

Source: Regulatory Assistance Project (RAP) analysis.

5.2 Picking Appropriate Costs, Benefits, and Methodology

With the cost-effectiveness tests determined, it is equally important to pick the appropriate costs, benefits, and methodology to align the energy efficiency portfolio with the overall policy goals and context for energy efficiency. The choices should ultimately reflect the situation of the utility and the state, its history in implementing energy efficiency, and other considerations. To provide some guidance, four hypothetical situations are considered along with several recommendations of possible approaches in each situation. Since the hypothetical situations do not consider any specific state, they should be viewed as a starting point for discussion and not specific policy recommendation for every context.

5.2.1 Situation A: Peak Load Growth and Upcoming Capital Investments

States or regions that are experiencing high peak load growth and associated large capital investments will want to ensure that the energy efficiency portfolio appropriately targets the peak and also provides higher benefits for peak load reduction that can be used to justify higher-cost energy efficiency such as air conditioner incentives or demand response.

One approach is to introduce time-specific avoided costs by hour, or by TOU. In addition, it will be important to initiate system planning studies that integrate supply- and demand-side planning so that the energy efficiency programs have the opportunity to defer or delay the supply-side capital investments. Unless the two processes are linked in some way, the energy efficiency program may be successful in reducing peak loads only to find that the capital projects also built. This could create a situation with too much capacity, and overspending on peak load reductions. In order to coordinate demand- and supply-side planning, it is important to start early. The lead time for large supply-side projects can be five or even 10 years. In addition, it is much easier to defer or eliminate the need for the project before the supply-side project proponents are deeply vested in its outcome.

5.2.2 Situation B: Utility Financial Problems

In a situation with a utility with financial problems, due to low load growth and/or a rate freeze, a different set of energy efficiency policies might be considered. Though the problem probably cannot be fixed with energy efficiency program design, there is no need to make it worse.

There are several approaches to encourage energy efficiency without straining the utility financially. One approach is to introduce decoupling or another automatic rate adjustment for reduced sales from energy efficiency to ensure recovery of fixed costs that have already been allowed in a prior rate case. A rate adjustment, whether tied to decoupling or not, may also help improve the utility financial situation.

If rate adjustments are not possible (whether through direct adjustment, decoupling, or another approach), another option may be to limit the impact of energy efficiency by specifying a minimum portfolio RIM. This will reduce the level of energy that can be saved but allow the portfolio to continue, perhaps with some lower-scoring programs placed on hiatus, while the financial issues of the utility are addressed.

5.2.3 Situation C: Targeting Load Pockets

If a utility has areas of growing load that require new transmission and/or generation investments to be made, energy efficiency may provide an alternative. In this case, it may be less expensive to use energy efficiency and demand response to reduce peak loads than to build new supply-side infrastructure. Using demand-side resources to alleviate a load pocket also has a lower impact on the environment.

In order to target the load pockets, the energy efficiency portfolio should include programs that specifically target peak load reduction in these areas. This can be done by increasing marketing of the same programs used service-territory-wide, or by developing a specific program to target peak load reductions in an area. Area- and time-specific costing should be introduced to estimate the value of the peak load reductions. Energy efficiency program managers should be given the authority to target certain areas. In this case, the equity of providing all of the same measures service-territory-wide may be overshadowed by value of a targeted program.

Targeting marketing and implementation is, by definition, discriminatory, but for legitimate, cost-based reasons. Targeting efficiency for areas with capacity constraints can be a prudent and least-cost means of accommodating load growth or meeting reliability criteria. While they may appear to favor certain customers, targeted efforts can provide sufficient incremental value to offer net benefits for all customers.

As in Situation A, it will be important in Situation B to initiate system planning studies that integrate supply- and demand-side planning so that the energy efficiency programs have the opportunity to defer or delay the supply-side load pocket mitigation measures.

5.2.4 Situation D: Aggressive Greenhouse Gas and RPS Policies

Many states are introducing the RPS and beginning to implement aggressive GHG policies. In these situations, policy-makers will need to emphasize energy savings. One approach to consider is to focus on the TRC or SCT, and not to use the RIM results. Policy-makers might also consider including a forecast of avoided CO_2 reductions in the avoided costs. In addition, including the avoided costs of the renewable energy or low-carbon resource that would otherwise be purchased (nuclear, renewables, carbon-capture, and sequestration) as the marginal resource can increase the avoided costs. This raises the quantity of efficiency measures and programs considered cost-effective. Finally, policy-makers will want to focus the cost-effectiveness tests at the portfolio level, rather than at the program or measure level.

6: Detailed Cost-Effectiveness Test Comparison—How Is Each Cost-Effectiveness Test Used?

This chapter describes the cost-effectiveness tests in order to provide greater understanding of calculation, results, and appropriate use of each test. Information is provided on the perspective, purpose, costs, benefits, and other considerations for each of the cost-effectiveness tests.

6.1 Participant Cost Test

The PCT examines the costs and benefits from the perspective of the customer installing the energy efficiency measure (homeowner, business, etc.). Costs include the incremental costs of purchasing and installing the efficient equipment, above the cost of standard equipment, that are borne by the customer. The benefits include bill savings realized to the customer through reduced energy consumption and the incentives received by the customer, including any applicable tax credits. Table 6-1 outlines the benefits and costs included in the PCT. In some cases the NPV of incremental operations and maintenance costs (or savings) may also be included.

Table 6-1. Benefits and Costs Included in the Participant Cost Test

Benefits and Costs from the Perspective of the Customer Installing the Measure	
Benefits	**Costs**
▪ Incentive payments ▪ Bill savings realized ▪ Applicable tax credits or incentives	▪ Incremental equipment costs ▪ Incremental installation costs

Source: Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects.

The primary use of the PCT is to assess the appeal of an energy efficiency measure to potential participants. The higher the PCT, the stronger the economic incentive to participate. The PCT functions similarly to a simple payback calculation, which determines how many years it takes to recover the costs of purchasing and installing a device through bill savings. A cost-effective measure will have a high PCT (above 1) and a low payback period. The PCT also provides useful information for designing appropriate customer incentive levels. A high incentive level will produce a high PCT benefit-cost ratio, but reduce the PACT and RIM results. This is because incentives given to customers are seen as “costs” to the utility. The PCT, PACT, and RIM register incentive payments in different ways based on their perspective. Utilities must balance the participant payback with the goal of also minimizing costs to the utility and ratepayers.

> A positive PCT (above 1) shows that energy efficiency provides net savings for the customer over the expected useful life of the efficiency measure.

6.1.1 Additional Considerations

As a measure of payback period or economic appeal, the PCT reflects an important aspect of potential participation rates. However, it is not a comprehensive evaluation of all the determinants that influence customer participation. For example, the PCT does not consider the level of marketing and outreach efforts (or expenditures) to promote the program, and marketing can be a major driver of adoption rates. In addition, new technologies may have high upfront costs, or steep learning curves, which yield limited adoption despite high PCT ratios. As a key example, energy-efficient CFLs generally reach a plateau despite high cost-effectiveness, indicating the importance of other factors in behavior besides bill savings.[1] This can be due to several factors including customer resistance and limited availability of premium features, such as the ability to dim.

Ideally the PCT will be performed using the marginal retail rate avoided by the customer. In practice the PCT is often performed using the utility's average rates for an applicable customer class. With tiered and TOU rates, the marginal rate paid by individual customers can vary significantly, which makes the use of marginal rate savings in the PCT somewhat more difficult. Furthermore, the impact of energy efficiency on a customer's peak load is difficult to predict, making changes in customer demand charges hard to estimate. In practice, the level of effort required to estimate the customers' actual savings given their consumption profile and applicable rate schedule is significant. Often utilities find it is not worth the effort at the program design or evaluation level, though it may be useful for individual customer audits. Thus the PCT gives an indication of the direct cost-based incentives for customers to participate in a given energy efficiency program.

6.2 Program Administrator Cost Test

The PACT examines the costs and benefits of the energy efficiency program from the perspective of the entity implementing the program (utility, government agency, nonprofit, or other third party). The costs included in the PACT include overhead and incentive costs. Overhead costs are administration, marketing, research and development, evaluation, and measurement and verification.[2] Incentive costs are payments made to the customers to offset purchase or installations costs (mentioned earlier in the PCT as benefits).[3] The benefits from the utility perspective are the savings derived from not delivering the energy to customers. Depending on the jurisdiction and type of utility, the "avoided costs" can include reduced wholesale electricity or natural gas purchases, generation costs, power plant construction, transmission and distribution facilities, ancillary service and system operating costs, and other components.[4] These elements are discussed in more detail in Chapter 4. The benefits and costs included in the PACT are summarized in Table 6-2.

Table 6-2. Benefits and Costs Included in the Program Administrator Test

Benefits and Costs to the Utility, Government Agency, or Third Party Implementing the Program	
Benefits	**Costs**
▪ Energy-related costs avoided by the utility ▪ Capacity-related costs avoided by the utility, including generation, transmission, and distribution	▪ Program overhead costs ▪ Utility/program administrator incentive costs ▪ Utility/program administrator installation costs

Source: Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects.

The PACT allows utilities to evaluate costs and benefits of energy efficiency programs (and/or demand response and distributed generation) on a comparable basis with supply-side investments. A positive PACT indicates that energy efficiency programs are lower-cost approaches to meeting load growth than wholesale energy purchases and new generation resources (including delivery and system costs). States with large needs for new supply resources may emphasize the PACT to build efficiency alternatives into procurement planning.[5]

> A positive PACT indicates that the total costs to save energy are less than the costs of the utility delivering the same power. A positive PACT also shows that customer average bills will eventually go down if efficiency is implemented.

6.2.1 Additional Considerations

The PACT provides an estimate of energy efficiency costs as a utility resource. Even the most comprehensive avoided cost estimates cannot capture all of the attributes of energy valued by the utility. In addition, the PACT only includes the program administrator costs and not those costs borne by customers. Therefore the PACT may not be seen as sufficiently comprehensive as a primary determinant of cost-effectiveness.

As with all of the cost-effectiveness tests, there are simplifications made in the calculation that should be understood when they are applied. For example, the PACT does not incorporate the different regulatory and financial treatment of utility investments in energy efficiency versus utility infrastructure. Therefore, while the PACT provides an estimate of energy efficiency as a resource, a positive PACT result does not imply that a utility will be better off financially. Finally, in order to get meaningful results on the PACT, care must be taken to estimate the actual resource savings to the utility from the energy efficiency program, including the timing and certainty of load reductions and the resulting impact on the utility supply costs.

Since the PACT includes the full savings to the utility but not the full costs of purchasing and installing the energy efficiency measures (which are paid by participants), the PACT is usually the easiest cost-effectiveness test to pass. In the SCE program featured in Appendix C, for example, the PACT ratio is 9.9—a higher value than that produced by any other cost-effectiveness test.

> Jurisdictions seeking to increase efficiency implementation may choose to emphasize the PACT, which compares energy efficiency as a utility investment on par with other resources. Because the PACT includes only utility costs (and not customer contributions), the PACT is often the most permissive (and most positive) cost-effectiveness test.

6.3 Ratepayer Impact Measure

The RIM examines the impact of energy efficiency programs on utility rates. Unlike typical supply-side investments, energy efficiency programs reduce energy sales. Reduced energy sales can lower revenues and put upward pressure on retail rates as the remaining fixed costs are spread over fewer kWh. The costs included in the RIM are program overhead and incentive payments and the cost of lost revenues due to reduced sales.[6] The benefits included in the RIM are the avoided costs of energy saved through the efficiency measure (same as the PACT). Table 6-3 outlines the benefits and costs included in the RIM.

Table 6-3. Benefits and Costs Included in the Rate Impact Measure Test

Benefits and Costs to Ratepayers Overall; Would Rates Need to Increase?	
Benefits	**Costs**
▪ Energy-related costs avoided by the utility ▪ Capacity-related costs avoided by the utility, including generation, transmission, and distribution	▪ Program overhead costs ▪ Utility/program administrator incentive costs ▪ Utility/program administrator installation costs ▪ Lost revenue due to reduced energy bills

Source: Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects.

Note: The PACT and the RIM use the same benefits.

The RIM also gives an indication of the distributional impacts of efficiency programs on non-participants. Participants may see net benefits (by lowering their bills through reduced energy consumption) while non-participating customers may experience rate increases due to the same programs. As the impacts on non-participating customers depend on many factors including the timing of adjustments to rates, the RIM is only an approximation of these impacts.

> The RIM answers the question, “All other things being equal, what is the impact of the energy efficiency program on utility rates if they were to be adjusted to account for the program?” A negative RIM implies that rates would need to increase for the utility to achieve the same level of earnings in the short term.[7]

In the vast majority of cases, the RIM is negative since the retail rate is typically higher than the utility’s avoided cost. The RIM may be negative, even at the same time as average bills decrease (as evaluated using the PACT). Therefore, policy-makers have to decide whether to emphasize customer bills by using the PACT or customer rates by using the RIM.[8] The main reason cited for use of the RIM is to protect customer classes. Chapter 2 of the National Action Plan for Energy Efficiency Report (National Action Plan for Energy Efficiency, 2006) suggests effective ways to protect customer groups from rate increases in the rate design process that do not limit the use of energy efficiency. As described in Section 5.1 above, most jurisdictions do not choose the RIM as a primary test; many use it as a secondary consideration, if at all.[9]

6.3.1 Additional Considerations

It is sometimes observed that even least-cost utility investments made to maintain reliability often lead to a rate increase, yet the RIM has not been applied to these initiatives. One key consideration in assessing the RIM is that there is typically an allocation of fixed costs in the variable $/kWh rate. The fixed costs included in rates reflect the utility's existing revenue requirement and do not necessarily reflect future capital costs avoided through energy efficiency. Customers are often resistant to high fixed charges and lumpy utility investments are not always considered avoidable through efficiency savings that are realized gradually over time. In addition, avoided costs are often based on market prices, which tend to emphasize variable and short-term as opposed to long-term costs. Because many utilities have multiple standard, tiered, and TOU rate options, the actual marginal revenue loses to the utility can be difficult to estimate and not accurately captured when customer class average rates are used in the RIM calculation. Other considerations in the RIM, including the relationship to utility financial health over time and capacity-focused programs that yield higher RIM results, are discussed in further detail in Section 3.2.2 above.

> The RIM is the most restrictive of the five cost-effectiveness tests. When the utility's retail rates are higher than its avoided costs, the RIM will almost always be negative. Thus policy-makers may choose to emphasize the PACT and use the RIM as a secondary consideration for balancing the distribution of rate impacts.

6.4 Total Resource Cost Test

The TRC measures the net benefits of the energy efficiency program for the region as a whole. Costs included in the TRC are costs to purchase and install the energy efficiency measure and overhead costs of running the energy efficiency program. The benefits included are the avoided costs of energy (as with the PACT and the RIM). Table 6-4 outlines the benefits and costs in the TRC.

Table 6-4. Benefits and Costs Included in the Total Resource Cost Test

Benefits and Costs from the Perspective of All Utility Customers (Participants and Non-Participants) in the Utility Service Territory	
Benefits	**Costs**
▪ Energy-related costs avoided by the utility ▪ Capacity-related costs avoided by the utility, including generation, transmission, and distribution ▪ Additional resource savings (e.g., gas and water if utility is electric) ▪ Monetized environmental and non-energy benefits (see Section 4.9) ▪ Applicable tax credits (see text)	▪ Program overhead costs ▪ Program installation costs ▪ Incremental measure costs (whether paid by the customer or the utility)

Source: Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects.

The primary purpose of the TRC is to evaluate the net benefits of energy efficiency measures to the region as a whole. Unlike the tests describe above, the TRC does not take the view of individual stakeholders. It does not include bill savings and incentive payments, as they yield an intra-regional transfer of zero ("benefits" to customers and "costs" to the utility that cancel each other on a regional level). For some utilities, the region considered may be limited strictly to its own service territory, ignoring benefits (and costs) to neighboring areas (a distribution-only utility may, for example, consider only the impacts to its distribution system). In other cases, the region is defined as the state as a whole, allowing the TRC to include benefits to other stakeholders (e.g., other utilities, water utilities, local communities). The TRC is useful for jurisdictions wishing to value energy efficiency as a resource not just for the utility, but for the entire region. Thus the TRC is often the primary test considered by those states seeking to include the benefits not just to the utility and its ratepayers, but to other constituents as well. The TRC may be considered the sum of the PCT and RIM, that is, the participant and non-participant cost-effectiveness tests. The TRC is also useful when energy efficiency might fall through the cracks taken from the perspective of individual stakeholders, but would yield benefits on a wider regional level.[10]

The inclusion of tax credits or incentives depends to some extent on the region considered. A municipal utility might consider state and federal tax incentives as a benefit from outside the region defined for the TRC. For a utility with a service territory that includes all or most of a particular state, state tax incentives would be an intra-regional transfer that is not included in the TRC. Some jurisdictions chose to consider all tax incentives as transfers excluded from the TRC. Generally speaking, tax incentives in the TRC should be treated consistently with the other resources to which energy efficiency may be compared.

> The TRC shows the net benefits of the energy efficiency program as a whole. It can be used to evaluate energy efficiency alongside other regional resources and communicate with other planning agencies and constituencies.

6.4.1 Additional Considerations

The TRC is similar to the PACT except that it considers the cost of the measure itself rather than the incentive paid by the utility. Because the incentives are less than the cost of the measure in most cases, the TRC is usually lower than the PACT. Therefore, the TRC will be a more restrictive test than the PACT and fewer measures will pass the TRC. Indeed, it is not unusual for a measure to fail the TRC while appearing economical both to the utility (PACT) and to the participant (PCT). Due to the incentives paid by the utility, the participant and the utility each pay only a portion of the full incremental cost of the measure, which is the cost to the region as a whole considered by the TRC.

The TRC says nothing about the distributional impacts of the costs of energy efficiency. To address distributional effects, many jurisdictions that use the TRC as the primary criteria also look at other cost-effectiveness tests. In situations where budgets constrain the amount of energy efficiency investment, a threshold value may be used. A lower threshold may be applied to programs that serve low-income or hard-to-reach groups, representing the distinct societal value of reaching these customer groups that is not reflected in the benefit-cost calculation.

> The TRC is more restrictive than the PACT because it includes the full cost of the energy efficiency measure and not just the incentives paid by the utility. As a result, a program may have a positive PACT and PCT but still not pass the TRC, because the utility and customer pay a fraction of the total measure cost that is included in the TRC.

6.5 Societal Cost Test

The SCT includes all of the costs and benefits of the TRC, but it also includes environmental and other non-energy benefits that are not currently valued by the market. The SCT may also include non-energy costs, such as reduced customer comfort levels. Table 6-5 outlines the benefits and costs in the SCT.

Table 6-5. Benefits and Costs Included in the Societal Cost Test

Benefits and Costs to All in the Service Territory, State, or Nation as a Whole	
Benefits	**Costs**
▪ Energy-related costs avoided by the utility ▪ Capacity-related costs avoided by the utility, including generation, transmission, and distribution ▪ Additional resource savings (e.g., gas and water if utility is electric) ▪ Non-monetized benefits (and costs) such as cleaner air or health impacts	▪ Program overhead costs ▪ Program installation costs ▪ Incremental measure costs (whether paid by the customer or the utility)

Source: Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects.

In some cases, emissions costs are included in the market price used to determine avoided costs or are otherwise explicitly included in the TRC calculation (as in the SCE program example[11]). Emissions permit costs may already be included in the market price of electricity in some jurisdictions. In other jurisdictions, emissions are included in the SCT.[12]

As with the TRC, the inclusion of tax incentives varies by jurisdiction. Those using a broad definition of the society exclude tax incentives as a transfer. Others will include tax incentives originating from outside the immediate region considered.

> The SCT includes costs and benefits beyond the immediate region and those that are not monetized in the TRC, such as environmental benefits or GHG reductions.

6.5.1 Additional Considerations

Increasingly, benefits historically included only in the SCT are being included in the TRC in some jurisdictions. Including a cost for carbon dioxide (CO_2) emissions is a prime example. Though the future cost associated with CO_2 emissions remains highly uncertain and difficult to quantify, many utilities believe it is increasingly unlikely that the cost will be zero. In California, an approximate forecast is developed through a survey of available studies and literature. The IRPs of many utilities now include a risk or portfolio analysis to calculate an "expected" carbon value or to determine if the additional cost of a flexible portfolio is sufficiently robust under a range of possible futures.

Water savings are also being explicitly included in the TRC instead of the SCT. This helps promote measures such as front-loading clothes washers, which provide water savings that are of value to the region but beyond the direct purview of electric and natural gas utilities. There is also increasing interest in the West, where water supply is particularly energy intensive, in targeting the energy savings possible through water conservation.[13]

Some commissions eschew the SCT because factors not included in the TRC are found to be beyond their jurisdiction. Where this is the case, legislation would be needed to create or clarify the opportunity for commissions to consider the SCT. On the other hand, some states require that the societal test be considered when commissions evaluate energy efficiency programs. Some states adopt the California methodology, while other states adopt modified versions, adding or deleting costs or benefits consistent with state priorities. For example, Illinois uses a modified TRC defined in statute, in which gas savings are not included in electricity program evaluation. The New York State Energy Research and Development Authority (NYSERDA) calculates the TRC for three scenarios, adding non-energy benefits in Scenario 2 and macroeconomic benefits in Scenario 3.

> Energy efficiency is among the most cost-effective ways to reduce carbon emissions. The SCT is a useful test for jurisdictions seeking to implement or comply with GHG reduction goals. It can also be used to evaluate water savings.

6.6 Notes

[1] The PCT is only one of the determinants of customer participation, and bill savings are not the sole factor in a customer's decision to implement energy efficiency. Marketing and customer decision-making studies can be used to better understand the levels of customer participation more directly. See Golove and Eto, 1996; Schleich and Gruber, 2008.

[2] At a minimum, overhead costs generally include the salary (and benefits) of those employees directly involved in promoting energy efficiency. Some jurisdictions opt to include an allocation of fixed costs (i.e., office space) while others do not. To the extent they are applicable, research and development, marketing, evaluation, measurement, and verification and other costs may be included in the overall total, or reported individually as they are for the SCE example shown here. In cases where energy efficiency program costs are subject to special treatment (e.g., public funding and shareholder incentive mechanisms), detailed definitions of what may be included as an overhead cost are often required.

[3] The simplest example is a rebate paid to the customer for the purchase of an efficient appliance. However, as programs have grown in scope and complexity, so has the definition of an incentive. Two additional types of incentive are common: direct install costs and upstream payments. In many cases, the utility performs or pays for the labor and installation associated with an efficiency measure. Such payments, which are not for the equipment itself, but nevertheless reduce the cost to the customer, are considered direct install costs. Another approach, which is now common for CFL programs, calls for utilities to pay incentives directly to manufacturers and distributors. These upstream payments lower the retail cost of the product, though no rebate is paid directly to the customer.

[4] Avoided cost benefits vary according to the time and location of the energy savings. Chapter 5 describes various alternative approaches for estimating the benefits of energy efficiency.

[5] A specialized application of the PACT is in local IRPs. When a local area is at or near the system's capacity to serve its load, significant infrastructure investments are often required. If such investments can be deferred by reducing loads or load growth, there is additional value to the utility in installing energy efficiency and other distributed resources in that area. The additional savings that can be realized by the utility can justify increased customer incentives and marketing for a targeted efficiency program.

[6] The RIM, PACT, and PCT assess the impacts of the program from different, but interconnected stakeholder perspectives. The RIM includes the overhead and incentive payments included as costs in the PACT, but also includes revenue losses. The RIM recognizes the incentives and bill savings reported as benefits in the PCT, but the RIM reports these terms as costs (revenues losses).

[7] Even with a negative RIM result, efficiency may still be the most cost-effective means of meeting load growth. The full array of long-term investment options considered in utility resource planning cannot always be captured in the avoided costs used to evaluate energy efficiency.

[8] The exception to the predominance of the negative RIM result are utilities that can serve most of their loads with existing, low-cost generation, but are facing high costs to build new generation. In such cases, the avoided costs for energy efficiency may well be higher that the utility's retail rates.

[9] In practice, since utility rates are often frozen between rate-setting cycles and not continuously reset, the utility itself absorbs the losses (or gains) in its earnings until rates are adjusted. These adjustments can be made in several ways: the regular rate-setting cycle, a decoupling mechanism, or a revenue adjustment mechanism. In the long run, the reduced capital investments necessary as a result of energy efficiency will mitigate the rate increases. The National Action Plan for Energy Efficiency's Energy Efficiency Benefits Calculator can evaluate these impacts over time: <http://www.epa.gov/cleanenergy/energy-programs/napee/resources/calculator.html>.This is discussed in more detail in Chapter 4.

[10] As an example, in areas of competitive procurement, distribution-only utilities may not see energy efficiency as an immediate interest because it may not yield significant T&D savings (and generation costs are not part of their purview). In such a case, the utility may not implement energy efficiency even if it is cost-effective from a regional perspective. As a result, regulators may ask the utility to focus on the TRC rather than the PACT when evaluating efficiency programs.

[11] California includes emissions permits and trading costs in the avoided cost calculations of the TRC.

[12] Tax incentives paid by the state or federal governments and financing costs are excluded from the SCT, because they are considered a zero net transfer. A wide range of NEBs have been considered and evaluated throughout the United States. For the participant and community, these NEBs resulted in increased comfort, improved air quality, greater convenience, and improved health and aesthetic benefits. For the utility, fewer shut-off notices or bill complaints occurred.

[13] The California Public Utilities Commission has approved pilot programs for investor-owned utilities to partner with water agencies and provide funding for water conservation incentives that provide energy savings (A.07-01-024).

Appendix A: National Action Plan for Energy Efficiency Leadership Group

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President, National Association of Regulatory Utility Commissioners

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Chairman, President, and C.E.O.
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Entergy Corporation

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Office of the Ohio Consumers' Counsel

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Brock Nicholson
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Jed Nosal
Chief, Office of Ratepayer Advocacy
Massachusetts Office of Attorney General Martha Coakley

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Washington Utilities and Transportation Commission

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Energy Programs Consortium

Lisa Wood
Executive Director
Institute for Electric Efficiency

Facilitators

U.S. Department of Energy

U.S. Environmental Protection Agency

Appendix B: Glossary

Avoided costs: The forecasted economic benefits of energy savings. These are the costs that would have been spent if the energy efficiency had not been put in place.

Discount rate: A measure of the time value of money. The choice of discount rate can have a large impact on the cost-effectiveness results for energy efficiency. As each cost-effectiveness test compares the net present value of costs and benefits for a given stakeholder perspective, its computation requires a discount rate assumption.

Energy efficiency: The use of less energy to provide the same or an improved level of service to the energy consumer in an economically efficient way. “Energy conservation” is a term that has also been used, but it has the connotation of doing without in order to save energy rather than using less energy to perform the same or better function.

Evaluation, measurement, and verification: The process of determining and documenting the results, benefits, and lessons learned from an energy efficiency program. The term “evaluation” refers to any real time and/or retrospective assessment of the performance and implementation of a program. “Measurement and verification” is a subset of evaluation that includes activities undertaken in the calculation of energy and demand savings from individual sites or projects.

Free rider: A program participant who would have implemented the program measure or practice in the absence of the program.

Impact evaluation: Used to determine the actual savings achieved by different programs and specific measures.

Integrated resource planning: A public planning process and framework within which the costs and benefits of both demand- and supply-side resources are evaluated to develop the least-total-cost mix of utility resource options. In many states, integrated resource planning includes a means for considering environmental damages caused by electricity supply/transmission and identifying cost-effective energy efficiency and renewable energy alternatives.

Levelized cost: A constant value or payment that, if applied in each year of the analysis, would result in a net present value equivalent to the actual values or payments which change (usually increase) each year. Often used to represent, on a consistent basis, the cost of energy saved by various efficiency measures with different useful lives.

Marginal cost: The sum that has to be paid for the next increment of product or service. The marginal cost of electricity is the price to be paid for kilowatt-hours above and beyond those supplied by presently available generating capacity.

Marginal emission rates: The emissions associated with the marginal generating unit in each hour of the day.

Market effects evaluation: Used to estimate a program's influence on encouraging future energy efficiency projects because of changes in the energy marketplace. All categories of programs can have market effects evaluations; however, these evaluations are primarily associated with market transformation programs that indirectly achieve impacts.

Market transformation: A reduction in market barriers resulting from a market intervention, as evidenced by a set of market effects, that lasts after the intervention has been withdrawn, reduced, or changed.

Measures: Installation of equipment, installation of subsystems or systems, or modification of equipment, subsystems, systems, or operations on the customer side of the meter, in order to improve energy efficiency.

Net-to-gross ratio: A key requirement for program-level evaluation, measurement, and verification. This ratio accounts for only those energy efficiency gains that are attributed to, and the direct result of, the energy efficiency program in question. It gives evaluators an estimate of savings that would have occurred even without program incentives.

Net present value: The value of a stream of cash flows converted to a single sum in a specific year, usually the first year of the analysis. It can also be thought of as the equivalent worth of all cash flows relative to a base point called the present.

Nominal: For dollars, "nominal" means the figure representing the actual number of dollars exchanged in each year, without accounting for the effect of inflation on the value or purchasing power. For interest or discount rates, "nominal" means that the rate includes the rate of inflation (real rate plus inflation rate equals the nominal rate).

Participant cost test: A cost-effectiveness test that measures the economic impact to the participating customer of adopting an energy efficiency measure.

Planning study: A study of energy efficiency potential used by demand-side planners within utilities to incorporate efficiency into an integrated resource planning process. The objective of a planning study is to identify energy efficiency opportunities that are cost-effective alternatives to supply-side resources in generation, transmission, or distribution.

Portfolio: Either (a) a collection of similar programs addressing the same market, technology, or mechanisms or (b) the set of all programs conducted by one organization.

Potential study: A study conducted to assess market baselines and energy efficiency savings potentials for different technologies and customer markets. Potential is typically defined in terms of technical, economic, achievable, and program potential.

Program administrators: Typically procure various types of energy efficiency services from contractors (e.g., consultants, vendors, engineering firms, architects, academic institutions, community-based organizations), as part of managing, implementing, and evaluating their portfolio of energy efficiency programs. Program administrators in many states are the utilities; in some states they are state energy agencies or third parties.

Program design potential study: Can be undertaken by a utility or third party for the purpose of developing specific measures for the energy efficiency portfolio.

Ratepayer impact measure: A cost-effectiveness test that measures the impact on utility operating margin and whether rates would have to increase to maintain the current levels of margin if a customer installed energy efficient measures.

Real: For dollars, "real" means that the dollars are expressed in a specific base year in order to provide a consistent means of comparison after accounting for inflation. For interest and discount rates, "real" means the inflation rate is not included (the nominal rate minus the inflation rate equals the real rate).

Societal cost test: A cost-effectiveness test that measures the net economic benefit to the utility service territory, state, or region, as measured by the total resource cost test, plus indirect benefits such as environmental benefits.

Time-of-use periods: Blocks of time defined by the relative cost of electricity during each block. Time-of-use periods are usually divided into three or four time blocks per 24-hour period (on-peak, mid-peak, off-peak, and sometimes super off-peak) and by seasons of the year (summer and winter).

Total resource cost test: A cost-effectiveness test that measures the net direct economic impact to the utility service territory, state, or region.

Utility/program administrator cost test: The program administrator cost test, also known as the utility cost test, is a cost-effectiveness test that measures the change in the amount the utility must collect from the customers every year to meet an earnings target—e.g., a change in revenue requirement. In a number of states, this test is referred to as the program administrator cost test. In those cases, the definition of the "utility" is expanded to program administrators (utility or third party).

Appendix C: Cost-Effectiveness Tables of Best Practice Programs

Southern California Edison Residential Incentive Program

SCE's Residential Energy Efficiency Incentive Program provides customer incentives for efficient lighting and appliances (not including HVAC). It is part of a coordinated statewide mass market efficiency program that coordinates marketing and outreach efforts. This program is used as the example in Section 3.1 to illustrate the calculation of each of the cost-effectiveness tests.

The values shown in Tables C-1, C-2 and C-3 are for the fourth quarter of 2006. Note that dollar benefits associated with emissions reductions are included in the forecasted avoided cost of energy, and are therefore not separately reported. The other category in this case includes direct implementation activity costs incurred by SCE that are over and above the cost of the efficiency measure. Direct installation costs paid by the utility that offset the cost of the measure are included under "program incentives."

Table C-1. SCE Program Costs

Cost Inputs			Var.
Program overhead			
Program administration	$	898,548	
Marketing and outreach	$	559,503	
Rebate processing	$	1,044,539	
Research and development		—	
Evaluation, measurement, and verification		—	
Shareholder incentive		—	
Other	$	992,029	
Total program administration	**$**	**3,494,619**	**O**
Program incentives			
Rebates and incentives	$	1,269,393	
Direct installation costs	$	564,027	
Upstream payments	$	13,624,460	
Total incentives	**$**	**15,457,880**	**I**
Total program costs	**$**	**18,952,499**	
Net measure equipment and installation	**$**	**41,102,993**	**M**

Source: SCE 4TH Quarter 2006 EE Report & Program Calculators,
<http://www.sce.com/AboutSCE/Regulatory/eefilings/Quarterly.htm>.

Table C-2. SCE Program Benefits

Net Benefit Inputs				Var.
Resource savings	**Units**		**$**	
Energy (MWh)	2,795,290	$	187,904,906	
Peak demand (kW)	55,067		—	
Total electric	—	$	187,904,906	
Natural gas (MMBtu)	—		—	
Total resource savings		**$**	**187,904,906**	**S**
Participant bill savings	Electric	$	278,187,587	**B**
	Gas		—	
Monetized emission savings	**Tons**			
NO_x	421,633		—	
SO_x	—		—	
PM_{10}	203,065		—	
CO_2	1,576,374		—	
Total emissions		$	—	**E**
Non-monetized emissions (externalities)	**Tons**			
NO_x	—		—	
SO_x	—		—	
PM_{10}	—		—	
CO_2	—		—	
Total emissions			—	**EXT**
Non-energy benefits		$	—	**NEB**

Source: SCE 4TH Quarter 2006 EE Report & Program Calculators, <http://www.sce.com/AboutSCE/Regulatory/eefilings/Quarterly.htm>.

Table C-3. SCE Program Cost-Effectiveness Test Results

Summary of Cost-Effectiveness Results

Lifecycle costs and benefits

Test	Cost	Benefits	Ratio
PCT	$ 41,102,993	$ 293,645,467	7.14
PAC	$ 18,952,499	$ 187,904,906	9.91
RIM	$ 297,140,086	$ 187,904,906	0.63
TRC	$ 44,597,612	$ 187,904,906	4.21
SCT	$ 44,597,612	$ 187,904,906	4.21

Costs and benefits included in each test

PCT	= M	= B + I
PAC	= O + I	= S
RIM	= O + I + B	= S
TRC	= O + M	= S + E
SCT	= O + M	= S + E + EXT + NEB

Estimated levelized costs and benefits

Test	Cost $/kWh	Benefits $/kWh
PCT	$0.026	$0.184
PAC	$0.012	$0.117
RIM	$0.186	$0.117
TRC	$0.028	$0.117
SCT	$0.028	$0.117

Assumptions for levelized calculations

Average measure life	14
WACC	8.50%
Discount factor for savings	57%

Source: SCE 4TH Quarter 2006 EE Report & Program Calculators, <http://www.sce.com/AboutSCE/Regulatory/eefilings/Quarterly.htm>.

Note: The discount factor uses an estimate of average measure life and the utility weighted average cost of capital to convert the net present value of costs and benefits into levelized annual figures. The levelized annual costs and benefits are then used to calculate costs and benefits on a $/kWh basis.

Avista Regular Income Programs

Avista is an electric and natural gas utility in the Northwest with headquarters in Spokane, Washington. The best practice program highlighted here represents the 2007 Regular Income Portfolio of electricity energy efficiency measures implemented by Avista. The numbers were obtained from the Triple-E Report produced by the Avista Demand-Side Management Team (Table 13E).

Avista reports gross results, which do not take free riders into account. Installation rates, persistence/failure and rebound (“snap-back” or “take-back”) are taken into account in Avista’s estimates of energy savings. Avista does consider NEBs when they are quantifiable and defensible, which are predominately benefits from the customer’s perspective.

Avista contributed to projects saving over 53 million kWh and 1.5 million therms in 2007. The HVAC and lighting categories made up 81 percent of the electric savings while 97 percent of the natural gas savings were in the HVAC and Shell categories.

Avista incorporates quantifiable labor and operation and maintenance as non-energy benefits, which are included in the PCT, SCT, and TRC cost-effectiveness tests.

Table C-4. Avista Program Costs

Cost Inputs			Var.
Program overhead			
Program administration	$	2,564,894	
Marketing and outreach		—	
Rebate processing		—	
Research and development		—	
Evaluation, measurement, and verification		—	
Shareholder incentive		—	
Other		—	
Total program administration	**$**	**2,564,894**	**O**
Program incentives			
Rebates and incentives	$	4,721,881	
Direct installation costs		—	
Upstream payments		—	
Total incentives	**$**	**4,721,881**	**I**
Total program costs	**$**	**7,286,775**	
Net measure equipment and installation	**$**	**16,478,257**	**M**

Source: Avista Triple-E Report , January 1, 2007—December 31, 2007.

Table C-5. Avista Program Benefits

Net Benefit Inputs				Var.
Resource savings	**Units**		**$**	
Energy (MWh)	—	$	30,813,091	
Peak demand (kW)	—		—	
Total electric	—	$	30,813,091	
Natural gas (MMBtu)	—	$	(355,426)	
Total resource savings		$	**30,457,665**	**S**
Participant bill savings	Electric	$	28,782,475	**B**
	Gas	$	(630,028)	
Monetized emission savings	**Tons**			
NO_x	—		—	
SO_x	—		—	
PM_{10}	—		—	
CO_2	—		—	
Total emissions		$	—	**E**
Non-monetized emissions (externalities)	**Tons**			
NO_x	—		—	
SO_x	—		—	
PM_{10}	—		—	
CO_2	—		—	
Total emissions			—	**EXT**
Non-energy benefits		$	12,595,276	**NEB**

Source: Avista Triple-E Report , January 1, 2007—December 31, 2007.

Table C-6. Avista Program Cost-Effectiveness Test Results

Summary of Cost-Effectiveness Results			
Lifecycle costs and benefits			
Test	**Cost**	**Benefits**	**Ratio**
PCT	$ 11,756,376	$ 40,747,723	3.47
PAC	$ 7,286,775	$ 30,457,665	4.18
RIM	$ 36,069,250	$ 30,813,091	0.85
TRC	$ 19,043,151	$ 43,052,941	2.26
SCT	$ 19,043,151	$ 43,052,941	2.26
Costs and benefits included in each test			
PCT	= M - I	= B + NEB	
PAC	= O + I	= S	
RIM	= O + I + B	= S	
TRC	= O + M	= S + E + NEB	
SCT	= O + M	= S + E + EXT + NEB	
Assumptions for levelized calculations			
Average measure life		14	
WACC		8.50%	
Discount factor for savings		57%	

Source: Avista Triple-E Report , January 1, 2007—December 31, 2007.

Puget Sound Energy Commercial/Industrial Retrofit Program

Puget Sound Energy's (PSE's) Commercial/Industrial Retrofit Program encourages customers to use electric and natural gas efficiently by installing cost- and energy-efficient equipment, adopting energy efficient designs, and using energy-efficient operations at their facilities. In addition, incentives are available for fuel switch measures that convert from electric to natural gas while serving the same end use. Applicable Commercial and Industrial Retrofit measure category headings include, but are not limited to: HVAC and refrigeration, controls, process efficiency improvements, lighting improvements, building thermal improvements, water heating improvements, and building commissioning.

Customers provide PSE with project costs and estimated savings. Customers assume full responsibility for selecting and contracting with third-party service providers. Projects must be approved for funding prior to installation/implementation. Maximum grants for hardware changes are based on PSE's cost-effectiveness standard. Grants for projects are made available as a percentage of the measure cost. Electric and gas measures may receive incentive grants up to 70 percent of the measure cost where the grant incentive does not exceed the cost-effectiveness standard minus program administration costs. Measures exceeding the cost-effectiveness standard will receive grants that are on a declining scale and will be less than 70 percent of the measure cost. Electric and gas measures that have a simple payback of less than a year are not eligible for a grant incentive.

Unlike the other programs presented in this document, PSE shows a positive RIM. A positive RIM is possible in the Pacific Northwest because of the allocation of low-cost hydro generation from the Bonniville Power Administration to municipal utilities. In some cases the marginal cost of avoided generation is determined by higher-cost thermal generation and is higher than the utility's average retail rate.

Table C-7. PSE Program Costs

Cost Inputs			Var.
Program overhead			
Program administration	$	2,745,048	
Marketing and outreach		—	
Rebate processing		—	
Research and development		—	
Evaluation, measurement, and verification		—	
Shareholder incentive		—	
Other		—	
Total program administration	**$**	**2,745,048**	**O**
Program incentives			
Rebates and incentives	$	9,914,463	
Direct installation costs		—	
Upstream payments		—	
Total incentives	**$**	**9,914,463**	**I**
Total program costs	**$**	**12,659,511**	
Net measure equipment and installation	**$**	**25,103,588***	**M**

Source: Data provided by Laura Feinstein at PSE.

* Total value

Table C-8. PSE Program Benefits

Net Benefit Inputs				Var.
Resource savings	**Units**		**$**	
Energy (MWh)	775,469	$	50,465,421	
Peak demand (kW)	—		—	
Total electric	—	$	50,465,421	
Natural gas (MMBtu)	661,480	$	2,575,451	
Total resource savings		**$**	**53,040,873**	**S**
Participant bill savings	Electric	$	33,297,727	**B**
	Gas		—	
Monetized emission savings	**Tons**			
NO_x	—		—	
SO_x	—		—	
PM_{10}	—		—	
CO_2	1,576,374		—	
Total emissions		$	—	**E**
Non-monetized emissions (externalities)	**Tons**			
NO_x	—		—	
SO_x	—		—	
PM_{10}	—		—	
CO_2	—		—	
Total emissions			—	**EXT**
Non-energy benefits		$	—	**NEB**

Source: Data provided by Laura Feinstein at PSE.

Table C-9. PSE Program Cost-Effectiveness Test Results

Summary of Cost-Effectiveness Results			
Lifecycle costs and benefits			
Test	**Cost**	**Benefits**	**Ratio**
PCT	$ 25,103,588	$ 43,212,190	1.72
PAC	$ 12,659,511	$ 53,040,873	4.19
RIM	$ 45,957,238	$ 53,040,873	1.15
TRC	$ 27,848,636	$ 53,040,873	1.90
SCT	$ 27,848,636	$ 53,040,873	1.90
Costs and benefits included in each test			
PCT	= M	= B + I	
PAC	= O + I	= S	
RIM	= O + I + B	= S	
TRC	= O + M	= S + E	
SCT	= O + M	= S + E + EXT + NEB	
Estimated levelized costs and benefits			
Test	**Cost $/kWh**	**Benefits $/kWh**	
PCT	$0.05	$0.09	
PAC	$0.03	$0.11	
RIM	$0.10	$0.11	
TRC	$0.06	$0.11	
SCT	$0.06	$0.11	
Test	**Cost $/Therm**	**Benefits $/Therm**	
PCT	$3.22	$5.54	
PAC	$1.62	$6.80	
RIM	$5.90	$6.80	
TRC	$3.57	$6.80	
SCT	$3.57	$6.80	
Assumptions for levelized calculations			
Average measure life		14	
WACC		8.50%	
Discount factor for savings		57%	

Source: Data provided by Laura Feinstein at PSE.

National Grid MassSAVE Program

The Massachusetts MassSAVE program is a residential conservation program targeting electricity and natural gas savings. The data shown in the tables that follow are taken from the National Grid 2006 Energy Efficiency Annual Report, submitted to the Massachusettes Department of Energy Resources and Department of Public Utilities in August 2007.

In the residential sector, there are diminishing energy savings available from single-measure incentive programs, in part due to federal appliance and lighting standards, as well as rapid progress in increasing the market penetration of CFLs relative to incandescent lighting. As a result, more utilities are seeking to develop program models that tackle harder-to reach opportunities and offer more comprehensive savings. National Grid's Home Performance with ENERGY STAR is one such program model. This program offers comprehensive whole-house improvements (insulation, air sealing, duct sealing, and HVAC improvements) for homeowners. Customers receive in-home services, step-by-step guidance, incentives for energy measures, quality installations and inspections, and low-interest financing.

Since contractors that deliver home performance services are in short supply in most markets, an infrastructure building phase is typically needed. During the initial two- to three-year startup phase, program costs may be high relative to energy savings. However, as contracting services increase over time, energy savings tend to increase dramatically. Limiting cost-effectiveness tests to three-year program cycles or less may inadvertently limit the development of these long-term, comprehensive program models. National Grid was able to reduce administrative costs associated with contractor recruitment, training, and quality assurance by limiting contractor participation in program startup and by requiring participating contractors to directly install some measures.

Comprehensive, whole-building program models such as Home Performance with ENERGY STAR may face a number of additional challenges using commonly employed practice for calculating cost-effectiveness. For example, installing air sealing and insulation reduce heating and cooling loads, which reduces the savings associated with installing efficient HVAC equipment (interactive effects; see Section 3.2.1). However, reduced heating and cooling loads can also provide opportunities for downsizing heating and cooling systems, which are not captured by the cost-effectiveness tests. Furthermore, whole-house improvements provide a variety of non-energy benefits (Section 4.9) that can be difficult to quantify and are often not included as benefits in the cost-effectiveness tests.

More information can be found online at <http://www.masssave.com/customers/>.

Table C-10. National Grid Program Costs

Cost Inputs			Var.
Program overhead			
Program administration	$	760,324	
Marketing and outreach	$	296,628	
Rebate processing		—	
Research and development		—	
Evaluation, measurement, and verification	$	134,077	
Shareholder incentive		—	
Other		—	
Total program administration	**$**	**1,191,029**	**O**
Program incentives			
Rebates and incentives	$	3,507,691	
Direct installation costs		—	
Upstream payments		—	
Total incentives	**$**	**3,507,691**	**I**
Total program costs	**$**	**4,698,720**	
Net measure equipment and installation	**$**	**2,452,985**	**M**

Source: Data provided by Lynn Ross at National Grid.

Table C-11. National Grid Program Benefits

Net Benefit Inputs				Var.
Resource Savings	**Units**		**$**	
Energy (MWh)	46,385	$	2,550,000	
Peak demand (kW)	6,921		3,328,000	
Total electric	—	$	5,878,000	
Natural gas (MMBtu)	655,547		6,506,048	
Total resource savings		**$**	**12,384,048**	**S**
Participant bill savings	Electric	$	679,800	**B**
	Gas		—	
Monetized emission savings	**Tons**			
NO_x	7		—	
SO_x	19		—	
PM_{10}	—		—	
CO_2	1,576,374		—	
Total emissions		$	—	**E**
Non-monetized emissions (externalities)	**Tons**			
NO_x	—		—	
SO_x	—		—	
PM_{10}	—		—	
CO_2	—		—	
Total emissions			—	**EXT**
Non-energy benefits		$	155,601	**NEB**

Source: Data provided by Lynn Ross at National Grid.

Table C-12. National Grid Program Cost-Effectiveness Test Results

Summary of Cost-Effectiveness Results			
Lifecycle costs and benefits			
Test	**Cost**	**Benefits**	**Ratio**
PCT	$ 2,452,985	$ 4,187,491	1.71
PAC	$ 4,698,720	$ 12,384,048	2.64
RIM	$ 5,378,520	$ 12,384,048	2.30
TRC	$ 7,151,705	$ 12,384,048	1.73
SCT	$ 7,151,705	$ 12,539,649	1.75
Costs and benefits included in each test			
PCT	= M	= B + I	
PAC	= O + I	= S	
RIM	= O + I + B	= S	
TRC	= O + M	= S + E	
SCT	= O + M	= S + E + EXT + NEB	
Estimated levelized costs and benefits			
Test	**Cost $/kWh**	**Benefits $/kWh**	
PCT	$0.04	$0.06	
PAC	$0.07	$0.18	
RIM	$0.08	$0.18	
TRC	$0.10	$0.18	
SCT	$0.10	$0.18	
Test	**Cost $/Therm**	**Benefits $/Therm**	
PCT	$2.79	$4.76	
PAC	$5.34	$14.08	
RIM	$6.11	$14.08	
TRC	$8.13	$14.08	
SCT	$8.13	$14.26	
Assumptions for levelized calculations			
Average measure life		8	
WACC		8.50%	
Discount factor for savings		70%	

Source: Data provided by Lynn Ross at National Grid.

Appendix D: References

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